SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 170

CHANGES IN THE TECHNICAL CONDITION OF VEHICLE BRAKES COMPARED TO 2014 YEAR

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Purpose: The purpose of the tests is to determine whether and to what extent there has been a change in the parameters of the car's braking system, assessed during the technical inspection.
Design/methodology/approach: Diagnostic tests were performed, braking force measurements on a roller device, the following were analyzed: differences in braking force on axle wheels, non-linear increases in braking force, deceleration of braking force, changes in the value of braking force.
Findings: Changes in the technical condition of vehicle braking systems in 2022 compared to 2014 were demonstrated.
Research limitations/implications: In the future, a trend line of changes in the technical condition of vehicle braking systems can be created.
Practical implications: In the course of the research, it was found that the technical tests made it possible to determine the direction of positive changes in the technical condition of the braking systems in the tested vehicles, which translates into vehicle safety in road traffic.
Originality/value: Changes in the condition of the brake system in 2022 compared to 2014.

Keywords: Safety and quality of transport, braking system, changes of conditions.

Category of the paper: Technical paper.

1. Introduction

The development of many different driver assistance systems in the area of traffic safety (Front assist, turn assistant, side assist etc.) (Kornacki, 2022), has not changed the brake system still remains a system that in the vast majority of road situations, determines the possibility of avoiding accidents.

According to the regulations (Rozporzadzenie Ministra Infrastruktury z dnia 31 grudnia…), vehicles moving on public roads must be equipped with a braking system that can be activated by at least two methods. Due to the methods of actuating the brakes in passenger cars, the following brake is distinguished:

- main - in most cases, foot operated by pressing the brake pedal. Braking only takes place while the brake pedal is depressed.
- emergency - the brake also works as a parking brake in order to prevent the vehicle from leaving the parking place. In case of a failure of the main brake, it is designed to brake the vehicle in an emergency. The emergency brake is activated by hand or foot, depending on the construction. It works from the moment it is turned on until it is turned off.

Testing the braking system during the annual technical tests of vehicles is a mandatory process and carried out in a strictly defined way (Dz.U. z 2015 r. poz. 776, Rozporządzenie Ministra Infrastruktury i Rozwoju z dnia 18 grudnia…).

According to the regulations, the acceptable methods of brake testing are roller stand and braking deceleration test. The results collected during the brake tests make it possible to calculate the so-called the braking rate.

Brake tests were carried out at a vehicle control station on another 100 passenger cars in 2014. Brake tests which a periodic technical inspection was carried out. The tests were carried out on a CARTEC BDE 3504 roller device. The tests were carried out with the use of a brake pedal pressure sensor.

The tests were carried out in the excatly described in the relevant Regulation (Dz.U. z 2015 r. poz. 776, Rozporządzenie Ministra Infrastruktury i Rozwoju z dnia 18 grudnia…).

The results obtained during the research were divided into nine groups. Eight groups of resulted from possible faults of the braking system, the occurrence of which necessitated the recognition of the system as out of order. The ninth group includes vehicles with the correct operation of the braking system. The collected results were as follows:

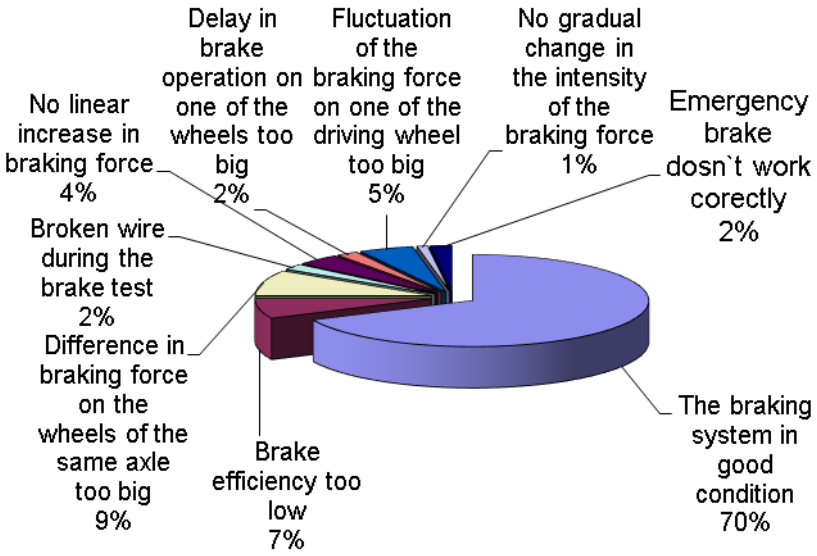

Figure 1. The results of the brake system test - the research carried out in 2014.
Source: Miros, 2014.

The testing of braking systems was extended to measure the boiling point of the brake fluid. The measurement was carried out in a brake fluid reservoir with the use of the WTM TPH-302 device.

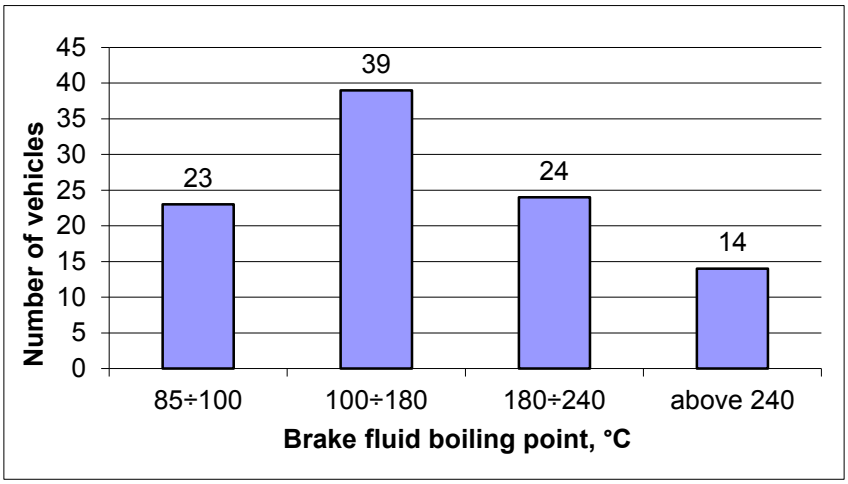

Figure 2. Brake fluid boiling point test - the research carried out in 2014.

Source: Miros, 2014.

A similar tests were carried out in 2022 at one of the Basic Vehicle Inspection Stations located in a medium-sized city in the Upper Silesian Industrial District.

2. Materials and research methods

The research carried out in the period from june to september 2022 was research, similarly to the research conducted and published in 2014, based on the guidelines for the operation of the braking system provided in the relevant Regulation (Dz.U. z 2015 r. poz. 776, Rozporządzenie Ministra Infrastruktury i Rozwoju z dnia 18 grudnia…).

The brakes were tested in a vehicle control station on 100 passenger cars, during periodic technical inspections were carried out. The tests were carried out on a CARTEC BDE 3504 roller device. The tests were carried out with the use of a brake pedal pressure sensor - with a brake pressure of 50 daN. The technical parameters of the roller stand are shown in Table 1.

Table 1.

Technical data of the CARTEC BDE 3504

Parameter name	Value
Max. axle load	130 kN
the diameter of the drive rollers	205 mm
the length of the drive rollers	1000 mm
the speed of drive rollers for vehicle inspection	5,2 km/h
the value of the slip of the wheel relative to the rollers	15 ÷ 40 %
measurement error the range in braking force	+/- 10

Cont. table 1.

coefficient of adhesion of tires to drive rollers: dry:	0,7
wet:	0,9
Ppermissible difference in the measurement of the left and right brake force measuring system	< 2%
braking rate max calculation error	-1%
measurement range	0-30/0-40

Source: Cartec-Poland information materials, *Manual of CARTEC BDE 3504.*

Before starting the brake test, the static wheel pressure on the ground was measured – it`s allowed to determine the actual mass of the vehicle at the time of the test. The braking force of individual wheels, obtained mass of the car during the test allowed for the calculation of the braking efficiency coefficient in accordance with the formula 1.

$$z = \frac{\sum T}{P} * 100 \tag{1}$$

where:

z – braking efficiency coefficient (%),

ΣT – braking force obtained from all wheels (kN) for the each type of brake,

P – force of gravity (pressure) from the permissible total weight of the tested vehicle (kN), assuming 1 kN = gravity force of 100 kg of mass for the calculation (for part vehicles, the permissible load of a given axle may be taken into account).

Assessment of the braking efficiency in accordance with the applicable regulation is based on the value of the braking efficiency coefficient and the relative difference of braking forces between the wheels of the same axle.

In accordance with the Regulation, the car's main brake should be considered defective if, among other things, it is noticed (Rozporzadzenie Ministra Infrastruktury z dnia 31 grudnia…, Dz.U. z 2015 r. poz. 776, Rozporządzenie Ministra Infrastruktury i Rozwoju z dnia 18 grudnia…):

- The braking force on one wheel is less than 70% of the greatest braking force measured on the other wheel on the same axle.
- No constant increase in braking force.
- Brake action at any wheel is too late to either wheel.
- Too large fluctuations in the braking force during each full rotation of the wheel.
- No gradual change in braking force.
- Efficiency lower than the minimum values contained in the Regulation of technical conditions (50 daN - for passenger cars).
- Too much corrosion of brake lines.
- Emergency brake doesn’t work properly.

As in the previous study (in 2014 year), the results obtained were divided into nine groups.

Eight groups concerned possible faults of the braking system, the finding of which made it necessary to recognize the system as inoperative.

The ninth group includes vehicles which the correct braking system was found. The results were as follows:

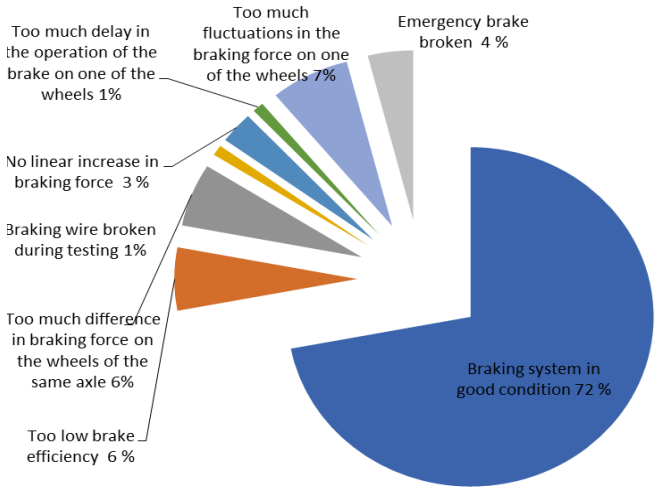

Figure 3. Results of investigations of the braking systems.

The results obtained in 2022 were compared with the results of the research conducted in 2014. Percentage changes in the results of individual tested parameters and the change in the number of properly functioning braking systems are shown in Figure 4.

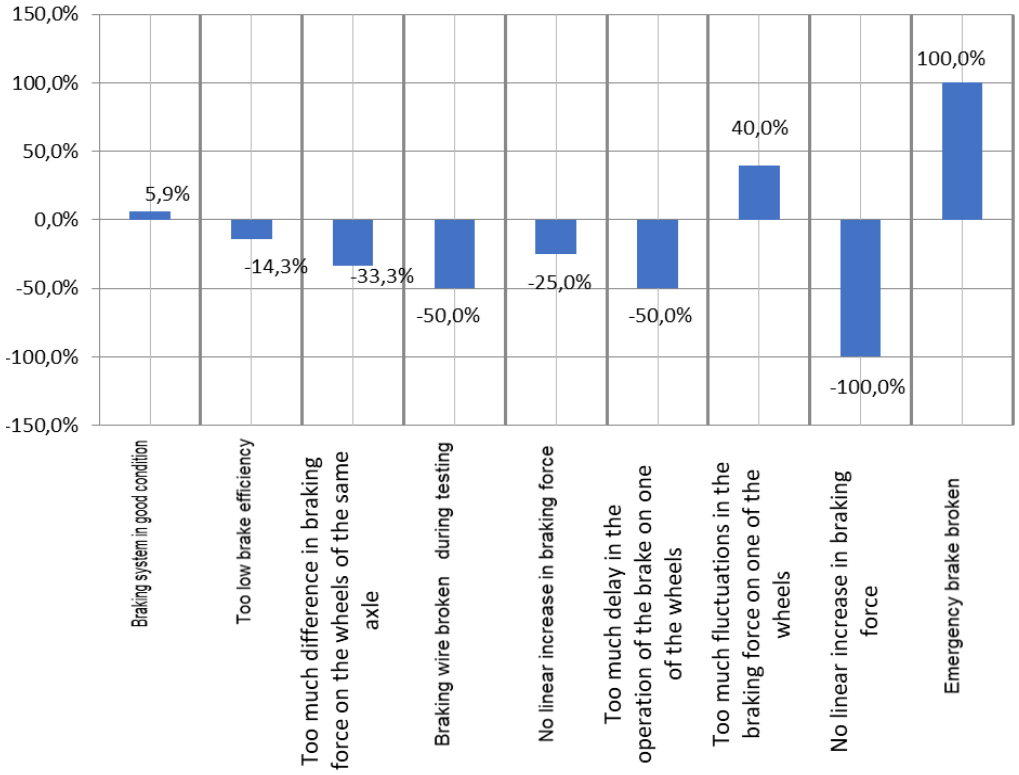

Figure 4. Percentage changes in the results of the tested parameters of the braking systems.

The above graph shows that the number of cars with a fully functional braking system has increased by almost 6%. This result was caused by a decrease in the number of all tested parameters indicating incorrect operation of the braking systems. It was also noticeable that two of the tested braking system performance parameters increased. These parameters were the no linear increase in the braking force - an increase by 40% compared to 2014, and incorrect operation of the emergency brake - an increase by 100%.

Just like in 2014. also in the current study, the boiling point of the brake fluid was checked.

The testing of brake systems was extended to include the measurement of the boiling point of the brake fluid. The measurement was carried out in the brake fluid reservoir using the WTM TPH-302 device. Selected technical parameters of the device are presented in table 2 (Cartec-Poland information materials, *Manual of the Brake…*).

Table 2.
Technical information of the WTM TPH-302 device

Parameter name	**Value**
Boiling point of measured fluids	85 do 300°C
Measurement accuracy	+/- 3%

Source: Cartec-Poland information materials, *Manual of the Brake Fluid Tester TPH-302 by WTM.*

The results of the brake fluid boiling point test were divided into 5 groups. The results are shown in Figure 5.

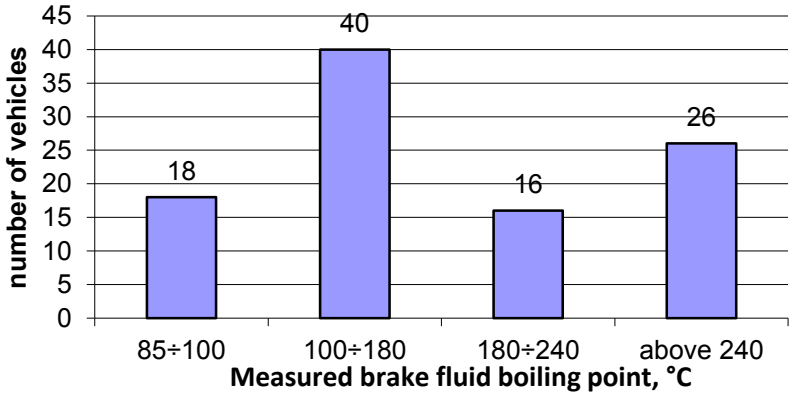

Figure 5. The results of brake fluid boiling point.

The results obtained in 2022 were compared with the results of the research conducted in 2014. Percentage changes in the results are shown in Figure 6.

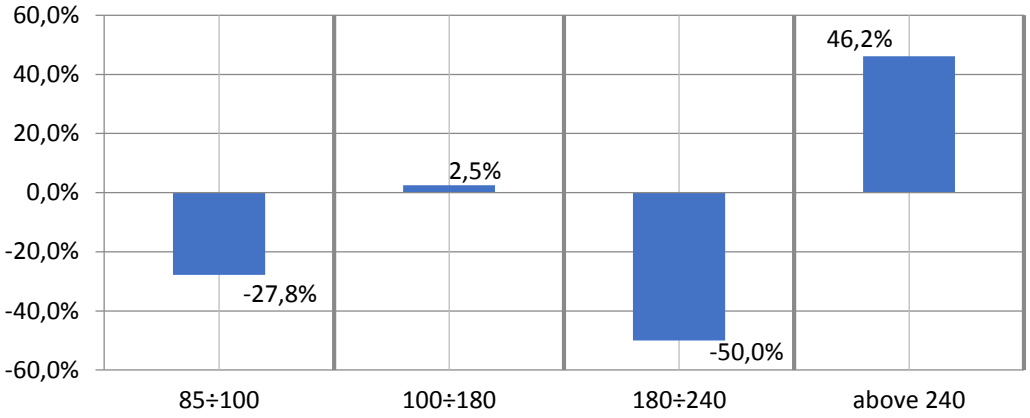

Figure 6. Percentage changes in the results of the tested brake fluid boiling points.

The collected information showed that more than 60% of the tested cars have a fluid in the brake system whose boiling point is below 180° C. The value of 180° C is the boundary boiling point of the brake fluid when measured in the tank (Cartec-Poland information materials, *Manual of the Brake…)*.

3. Summary

To sum up, it should be stated that a positive change in the technical condition of the braking systems in 2022 compared to 2014 has been noticed. The percentage share of brake system failures was lower in 2022 than in 2014. The conducted analyzes allowed the formulation of the following conclusions:

1. In 28% of the tested cars, defects of the braking system were found, which, according to the applicable Regulation, are defects qualifying the system as defective. The results showed a decrease in the number of cars with a damaged braking system by 2% compared to the research in 2014.
2. In 58% of the tested cars, the presence of brake fluid with too low a boiling point was found. The result shows a decrease in the number of cars with too low boiling point brake fluid compared to 2014 by 27.8%.

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