Marcin Rychter, Piotr Sułek

Analysis of the research method in assessing the impact of tire wear on the error of measuring digital recording devices in heavy goods vehicles

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The article presents the issues of the research method in assessing the impact of tire wear on the error of measuring digital recording devices used in heavy goods vehicles. The information related to the occurring measurement error in mounted digital recording devices has been presented in the driver's cab, analysis of detected violations in road transport related not only directly to the measurement error and solving the problem with the proposed research methodology. Finding out how to solve the problem is associated with fewer violations in road transport.

Słowa kluczowe: digital recording device, measurement error, tires.

Introduction

The tachograph, also known as a recording equipment, shall be installed and used in vehicles in order to register the driving time, other periods of work or of availability, breaks from work and daily rest periods of the driver. This recording equipment is also used for recording the distance travelled by the vehicle and speed of the vehicle. Tachograph should be installed in all motor vehicles registered in European Union, which are used for the carriage of passengers (in vehicles which are constructed or permanently adapted for carrying more than nine persons including the driver and are intended to this purpose) or goods by road (where the maximum permissible mass of the vehicle, including any trailer, or semi-trailer, exceeds 3.5 tonnes). The time caesura of the introduction of recording equipment and tachograph, is the year 1939, since when it has been stated the obligation of installation and usage of analogue tachograph in the United States of America (USA). In Europe, the tachograph is used for more than 60 years [1]. The multiannual application of analogue tachograph showed that the construction of these devices allows numerous abuses by the interference with their proper functioning. Increasingly, there have been cases of manipulation in analogue tachograph records. These experiences become a contributory factor to the quest for a device that would prevent falsification of records of the recording equipment in road transport. These requirements was to meet the digital tachograph, as a device to ensure unambiguous assessment attempts to make changes to comply with the rules relating to the working time of a driver and speed limits. To be more precise it should be pointed that digital tachograph is only the part of the whole digital tachograph system, which consists of three main elements: the motion sensor, the digital tachograph and tachograph smartcards [2]. Increasingly lower costs and high reliability of microprocessor systems have contributed to the rapid development of electronic systems used in motor vehicles. A scope of control possibilities has been expanded and new application areas have emerged in which the use of an advanced technology was not previously possible, such as real time control of quick-change processes through monitoring and recording.

For many years, global organizations have been marking out a direction of a developmental work related to the development of vehicle technologies for manufactures of vehicles and on-board devices. Such work is also related to the development of on-board recording devices, which may influence the improvement of the vehicle transport safety.

A digital tachograph implemented within the area of the European Union has replaced a worn- out and technologically obsolete analogue unit. A digital tachograph, which uses the latest cryptographic solutions, may make any misuse by drivers and employers more difficult [3,13].

1.Permissible errors of the digital recording device mounted in the driver's cab

Periodic checks are a combination of activities performed to check that the recording equipment is working properly and that its settings match the parameters of the vehicle in which they were originally installed. Periodic inspections should be carried out in the case of:

a) recording equipment repairs,
b) changes in the characteristic values of the vehicle,
c) changing the effective tire circumference value,
d) change of registration number, VRN (vehicle registration number) and RMS,
e) when the UTC time (universal time) differs from UTC time by more than 20 minutes,
f) 24 months have elapsed since the last periodic inspection.

Periodic checks of the vehicle unit are carried out to check that the recording equipment is working properly and its settings match the vehicle's parameters (tab 1–3). It is performed in the following cases:

– checking that compliance with the maximum tolerance requirements during device installation is maintained,
– checking that the device has a type approval mark,
– checking that the safety seals on the device are not damaged,
– changing the vehicle unit number,
– within 24 months of the last periodic inspection.

Tab. 1. Requirements for speed, distance and time measurement[4]

Speed	
Measuring range	0–220 km/h
Measuring range with defined accuracy	20–180 km/h
The accuracy of measurment before installation for the factor "in" from the scope of the 4000–25000 imp/km	±1 km/h
Accurary after instalation and calibration	±2 km/h
Accuracy during service, talking into acount changing tyres	±6 km/h
Resolution	±1 km/h
Dynamic measurement	2s stability after acceleration or braking advertising spots shall not exceed 2 m/s²

Tab. 2. Reaquirements for speed, distance and time measurement [4]

Distance	
Measuring range	0–9 999 999,9 km
Accurary before installation	± 1%
Accurary after installation	± 2%
Accurary during service	± 4%
Resolution	± 0.1 km

Tab. 3. Requirements for speed, distance and time measurement[4]

Time
Scope of the UTC is the date and time. Change the local time by increments of toll. Accurary of the ±2s/24 h. Resolution of the ±s/24 h.

The permissible speed error in years is up to a maximum of 6 km / h and results from the accuracy of calibration in the speed range from 20 km / h and the characteristic coefficient of the vehicle "z" within the limits from 4000 to 25000 imp / km (1km / h) speed, coefficient error "in" (1km / h), error on the circumference of the wheels to "1", as well as other factors. The permissible distance error during 2 years of service is 4% and due to the accuracy of the calibration frequency in the speed range from 20 to 180 km / h and the characteristic coefficient of the vehicle 'z' included in the range from 4,000 to 25,000 imp / km, error rates resulting from the characteristic coefficient of the vehicle 'w'[12].

In order to correctly check the measurement of errors during installation, they should be carried out under normal conditions:

- the vehicle is left without goods,
- the tire pressure complies with the vehicle manufacturer's instructions,
- tire wear within the limits allowed,
- vehicle movement.

2.Analysis of detected infringements in digital recording devices mounted in the driver's cabin

Road transport control is the statutory task of the Road Transport Inspection. In addition, it is worth noting that policemen, border guards, customs services and the National Labor Inspectorate also have the right to carry out inspections regarding the installation of tachographs in vehicles and registration of the driver's working time. Inspectors, taking into account continuous attempts to manipulate recording equipment, train to increase road transport safety. The analysis of the number of roadside checks does not determine the changes that have taken place in recent years. The chart below shows the changes taking place in the case of the number of road inspections that were carried out on Polish roads.

[5]

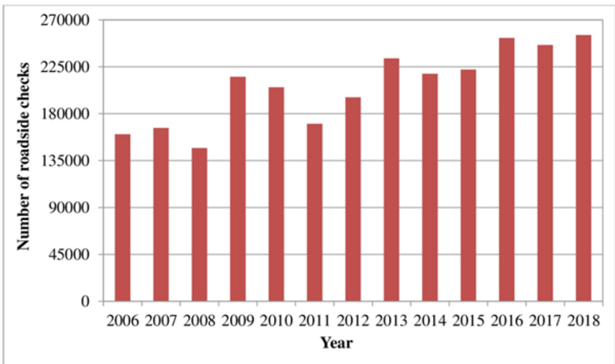

Fig. 1. Number of roadside checks

The analysis of the information contained in the chart above shows that the largest number of roadside inspections was found in the last research year. In the last twelve years, there has been a recurring cycle of decreasing number of roadside checks, every two research periods. In addition, it is worth mentioning that in 2006 two types of recording devices appeared on the market: analog devices and new digital recording devices introduced into circulation at that time, which evolved over time. Currently, intelligent tachographs have appeared on the market that significantly technically secure the digital tachograph system. Then we can see on the next chart that the number of roadside checks does not significantly affect the number of detected violations in the use of recording devices.

[5]

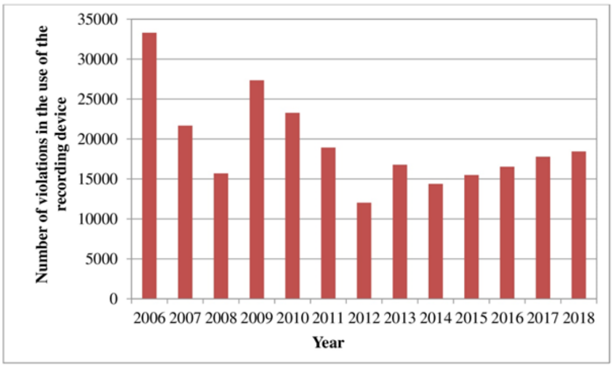

Fig. 2. Number of violations in the use of the recording device

Based on the data in figure 2, it appears that the largest number of detected infringements was found twelve years ago. Violations in the use of the recording equipment were caused by the fact that the analogue tachograph, older technology was more susceptible to manipulation of truck drivers. It is worth considering the issue of the latest technology at this point, looking at recent years, where there is an increase in the number of violations in the use of recording devices, which may indicate the need to increase the number of controls marked on this aspect. Lack of decisive reaction to the occurrence of these violations exposes the entire digital tachograph security system, including interference in the device's calibration system.

Next, it is worth noting in figure 3 the increase in the number of manipulations in the operation of the device switch enabling the change of the driver's activity over the last three years. The driver's activity is daily driving time, weekly driving time and other driver activities entered into the digital recording device. It is noteworthy that the introduction of a digital recording device commonly used in road transport caused little interference in the activity switch, but since other manipulation options were removed, the fight against control bodies went into manipulation similar to that of a driver.

[5]

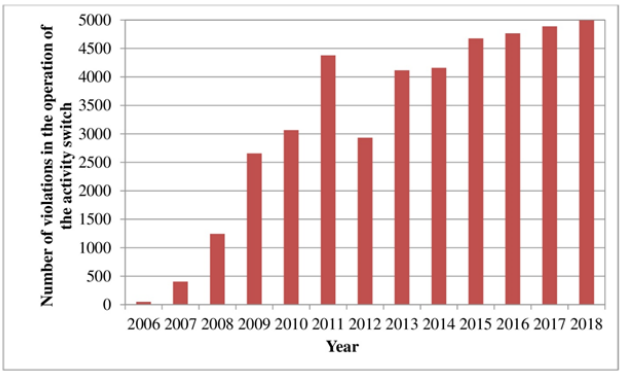

Fig. 3. Number of violations in the operation of the activity switch to change the type of driver activity

Recent violations show that the indications regarding vehicle speed, driver activity and distance traveled are not recorded. The last three years have seen an upward trend in infringements in this regard. The new intelligent digital tachographs will secure the digital tachograph system for a short time and the lack of searching for other solutions that may affect the system will result in destabilization with the possibility of bypassing the system which directly threatens road safety. Violations regarding the failure to register vehicle speed, driver activity and the distance traveled are associated with especially with violations occurring when operating the switch changing the type of driver's activity.

[5]

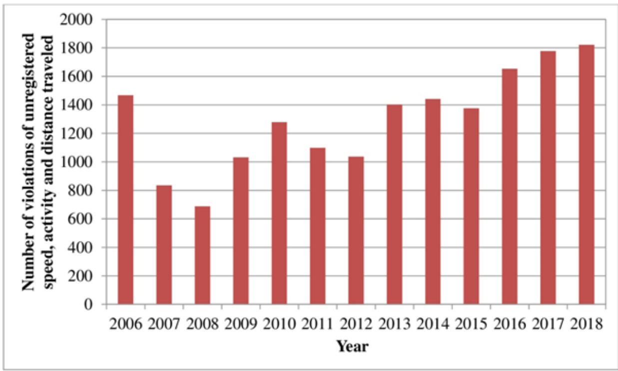

Fig. 4. Number of violations of unregistered speed, activity and distance traveled

Road Transport inspectors, having the authority to control heavy goods vehicles over the last twelve years, focus not only on road control checking transport documents, driver's working time, rest periods taken, but on testing and detecting new manipulations that occur in road transport. Sealing the system by introducing innovative solutions will allow to maintain a stable situation on national roads.

3.Construction of a modern tire, testing of tire tread abrasive.

The subject of research on the impact of tread wear on data reading from a recording device commonly used in the truck fleet is not sufficiently implemented in scientific topics. Increasing the correctness of readings of the digital recording device significantly affects the safety of road transport. Contrary to appearances, the construction of a modern tire used in a truck fleet is not a simple construction, but it is made of several layers with different parameters (Fig 5). Each of them has an effect on driving characteristics.

The basic components of a tire include:

1. Tread,
2. Belting,
3. Side wall,
4. Warp,
5. Inner liner,
6. Footer conection,
7. Vertices,
8. A piece of fabric between the presser foot and the wrap around,
9. Chafer,
10. Tube (used in tube tires),
11. Protective rubber flap between the rim and the inner tube (used in tube tires).

[6]

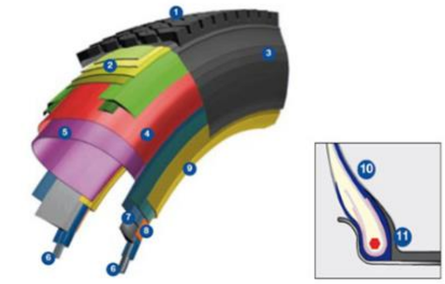

Fig. 5. Tire construction

The specificity of tire construction makes us aware of the important role tires play in the daily operation of trucks. More than 80 percent of the top of the tire is made of tread. This is an extremely important element that determines the grip and stability of the wheel while driving. Its sculpture and thickness affect driving comfort and road safety. The tread is made of variable thickness rubber. It consists of a forehead, shoulders and side parts. It consists of a forehead, shoulders and side parts.

The main tread components include:

- lamellar notches (slats, slats) - narrow gaps in the tread blocks, creating gaps 0.3-1.5 mm wide,
- tread blocks, tread blocks - create tread elements, ensure good traction of the tire,
- tread shoulder blocks - are responsible for the tire to stick to the ground [7,8].

The service life of a tire depends on many factors, mainly on the construction of the tire, but also on the technical condition of the vehicle and the ground on which the vehicle is rolling. There are many factors that affect the service life (tire pressure). According to the catalog data, the tire should drive 400,000 km if used correctly, but in fact half of this distance, or about 200,000 km, is considered a success [8,9]. The basic explanation is that neither the truck nor the road are in perfect condition. Improper road maintenance is a frequent cause of recorded mechanical damage to tires. Focus should be on:

- impacts against a sharp obstacle causing rupture of the carcass layer and steel belt
- mechanical tire cuts on the shoulder along with rupture of the carcass layers
- damage at high speeds or a violent impact on an obstacle (mechanical damage to the tread face, tearing of the carcass layers and strapping)
- tread punctures with a sharp object (nail)
- frequent rubbing of the tire against the curb - peripheral wiping of the tire side surface [9,10].

In turn, the wrong condition of the vehicle, and above all the incorrect convergence of the wheels or axles, car geometry, the condition of the brakes have a destructive effect on the life of the tires, tread, which is why these elements should be checked regularly. The axes must be correctly aligned. Often, the axles of semi-trailers show incorrect convergence, which not only leads to faster tire wear, but also causes a waste of fuel. Even small continuous leaks of oil and fuel on tires can permanently damage them. The condition of the rim also affects tire tread wear.

- A As a result of the literature review and analyzes carried out in recent years, it is proposed to test the tread condition for the readout status of the digital recording device. It is known that the tread has a real impact on changing the speed of trucks. By calibrating the recording device at the moment on used tires, the speed of the truck will show a maximum of 89 km / h, which the calibration service deems to be in accordance with the law, but the problem arises when the user of the truck changes in the time interval (next calibration) of the tire to brand new. The proposed tests are to clearly determine the effect of tread wear on the reading status of the digital recording device. The following tasks are proposed:

- measurement of wheel circumference and tread thickness in the initial phase, state zero (Fig 11),

[11]

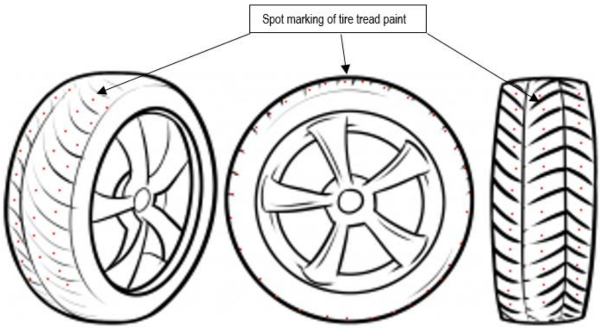

Fig. 6. Spot marking of tire tread paint

- calibration of the digital device, determination of the initial state,
- reading the number of turns signals over time and analyzing individual quantities:
  a) speed distribution (scale 0 - 89km / h),
  b) determination of ranges (scale 0 - 200,000km),

[1]

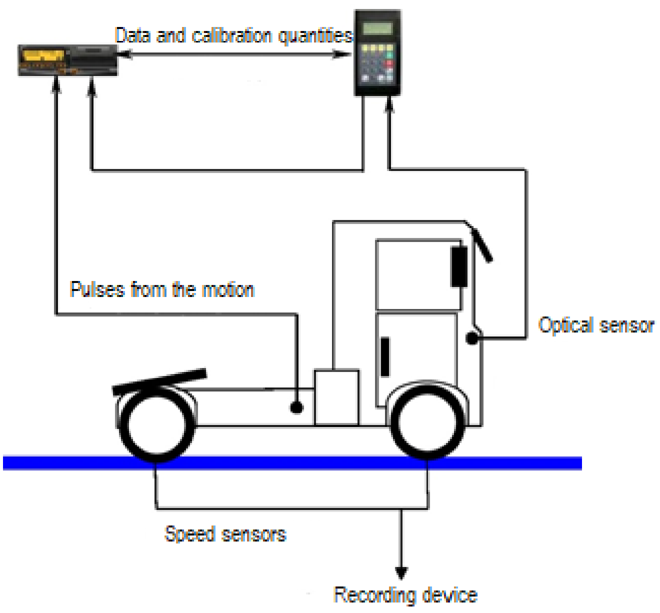

Fig. 7. Research position

- Re-measurement of wheel circumference and tread thickness, reading of subsequent signals, after traveling one specific route, number of kilometers (0 - 10,000 km; 10,000 - 20,000 km),
- end of tire life in a truck, the status of the TWI indicator indicates that the tire cannot be used.

The above tests will determine whether the tire tread affects the measurement of the digital recording device, how to calibrate the recording device to increase road transport safety, and will outline a new concept of changes that should occur between carriers and road transport control authorities.

Summary

Recording devices in road transport are necessary to indicate driving periods and rest periods for drivers, as well as to ensure that the inspection bodies can carry out effective checks on compliance with social provisions in force in road transport. Lack of effective control reduces the safety of road transport which results in more unpredictable transport situations. The Road Transport Inspection, tasked with controlling road transport, ensures the safety of the digital tachograph system. In recent years, there has been an increase in violations of manipulation in not registering indications in terms of vehicle speed, driver activity and distance traveled, and in operating the device switch to change the type of driver activity. The lack of sealing of the digital tachograph security system commonly used in road transport together with the lack of search for new solutions threatens with increased manipulation in available areas, which will result in the lack of proper supervision in road transport. The proposed method reduces the measurement error, which will increase safety in road transport.

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Analiza metody badawczej w ocenie wpływu zużycia ogumienia na błąd pomiaru cyfrowych urządzeń rejestrujących w pojazdach ciężarowych.

W artykule zaprezentowano problematykę metody badawczej w ocenie wpływu zużycia ogumienia na błąd pomiaru cyfrowych urządzeń rejestrujących zastosowanych w pojazdach ciężarowych. Przedstawiono informacje związane z występującym błędem pomiarowym w cyfrowych urządzeniach rejestrujących zamontowanych w kabinie kierowcy, analizę wykrytych naruszeń w transporcie drogowym związanym nie tylko bezpośrednio z błędem pomiarowym oraz rozwiązanie problemu z proponowaną metodyką badawczą. Poznanie rozwiązania problemu wiąże się z mniejszą ilością występujących naruszeń w transporcie drogowym.

Słowa kluczowe: cyfrowe urządzenie rejestrujące, błąd pomiaru, opony.

Authors:

dr hab. inż. **Marcin Rychter** prof.PWSZ – Vocational State School of Ignacy Mościcki in Ciechanów, Faulty of Engineering and Economics, Gabriela Narutowicza 9, 06-400 Ciechanów, Poland, e-mail: rychter@poczta.fm

mgr inż. **Piotr Sułek** – Technical Secondary School of Transport and Communication in Lublin, piotr_suleczek@wp.pl