

## STATIC WEIGHING OF VEHICLES – THE CRUX OF THE PRESSURES ON THE AXLES AND ROAD SAFETY

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### **Abstract**

*Weighing of road vehicles using static platform weights is as important as weight control of vehicles in motion. Overloading of cargo vehicles is increasingly common in occurrence. Such vehicles cause significant wear of road infrastructure, effect of which may cause reduced safety of road traffic. Amongst others, the improper loading of vehicles is the cause of direct overloading or unequal load distribution on the axles. Institutions and official services supervising cargo vehicles and loading are endeavouring to reduce the incidence of vehicle overloading and improper loading by providing clear rules and guidelines. Technical requirements set for road freight vehicles must be met and the effectiveness of these is reviewed by organs created for this task, such as the Main Inspectorate of Road Transport. Authorized inspectors performing control measurements of each axle on a static weight direct the vehicle to a specially prepared measurement area where the said vehicle is excluded from traffic.*

*To ensure road surface quality the state issues fines on firms which do not meet the requirements set for road transport vehicles, in certain circumstances, to guarantee road safety, temporary exclusion of road transport from traffic is imposed, e.g. in times of elevated temperature. However, it can be observed that such methods are not sufficient to reduce the number of overloaded vehicles on the Polish roads.*

*The article describes the events having a deteriorating effect on the road infrastructure as well as requirements set for road vehicles. The problem of overloaded vehicles on the Polish roads, methods of verification of such and the consequences of these are discussed displaying the extent of the problem.*

**Keywords:** *road transport, weighing of vehicles, overloading, use of technical and road infrastructure*

### **1. Road transport infrastructure**

Extended system of motor roads in Poland creates more and more possibilities for evolution of the road transport. As the way we understand a strip of land adapted by laying the road surface and the application of appropriate technical devices for trackless vehicles [2]. Kilometres of these roads are definitely much longer in comparison to railway lines. According to Karbowski, significant increase of motor roads length, and at the same time, amount of vehicles, is the reason of motion blockades and it causes problems with shortage of parking spaces, especially in the cities and large agglomerations [4].

The most important road components are characterised by shape, width and camber angle of the roadway, type of surface and its traction, technical – operating qualities and other infrastructure elements.

Motor roads consist of one or two roadways, which are intended for use each of motion directions. Each roadway has established width, from 5 (4.5) metres to 7.5 meters, depends on type

of the motor road and its environment [4]. Inadequacy of roadway width to conditions, roadside shortage or its poor quality are the reasons of many traffic accidents [1].

An issue with roadways surface quality and its condition is significant as well. These parameters considerably influence tyre adhesion. Technical condition of motor roads does not meet the requirements for intensive and heavy freight traffic. Numerous ruts and potholes are sources of additional noise and vibration, which have negative influence on drivers work environment.

## 2. The requirements for roadworthy vehicles

Within the meaning of Article 71 of the Traffic Law Act vehicle is roadworthy when it meets the law requirements with regard to technical conditions, it also became licensed and has legal registration number and license tab (motor vehicle) [7]. Technical condition of the vehicle should be meant by the vehicle efficiency, it also should be stated as a roadworthy by a diagnostician, who executes motor vehicle roadworthiness tests at a district vehicle control station and if the certain group of vehicles has homologation. Obtaining the homologation in comparison to obtaining the positive result of motor vehicle roadworthiness test does not depend on the vehicle owner, but on its producer who lunches the vehicles on certain country's market and has to obtain type-approval certificate issued by empowered organization.

According to the regulation of the Minister for Infrastructure of 31st December 2002 on detailed requirements for the vehicles technical state and essential equipment [9] motor vehicles have to meet multiple technical requirements in regard to weight and axle pressure [6] especially in reference to vehicles intended for road transport of goods (Tab. 1 and 2).

Axle weight of vehicles, according to Kęsek, Nosal and Starowicz, cannot be less than 25% in case of its maximum total weight [5].

General conditions for placement and load transport presuppose that transported load should not cause overdraw of capacity limitations or overall weight of vehicle. Load should be well attached, not to cause sedateness and steering of the vehicle, it also cannot be the reason for exceeding permissible axle weight on road and it cannot reduce visibility on the road. Load put inside the vehicle should be stably located in order not to move or cause excessive noise according to Prochowski and Żuchowski [6].

Tab. 1. Permissible heavy goods vehicle total weight [5]

Type of heavy goods vehicle	Maximal weight quantity
Individual 2 axles	18 tons
Individual 3 axles	25 tons
Individual 3 axles, which has twin tyres on indrawn axles and air suspension	26 tons
Individual number of axles more than 3	32 tons
Consists of 4 axles	36 tons
Consists of more than 4 axles	40 tons
Vehicles registered by 13th March 2003	42 tons

J. Kęsek, A. Nosal and W. Starowicz believe that polish roads are primarily designed for 80 or 100 kN/axle loading. Nowadays pressure on the trans-European roads is changing into 115 kN/axle. Technical requirements, which refer to maximal axle pressure, are the results of this condition. Unfortunately, statistics shows that overloading of the vehicles in Poland is common which leads to excessive axle pressure and further to roads damages [5]. The best chance to change the technical condition of the motor roads is amount depletion of overloaded vehicles. The authors propound increased amount of traffic checks with an axle pressure measurement and imposing sanctions.

Tab. 2. Permissible axle pressure [5]

Type and quantity of axles	Axle pressure
Individual non-driving axle	10 tons
Double trailer and semitrailer axles with distance (d) between component axles: <ul style="list-style-type: none"> <li>– less than 1 m (<math>d &lt; 1.0</math>),</li> <li>– between 1.0 m and 1.3 m (<math>1.0 \leq d &lt; 1.3</math>),</li> <li>– between 1.3 m and 1.8 m (<math>1.3 \leq d &lt; 1.8</math>),</li> <li>– 1.8 m or more (<math>1.8 \leq d</math>),</li> </ul>	<ul style="list-style-type: none"> <li>11 tons</li> <li>16 tons</li> <li>18 tons</li> <li>20 tons</li> </ul>
Triple trailer and semitrailer axles with distance (d) between component axles: <ul style="list-style-type: none"> <li>– 1.3 m and less than 1.3 m (<math>d \leq 1.3</math>),</li> <li>– between 1.3 m and 1.4 m (<math>1.3 \leq d \leq 1.4</math>)</li> </ul>	<ul style="list-style-type: none"> <li>21 tons</li> <li>24 tons</li> </ul>
Individual driving axle: <ul style="list-style-type: none"> <li>– vehicles mentioned in §3 paragraph 1 points 2 &amp; 3</li> <li>– vehicles mentioned in §3 paragraph 1 points 4-9</li> </ul>	<ul style="list-style-type: none"> <li>11.5 tons</li> <li>11.5 tons</li> </ul>
Double driving axle with distance (d) between component axles: <ul style="list-style-type: none"> <li>– less than 1 m (<math>d &lt; 1.0</math>),</li> <li>– between 1.0 m and 1.3 m (<math>1.0 \leq d &lt; 1.3</math>),</li> <li>– between 1.3 m and 1.8 m (<math>1.3 \leq d &lt; 1.8</math>).</li> </ul>	<ul style="list-style-type: none"> <li>11.5 tons</li> <li>16 tons</li> <li>18-19 tons (if driving axle was equipped in twin tyres, maximal pressure for each of them is not more than 9.5 tons)</li> </ul>

### 3. Static weighing of vehicles

When Poland joined the European Union in May 2004, it adopted its decrees and directives and it adjusted its own legal acts to the European Union's law. Assimilation of legal regulations of the European Union resulted in unification of most of the national legislation. European Union law is more important than the Polish legislation.

Under the Council Directive 88/599/EEC of 23 November 1988 on standard checking procedures for the implementation of Regulation (EEC) No 3820/85 on the harmonization of certain social legislation relating to road, control board was established i.e. Road Transport Inspection. Within the meaning of the Article 48 The Road Transport Inspection was established and it is obliged to make controls over regulations respect in terms of vehicles road transport and the regulations contained in art. 3 par. 1a [8].

Road Transport Inspection has a responsibility to make i.e. vehicles technical condition checks, mode of load placement, examining vehicles weight and handing down decisions in administrative enforcement proceedings. Within the meaning of the Article 55 specifies duties of the inspectors. According to law in force, Road Transport Inspection can impose and charge penalties in case of not enforcing the law regulations [8].

When empowered inspectors are checking the vehicle, they except the vehicle from traffic. The vehicle is directed to especially designed stations. In these stations inspectors statically weights each of the vehicle axles.

J. Kęsek, A. Nosal and W. Starowicz mention types of regulations used by inspectors during the traffic check [5]. Control process is precisely defined in Act on Road Transport. Only uniformed inspectors with authority who stands near the business vehicle can stop the car due to control it. Controlled person is obliged not to impede the control process and is obliged to provide indispensable information. During the traffic check inspector can draw up film or photographic documentation in order to gather evidence and can interrogate witnesses and person controlled if

evidence is not sufficient to define all the facts. When check is completed inspector draws up a report, which contains signatures of traffic check participants and the results are used in administrative proceedings [8].

Summarizing factors damaging the roads, which were adduced above, it can be stated that efficient weight verification and removal of overloaded vehicles from the roads, in great measure will affect the condition of the roads and, at the same time, will provide safety of the road users.

Technology and legal regulations of the weighing vehicles system allow static weighing and dynamic weighing.

Static weights, considered in this article, are used for axle pressure measurement (including admissible measurement error usually not more than 1% or 2%) or for precise measurement of vehicle weight. These types of weights are subjected to legislation process, on which are based legalization certificates indispensable for weights usage.

Checks of axles pressure and actual vehicles total mass are conducted by empowered services using stationery weights (platforms) or portable static weights [10]. Control stations should be positioned in place advised by the manufacturer, without inclinations of the surface and with properly prepared foundations. Check should be conducted in accordance with the instructions for use.

Static platform weight is the special platform installed above or below the roadway surface on which the vehicle drives in order to measure its total mass (Fig. 1a). It is more used in industrial plants than traffic checks.

The other type of static weight used by Road Transport Inspection is portable weight (Fig. 1b). It allows setting each of axles pressure, and simultaneously its total mass calculated as a sum of axle pressure.

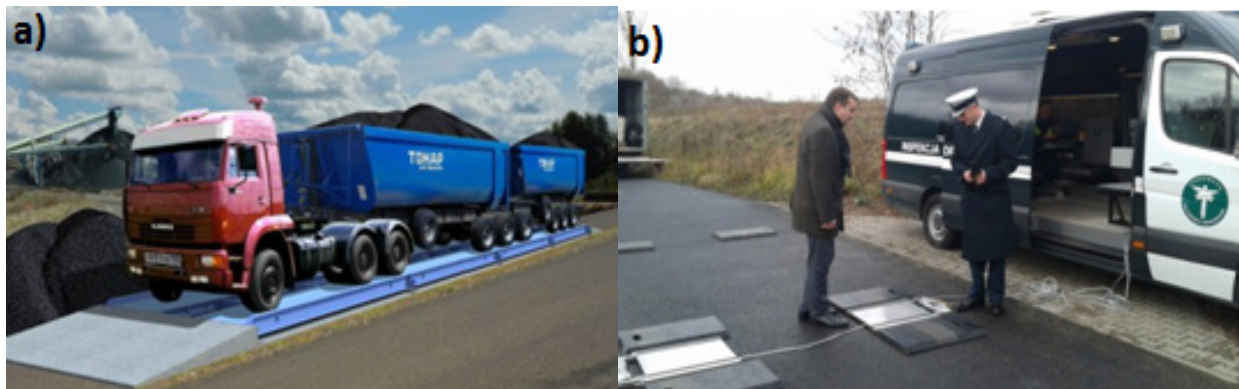


Fig. 1. a) Static platform weight [12] and b) portable static weight [11]

Conducting research and additional checks requires certain amount of time and has to encompass staff safety. Due to duration of vehicle stop, traffic check probability is slight and therefore hauliers consciously trespass vehicle overload [3].

#### 4. The analysis of permissible axle pressure

Since January 2015 until now, Road Transport Inspection checked 34458 cars driven on the polish roads, which belongs to polish and foreign hauliers (Fig. 2).

Road Transport Inspection during the checks used both – static and dynamic total mass weighing technology. However in exceeded amount of checks were used portable static weights and almost none of the stationery static weights, what is presented on Fig. 3.

Check of permissible vehicle axle pressure shows that among the 25 468 conducted checks, vast majority was conducted among the vehicles which axle pressure allowed above 10 tons, what is presented on Fig. 4.

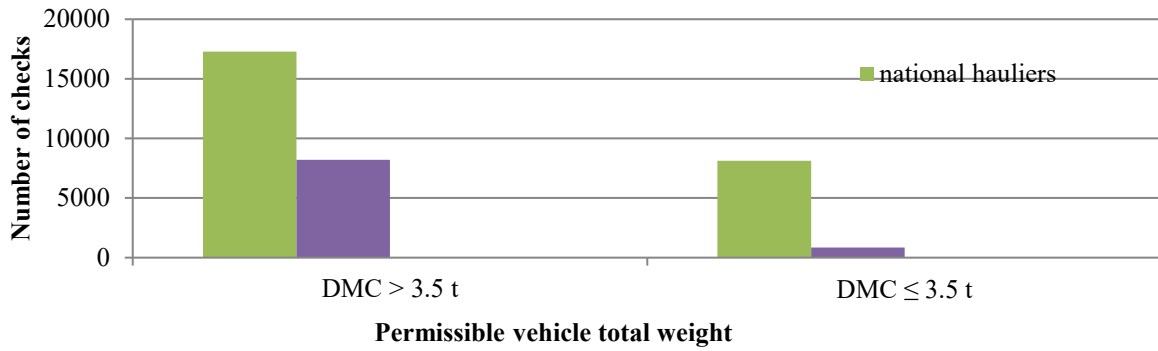


Fig. 2. Number of traffic checks conducted by Road Transport Inspection since 2015 with various total weight of the vehicle included [source: Information on Road Transport Inspection activity]

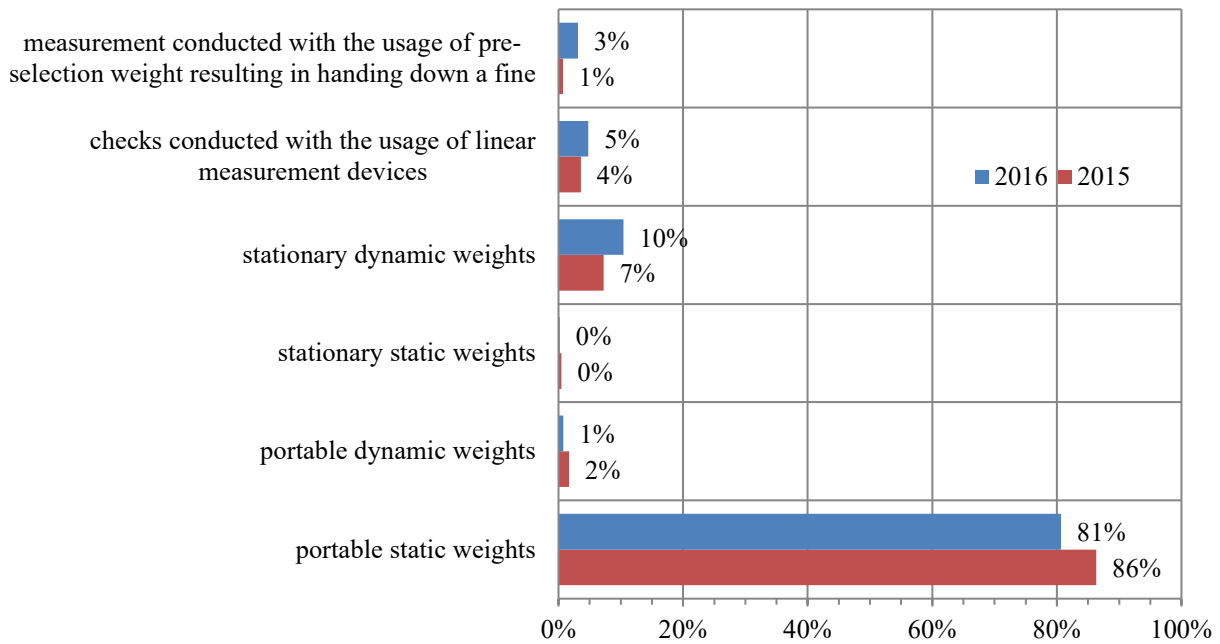


Fig. 3. Percentage of conducted traffic checks since 2015 with use of various technologies of weighing [source: Information on Road Transport Inspection activity]

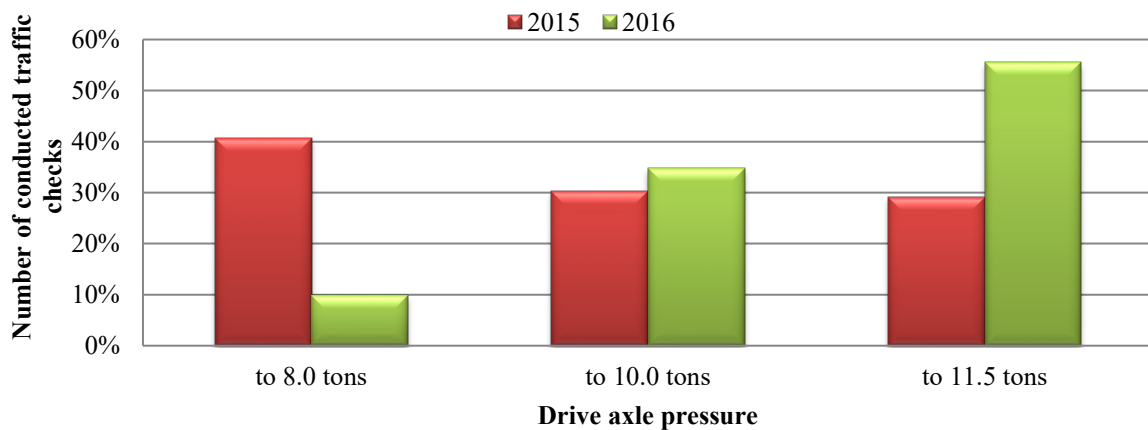


Fig. 4. Number of conducted traffic checks in accordance to permissible drive axle pressure. Source: Information on Road Transport Inspection activity

In accordance there were handed down 8 593 decisions relating to penalties. Sum of the penalties was equal 2 393 255 PLN in total for the drivers of vehicles  $DMC \leq 3.5$  tons, including more than 2 173 495 PLN for national hauliers (Fig. 5).

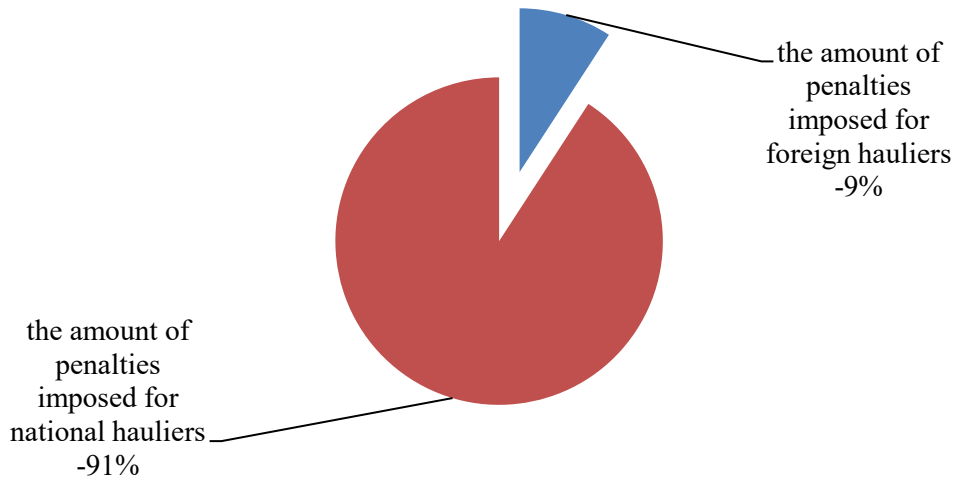


Fig. 5. The amount of the penalties imposed based on the decisions [source: Information on Road Transport Inspection activity]

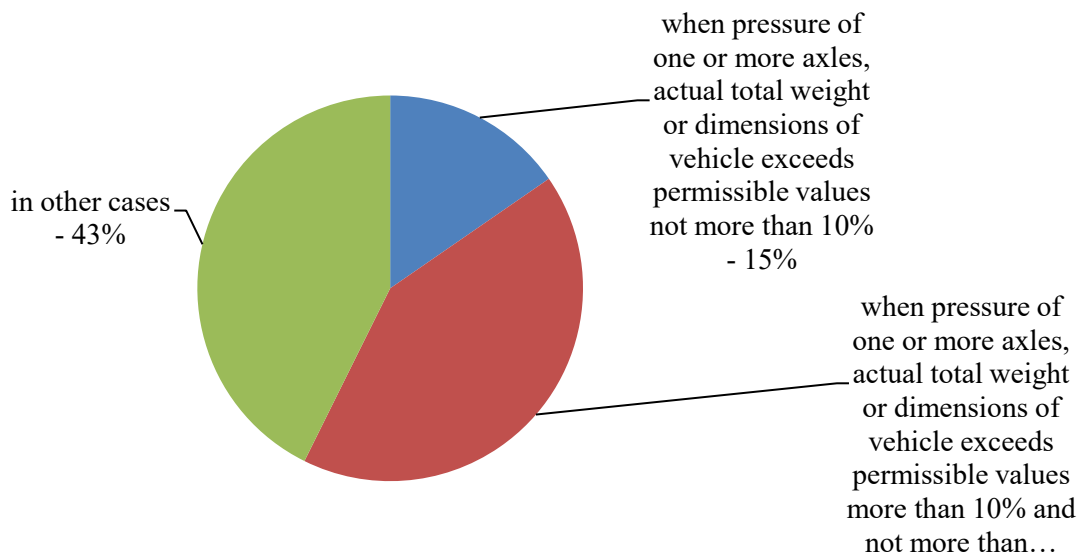


Fig. 6. Violation of weight detected by Road Transport Inspection [source: Information on Road Transport Inspection activity]

The least percentage of weight violation detected by Road Transport Inspection applied to vehicles exceeded not more than 10 % of acceptable standard (Fig. 6).

## 5. Conclusions

Static weighing of vehicles include many factors, however it does not show actual values of each axle pressure imposition on motor roads. Placement of the loading inside the vehicle is an important issue. Loading incorrectly placed can distort the axle pressure measurement results and therefore there is high probability of making the measurement error during the check.

As statistics show, the biggest role among available weight and axle pressure measurement devices have portable static weights. Such a big percentage of these weights usage proves, that it is universal (and common) and it is easier to use, considering weighing of the most frequently checked vehicles which drive axle pressure weights not more than 11.5 tons. Vast majority of the weight checks are conducted among the national hauliers, which can relate to ease of making settlement of disputes in court when fine is not accepted.

Axle pressure exceeds have an impact on minimization of the road traffic safety because damages of road infrastructure frequently arise from significant overloading. Among the checks conducted by Road Transport Inspection since the beginning of 2015, only 15% of detected violations related to acceptable weight standards exceed which were less than 10% in total.

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