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EUROPEAN PRACTICES FOR PREVENTING RELATIVE LOAD MOTION IN VEHICLES ²⁰

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Abstract: *This article provides a general overview of cargo securing in vehicles based on good European practices. The conditions under which the relative movement of the cargo is neutralized are indicated. An attempt is made to classify the methods of cargo securing. The factors that should be taken into account before proceeding with cargo securing actions and the need for preliminary study of the dynamics of the relative movement of the cargo, including the calculation of the forces acting on the cargo during its relative movement, are clarified.*

Keywords: *European practices, cargo, reinforcement, road transport*

INTRODUCTION

The relative movement of the load in the body has a significant impact on the stability of the vehicle, which often becomes a cause of road accidents. In the process of driving the vehicle along a curve or on slopes of descent and ascent, inertial forces arise. If the load is not secured or distributed correctly, it moves along the floor of the body, which additionally creates transfer and Coriolis forces. These further contribute to the loss of stability of the vehicle with subsequent sliding or overturning on or off the roadway.[1]

The load, including the means for securing it, as well as the loading and unloading equipment, must be installed and secured in such a way as to prevent sliding, falling, overturning or generating noise during emergency braking or sudden lateral maneuvers.

In Europe, the following standards apply: standard EN 12195:2010 "Securing of loads in road vehicles. Safety" and standard EN 12642 "Bodywork construction of commercial vehicles. Minimum requirements". According to European practices, the prevention of relative movement of cargo in vehicles is implemented mainly in two directions:[3]

- correct distribution of the load relative to the length and width of the vehicle body and symmetrical positioning of the total center of mass of the load;
- reliable securing of the load, carried out in such a way that neither road nor occupational safety is endangered.

EXPOSITION

In accordance with the topic, some of the methods for securing loads in the vehicle body according to European standards will be considered. When choosing a method and means of fastening, it is necessary to take into account the following factors:[4]

- the weight and dimensions of the cargo;
- the location of the center of gravity of the load;

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- the shape and type of cargo;
- the coefficient of friction;
- the vehicle's load capacity;
- the number and location of the loading platform attachment points and their maximum loads;
- **the strength of the body sides and covers.**

According to European standards, the following methods of securing cargo are applied: [4]

1) Increasing the friction force between the load and the transport platform.

During sudden braking, acceleration, starting off, or when driving around bends and curves, these forces can reach levels capable of displacing, overturning, or even throwing the load off the side of the vehicle. The magnitude of these forces has been determined theoretically and confirmed in practice. They can act in a forward direction during sudden braking, in a backward direction during sudden starting, and in a sideways direction to the left or right when the vehicle is moving around a curve. The term sudden braking or sudden starting refers to a greater deceleration or acceleration during the uneven movement of the vehicle.

In order for the load to remain stationary under the influence of these forces, the following condition must be met: the friction force between the load and the floor of the body F_{tr} , to be greater than the inertial force F_m , which occurs when the vehicle is stopped and accelerated respectively. $F_{tr} > F_m$

The calculated inertial force, in the presence of relative movement of the load, is additionally corrected by the so-called transfer and Coriolis forces.

The above inequality could be fulfilled in three ways:

- by placing anti-slip pads between the load and the floor of the body, which creates a greater coefficient of traction (fig. 1); [3]



Fig. 1. Increasing the coefficient of friction using anti-slip pads $\mu > 0,6$

- securing the load using tension straps;

In this method, the load is additionally pressed to the platform by means of tensioning straps, which do not change the weight, but only increase the pressure force. The magnitude of the pressure force depends on the number of tensioning straps and the tensioning force, which is realized by specially installed tensioners.

The vertical angle for placing the straps is recommended α to be within the limits of $75^{\circ} - 90^{\circ}$ (fig.2).

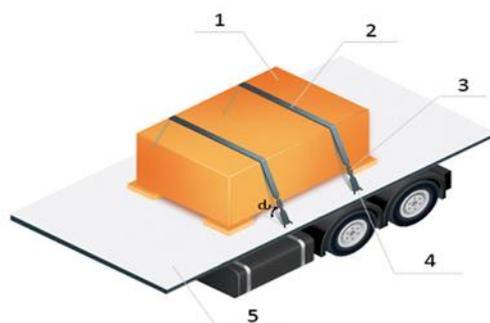


Fig. 2. Increasing the coefficient of friction by ensuring the force of pressing the load

1 – cargo; 2 - fastening belt; 3 – tensioner; 4 – anchor point;

- combined cargo securing.

To increase friction, the most effective method is a combination of anti-slip mats and lashing straps. This method of securing the load contributes to significantly reducing the number of lashing straps.

2) Strengthening the load by blocking against movement: [4]

The purpose of cargo blocking is to ensure the immobility of the cargo, as well as the distance between the individual loads, both between them and in relation to the walls and covers of the body, despite the inertial forces acting on them. In this case, the fastening means work under pressure and can be classified as follows:

Depending on the direction of the acting inertial forces, locks are divided into three types:

- in the direction of the countries;
- in a backward direction;
- in the forward direction.

Depending on their condition:

- - rigid (inelastic) - spacer bars, limiters, pallets, blocking strips, blocks, rods, beams.
- elastic - airbags filled with compressed air, elastic sealing material, such as polyurethane, rubber.

Depending on their type:

- wedge pads;
- pallets;
- panels;
- wooden spacers;
- inflatable pillows.

Onfig.3 some of the ways to block the load are listed:

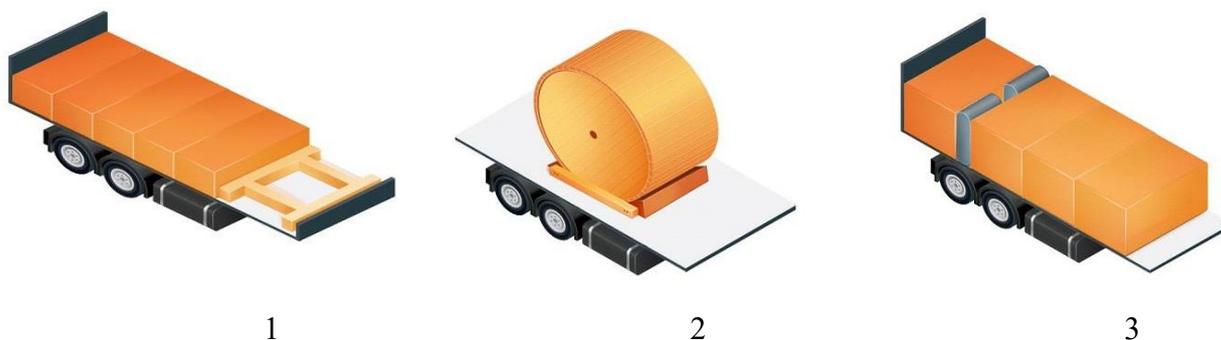


Fig. 3. Different types of cargo securing by blocking

1 – through wooden spacers; 2 –through wedges; 3 –through airbags.

3) Strengthening the load by tying: [4]

In this case, cargo securing is carried out using fastening methods using woven synthetic straps. They directly perceive the inertial force acting on the load and work in tension, that is, they perceive the tensile load.

The condition for the immobility of the load when secured by lashing remains the same as when blocked, i.e. the sum of the forces acting on the load in each of the specified directions must be equal to zero. The following methods of lashing are applicable: by directly securing the load. In this case, the belt is attached with one end to the load being secured, and with the other - to the attachment point on the vehicle platform.

- loop connection. This is a type of cargo securing using woven synthetic straps to one side of the vehicle body, preventing the cargo from shifting in the opposite direction.
- spring fastening – used to prevent the load from moving in the direction of travel or in the opposite direction.

Onfig. 4 different types of cargo lashing are visualized:

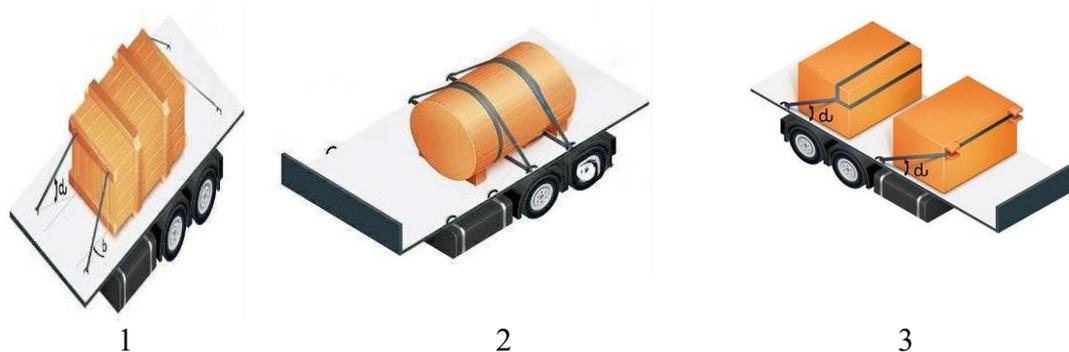


Fig. 4. Different types of cargo securing by tying
 1 – direct attachment; 2 –loop connection; 3 – spring fastening.

CONCLUSIONS

In the presence of relative movement of the load, different approaches to calculations are required than those conventionally used. The calculations are carried out in order to determine the type and stability of the load fastening depending on the magnitude of the inertial forces that arise. In this sense, a methodology is needed for calculating the forces that arise and for selecting the appropriate fastening, which will serve the transport companies.

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