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Naprave za varovanje tovora na cestnih vozilih - Varnost - 1. del: Izraļ un sil za zavarovanje tovora

Load restraint assemblies on road vehicles - Safety - Part 1: Calculation of securing forces

Ladungssicherungseinrichtungen auf Straßenfahrzeugen - Sicherheit - Teil 1: Berechnung von Sicherungskräften

Dispositifs d'arrimage des charges à bord des véhicules routiers - Sécurité - Partie 1: Calcul des forces de retenue

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Contents

Foreword

This document (prEN 12195-1:2008) has been prepared by Technical Committee CEN/TC 168 “Chains, ropes, webbing, slings and accessories - Safety”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 12195-1:2003.

EN 12195 consists of the following parts under the general title “*Load restraint assemblies on road vehicles – Safety*”:

Part 1: Calculation of securing forces

Part 2: Web lashing made from man-made fibres

Part 3: Lashing chains

Part 4: Lashing steel wire ropes

Annex A to Annex F are informative.

Introduction

This Part of EN 12195 has been prepared to provide one means of conforming with the essential safety requirements to calculate securing forces for load restraint assemblies to be used in the Common European Market and thus enabling the free movement of goods.

This Part of EN 12195 contributes to the harmonization of the calculation of load securing on road vehicles by defining the different procedures and equations of load securing.

Blocking and lashing procedures and appropriate combinations are described for load securing. The equations used are based on relevant scientific and, in particular, on mechanical laws and practical experience. For this purpose, a suitable vehicle with appropriate assemblies for blocking, bracing and securing is to be used to ensure safe load transportation. Transportation safety should be guaranteed by the dimensioning of load securing according to this Standard. The extent to which the hazards acting on the load during transport and resulting from the forces of load are addressed is given in the scope of this standard. In addition, load restraint assemblies for securing of loads on vehicles with respect to their securing and load bearing ability, which are not covered by this standard, should conform to the other parts of this standard and to EN ISO 12100 Part 2.

1 Scope

This Part of EN 12195 refers to the design of securing methods (blocking, lashing, and combinations) for securing of loads for surface transport by road vehicles or parts of them (lorries, trailers, containers and swap bodies), including their transport on vessels or by rail and/or combinations thereof. Hump shunting during railway transport is excluded. (Web lashings see EN 12195-2, lashing chains see EN 12195-3, lashing steel wire ropes see EN 12195-4).

This standard does not apply for vehicles with a total weight lower than 3,5 t.

Note: Lighter vehicles may have braking systems, which give higher values of acceleration on the road.

For dimensioning of load securing a distinction is made between steady loads and loads liable to tilting.

Furthermore, the acceleration coefficients for surface transport are specified.

For over top lashing the force loss in the tension force of the lashing at the outer edges between load and lashing is taken into account. The securing forces to be chosen for calculation in this EN 12195-1 are static forces produced by blocking or tensioning of lashings and dynamic forces, which act on the lashing as a reaction of the load movements.

Examples for the application of calculations are given in the Annexes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 12100-2, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

EN 12195-2:2000, *Load restraint assemblies on road vehicles — Safety — Part 2: Web lashing made from man-made fibres*

EN 12195-3, *Load restraint assemblies on road vehicles — Safety — Part 3: Lashing chains*

EN 12195-4, *Load restraint assemblies on road vehicles — Safety — Part 4: Lashing steel wire ropes*

EN 12640, *Securing of cargo on road vehicles — Lashing points on commercial vehicles for goods transportation - Minimum requirements and testing*

EN 12642:2006, *Securing of cargo on road vehicles — Body structure of commercial vehicles — Minimum requirements*

EN 1492-1, *Textile slings — Safety — Part 1: Flat woven webbing slings, made of man-made fibres, for general purpose use*

EN 1492-2, *Textile slings — Safety — Part 2: Roundslings, made of man-made fibres, for general purpose use*

3 Terms, definitions, symbols, units and abbreviations

For the purposes of this draft European Standard, the following terms, definitions, symbols, units and abbreviations apply.

3.1 General terms and definitions

3.1.1
load restraint assembly
systems and devices for the securing of loads

[EN 12195-2:2000]

3.1.2
lashing
securing method where bendable devices are used in the securing of the load on a load carrier

3.1.3
tensioning device
mechanical device inducing and maintaining a tensile force in a load restraint assembly (e. g. ratchets, winches, overcentre buckles)

[EN 12195-2:2000]

3.1.4
tension force indicator
device which indicates the force applied to the lashing system by means of the tension devices and movement of the load or elastic deformation of the vehicle body, acting on the lashing equipment

[EN 12195-2:2000]

3.1.5
attachment point
rigid part of the load, e. g. eyebolt, to place the load restraint assembly

3.1.6
lashing point
securing device on a load carrier to which a lashing may be directly attached .A lashing point can be e. g. an oval link, a hook, a D-ring, a lashing rail

3.1.7
standard tension force
S_{TF}
residual force after physical release of the handle of the tensioning device

[EN 12195-3:2001]

3.1.8
frictional lashing method
lashing procedure (e.g. top over) where the friction force is enhanced by adding a vertical force component to the weight of the load

3.1.9
direct lashing method
lashing procedure where the forces from the load are taken by the lashings to the fixed parts of a load carrier

3.1.10
blocking
securing method where the load lies flush against fixed structures or fixtures on the load carrier, may be in the form of headboards, sideboards, sidewalls, stanchions, wedges, supporting beams, bracing or other devices.

3.1.11
securing
locking, blocking, lashing or combination of blocking and lashing to secure a load to all directions on the load carrier to prevent sliding and tilting

3.1.12
bracing
method of blocking mostly wooden structure, fixed to the load carrier to keep a load in one ore more directions at its place.

3.1.13
unstable load
load which unsecured will tilt when exposed to the given accelerations

3.1.14
load carrier
device such as a vehicle, trailer, swap body, container etc. carrying load

3.1.15
locking
securing method where the load is secured by mechanical devices e.g. twist-locks on a load carrier

3.2 Definition of calculation parameters

3.2.1
mass of the load
m
mass which is to be secured

3.2.2
acceleration of the load
a
maximum acceleration of the load during a specific type of transportation

3.2.3
acceleration coefficient
c
coefficient which when multiplied by the acceleration due to gravity g gives the acceleration $a = c\,g$ of the load during a specific type of transportation

3.2.4
longitudinal force of the load
F_x
inertia force, which acts on the load as a result of the load carrier movements in its longitudinal axis (x-axis) ($F_x = m\, c_x\, g$)

3.2.5
transverse force of the load
F_y
inertia force, which acts on the load as a result of the load carrier movements in its transverse axis (y-axis) ($F_y = m\, c_y\, g$)

3.2.6
vertical force of the load
F_z
sum of forces that arise from the weight of the load and the inertia force which acts on the load ($F_z = m\, c_z\, g$) due to the load carrier movements during the transport in the vertical axis (z-axis) of a load carrier

3.2.7
estimated friction factor
μ
friction coefficient to be used in the equations based on practical tests and acting between the load and the adjoining surface

3.2.8
friction force
F_F
force acting due to the friction between load and adjoining surfaces against the movement of the load

3.2.9
blocking force
F_B
force acting on a blocking device in a specified direction

3.2.10
blocking capacity
BC
maximum force that a blocking device is designed to carry in a specified direction

3.2.11
number
n
number of lashings

3.2.12
tension force of a lashing
F_T
force in the lashing created by tensioning of a tensioning device

3.2.13
restraining force of a lashing
F_R
force carried by a lashing device to prevent movements of a load in relation to a load carrier during transport

3.2.14
lashing capacity
LC
maximum allowed force that a lashing device is designed to sustain in use

3.2.15
vertical lashing angle
α
angle between lashing and the horizontal plane

3.2.16
longitudinal lashing angle
β_x
angle between lashing and longitudinal axis (x-axis) of a load carrier in the plane of the loading area

3.2.17
transverse lashing angle
β_y
angle between lashing and transverse axis (y-axis) of a load carrier in the plane of the loading area

3.2.18
safety factor
f_s
factor to cover uncertainties of distribution of tension forces for frictional lashing

3.3 Symbols, units and terms

Table 1 — Symbols, units and terms

Symbol	Unit	Term
B	m	Total width of the load section
BC	kN	Blocking capacity
F	kN	Force
F_B	kN	Blocking force
F_R	kN	Restraining force of a lashing
F_T	kN	Tension force of a lashing
F_x	kN	Longitudinal force actuated by the load
F_y	kN	Transverse force actuated by the load
F_z	kN	Vertical force actuated by the load
F_F	kN	Friction force
F_{FM}	kN	Friction force as result of the vertical force F_z
F_{FR}	kN	Friction force as result of the restraining force F_R
F_{FT}	kN	Friction force as result of the tension force F_T
F_{LP}	kN	Maximum force to which a lashing point is designed
H	m	Total height of the load section
LC	kN	Lashing capacity
S_{TF}	kN	Standard tension force
a	m/s²	Acceleration
b	m	Lever arm of the standing moment
c	—	Acceleration coefficient
c_x	—	Longitudinal acceleration coefficient
c_y	—	Transverse acceleration coefficient
c_z	—	Vertical acceleration coefficient
d	m	Lever arm of the tilting moment
f_S	—	Safety factor for frictional lashing
g	m/s²	Gravitational acceleration
g_n	m/s²	Standard acceleration due to gravity g_n = 9,80665 m/s²
h	m	Lever arm of the lashing moment

Symbol	Unit	Term
i	—	Index for lashing lines
k	—	Coefficient of transmission
m	t	Mass of the load
n	—	Number of lashings
N	—	Number of rows
o	—	Number of lashings
p	m	Horizontal distance from the outer edge of the load to the point where the lashing acts on the load
r	m	Horizontal distance from the outer edge of the load to the tipping point
s	m	Vertical distance from the platform to the point where the lashing acts on the load
t	m	Vertical distance from the platform to the tipping point
w	m	Width of the load
α	°	Vertical lashing angle
β_x	°	Longitudinal lashing angle
β_y	°	Transverse lashing angle
μ	—	Estimated friction factor
μ_i	—	Internal friction

4 Acceleration coefficients

4.1 General

The acceleration coefficients given in the Tables 2, 3 and 4 are specified according to 3.2.2 and 3.2.3 as maximum values for a load on a vehicle for the specific type of transportation.

Combinations of longitudinal and transverse accelerations occurring during transport, e. g. values below the maximum values, are covered by the values of the tables.

Superposition of the weight of the load with high frequency stresses and occasional occurring shock loadings of short duration are absorbed by the elongation of the lashings and the shock absorber system of the lorries and trailers. This occurs without any significant increase of stress, so that this can be ignored for the purpose of this standard which gives a practical and not a scientific view.

4.2 Load on load carriers during road transport

The acceleration coefficients for load carriers during road transport shall be as given in Table 2.

Table 2 — Acceleration coefficients c_x, c_y and c_z during road transport

Securing in	Acceleration coefficients				
	c_x, longitudinally		c_y, transversely		c_z, vertically down
	forward	rearward	sliding only	tilting	
longitudinal direction	0,8	0,5	—	—	1,0
transverse direction	—	—	0,5	0,5/0,6[a]	1,0
[a] See 5.1					

4.3 Load on load carriers during rail transport

The acceleration coefficients for load carriers during rail transport shall be as given in Table 3.

Table 3 — Acceleration coefficients c_x, c_y and c_z during rail transport

Securing in	Acceleration coefficients				
	c_x, longitudinally		c_y, transversely	c_z, minimum vertically down	
	tilting	sliding		tilting	sliding
longitudinal direction	0,6	1,0	—	1,0	1,0
transverse direction	—	—	0,5	1,0	0,7

4.4 Load on load carriers during sea transport

The acceleration coefficients for load carriers during sea transport shall be as given in Table 4.

Table 4 — Acceleration coefficients c_x, c_y and c_z during sea transport

Sea area	Securing in	Acceleration coefficients		
		c_x, longitudinally	c_y, transversely	c_z, minimum vertically down
A	longitudinal direction	0,3	—	0,5
	transverse direction	—	0,5	1,0
B	longitudinal direction	0,3	—	0,3
	transverse direction	—	0,7	1,0
C	longitudinal direction	0,4	—	0,2
	transverse direction	—	0,8	1,0

NOTE See IMO regulations.

A Baltic Sea bordered in west by Jylland and in north by a line between Lysekil and Skagen

B West of Sea area A bordered in north by a line between Kristians and and Montrose, in west by UK and in south by a line between Brest and Land's End as well as the Mediterranean Sea

C Unrestricted

5 Methods of calculation

5.1 General

The general requirements for a safe transport are:

— the sum of forces in any direction equals zero;

— the sum of moments in any plane equals zero.

Web lashings according to EN 12195-2, lashing chains according to EN 12195-3 and lashing steel wire ropes according to EN 12195-4 have to sustain the forces and moments, longitudinally, transversely and vertically, the lashing and the cargo unit are supposed to sustain.

Generally, load securing consists of balancing the forces of a load by locking, blocking and/or lashing. Locking, a completely positive connection, is mainly used in the transport of containers and is not usually combined with lashings. Blocking results in a positive connection in the blocked direction only and therefore is often combined with lashings. This is taken into consideration in 5.3, 5.4 and 5.5.

The two basic lashing methods are:

— frictional lashing (see 3.1.8) which is characterized by a restraint that is produced by force on the loading area and a positive connection in the direction vertically down;

— direct lashing (see 3.1.9) which is a completely positive connection which permits the load to make small movements, the magnitudes of which depend on the elongation of the lashing and forces acting on the load.

For the design of direct lashing systems a conversion factor 0,85 of the estimated friction factor will be used in combination with μ without indices and is included in all appropriate equations.

The frictional lashing method is described in 5.4, the direct lashing method in 5.5.

For load of which the effectiveness of the load securing arrangements cannot be determined by means of calculations in this standard (e. g. for some non rigid goods), the calculations can be replaced by suitable tests reflecting basic design parameters (see Clause 7).

For unstable goods in combination with frictional lashing, the increased force in the lashing due to tilting of the goods should not exceed half of the LC. The number of lashings to be used should be the largest of the following two calculations:

— c_y = 0,5 calculated with $F_T = S_{TF}$

— c_y = 0,6 calculated with $F_T = 0{,}5\ LC$

alternatively direct lashing should be used based on

— c_y = 0,6 calculated with $F_R = LC$

5.2 Stability of unsecured load

The stability of a load should be determined both in longitudinal direction (x-axis) and in transverse direction (y-axis).

Using the designations of Figure 1, the stability condition for a load is specified as follows:

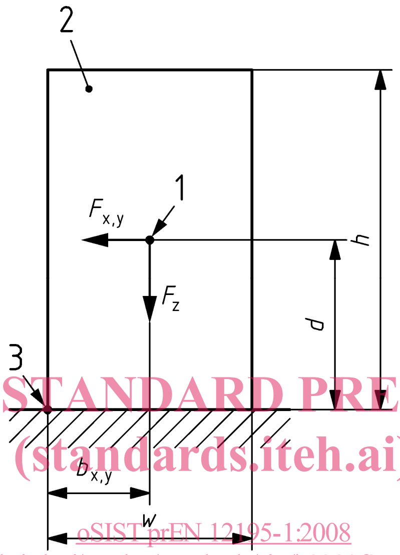
$$F_z \cdot b_{x,y} > F_{x,y} \cdot d$$

$$b_{x,y} > \frac{F_{x,y}}{F_z} d$$

$$b_{x,y} > \frac{c_{x,y}}{c_z} d \tag{1}$$

The quantities c_x, c_y and c_z are the acceleration coefficients in accordance with Clause 4 (For road transport c_y to be taken as 0,5).

If the condition of equation (1) is met, a load is stable. An unstable load will have a high centre of gravity in relation to the dimensions of the bottom surface. In the case of an unstable load the risk of tilting over has to be taken into account.



Key

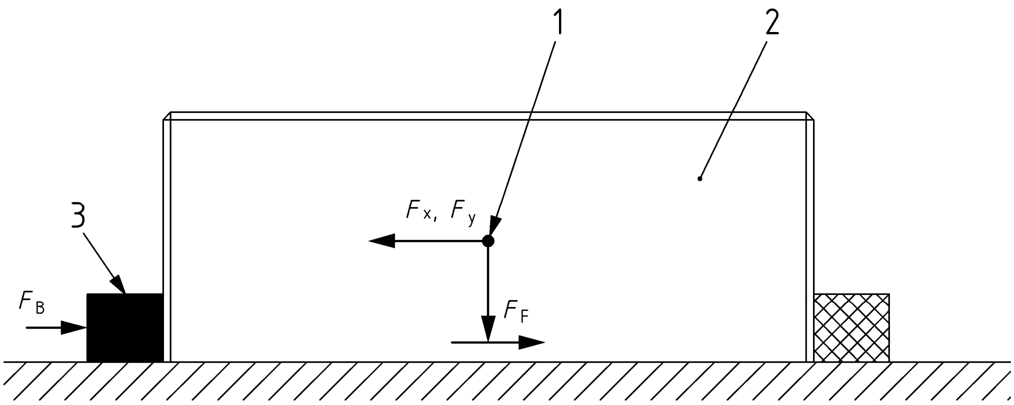
1 Center of gravity
2 Load
3 Tilting edge

Figure 1 — Stability of an unlashed load

5.3 Blocking

Blocking is the number one method for cargo securing, which always should be used if possible. Blocking is thus used to a very large extent in reality. If the blocking of a device is strong and height enough, it prevents sliding as well as tipping and no additional securing is required. Blocking should thus also be included under description of the used load securing arrangement.

For the design of blocking the estimated friction factor μ is to be used.



Key

1 Center of gravity
2 Load
3 Blocking device

Figure 2 — Load securing by blocking

The balance of forces in longitudinal or transverse direction are as follows:

$$F_B + F_F = F_{x,y}$$

$$F_B + \mu \cdot m \cdot c_z \cdot g = m \cdot c_{x,y} \cdot g$$

$$F_B = (c_{x,y} - \mu \cdot c_z)\, m \cdot g \qquad (2)$$

The equation for calculating the blocking capacity BC is as follows (see also Figure 2):

$$BC > (c_{x,y} - \mu \cdot c_z)\, m \cdot g \qquad (3)$$

where

BC	is the blocking capacity;
c_x, c_y and c_z	are the acceleration coefficients according to Clause 4;
g	is the gravitational acceleration;
m	is the mass of the load;
μ	is the estimated friction factor according to Annex B.

Blocking is the number one method for cargo securing, which always should be used if possible. Blocking of unstable load without lashing is only possible, if the blocking device is also designed to avoid tilting of the load, e.g. by bracing (see 5.2).

5.4 Frictional lashing

5.4.1 General

Frictional lashing, as shown in Figure 3, consists of tensioning the lashings to the tension force F_T so as to increase the friction force at the contact surface of the load to avoid any sliding of the load.