SLOVENSKI STANDARD
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Load restraining on road vehicles - Safety - Part 1: Calculation of securing forces

Ladungssicherung 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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Load restraining on road vehicles - Safety - Part 1: Calculation of securing forces

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Foreword

This document (EN 12195-1:2010) 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 European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2011, and conflicting national standards shall be withdrawn at the latest by May 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12195-1:2003.

The main changes compared to the previous edition of EN 12195-1 are:

a) title changed;

b) k-factor deleted;

c) tilting factor altered;

d) safety factors f_S = 1,1 and f_S = 1,25 and conversion factor f_μ = 0,75 for friction introduced;

e) Annex B on friction factors μ made normative and friction factors revised;

f) test methods for the determination of the friction μ and verification of securing arrangements included;

g) static and dynamic friction factors deleted and friction factors μ in accordance with Annex B introduced.

EN 12195, *Load restraint assemblies on road vehicles — Safety*, consists of the following parts:

— *Load restraining on road vehicles — Safety — Part 1: Calculation of securing forces*

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

— *Load restraint assemblies on road vehicles — Safety — Part 3: Lashing chains*

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This part of EN 12195 has been prepared to provide a 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 unrestricted transport of cargo.

This part of EN 12195 contributes to the harmonization of the calculation of load securing on road vehicles by giving 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 should be used to ensure safe load transportation. Transportation safety should be guaranteed by the dimensioning of load securing according to this European 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 European 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 European Standard, should conform to the other parts of this standard and to EN ISO 12100-2.

1 Scope

This European Standard is applicable 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 with acceleration over 1 g during railway transport is excluded, as it is not foreseen in combined transport. (Web lashings see EN 12195-2, lashing chains see EN 12195-3, lashing steel wire ropes see EN 12195-4).

This European Standard does not apply for vehicles with a total weight equal to or lower than 3 500 kg.

NOTE Lighter vehicles can have driving characteristics, which give higher values of acceleration on the road.

For dimensioning of load securing a distinction is made between stable 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 Annex A.

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

EN 12195-3:2001, *Load restraint assemblies on road vehicles — Safety — Part 3: Lashing chains*

EN 12195-4:2003, *Load restraint assemblies on road vehicles — Safety — Part 4: Lashing steel wire ropes*

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

EN ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

3 Terms, definitions, symbols, units and abbreviations

For the purposes of this document, the following terms, definitions, symbols, units and abbreviations apply.

3.1 General terms and definitions

3.1.1
lashing
securing method where bendable devices are used in the securing of the load on a load carrier

3.1.2
lashing device
flexible device used in the securing of the load on a load carrier

3.1.3
tensioning device
mechanical device inducing and maintaining a securing force in a load restraint assembly

EXAMPLES Ratchets, winches, overcentre buckles.

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

3.1.5
attachment point
rigid part of the load to place the load restraint assembly and lashing devices

3.1.6
lashing point
securing device on a load carrier to which a lashing device may be directly attached

NOTE 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 lashing devices are fixed directly to the solid parts of the load or to attachment points, that are intended for this purpose, and to the load carrier

3.1.10
blocking
securing method where the load lies 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 or 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
road vehicle or part of it

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

3.2 Terms and 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 $a = c \times g$ of the load during a specific type of transportation

3.2.4
longitudinal force actuated by the load
F_x
inertia force, actuated by 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 actuated by the load
F_y
inertia force, actuated by 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 actuated by the load
F_z
sum of forces that arise from the weight of the load and the inertia force actuated by 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
friction factor
μ
friction coefficient between the load and the adjoining surface

3.2.8
internal friction factor
μ_i
friction coefficient between rows of unstable loads, forming a load unit

3.2.9
friction force
F_F
force acting due to the friction between load and adjoining surfaces against the movement of the load

3.2.10
blocking force
F_B
force acting on a blocking device in a specified direction

3.2.11
blocking capacity
BC
maximum force that a blocking device is designed to carry in a specified direction

3.2.12
number
n
number of lashing devices or lashing lines

3.2.13
tension force of a lashing device
F_T
force in the lashing device created by tensioning of a tensioning device

3.2.14
restraining force of a lashing device
F_R
force carried by a lashing device to prevent movements of a load in relation to a load carrier during transport

3.2.15
lashing capacity
LC
maximum allowed force that a lashing device is designed to sustain in use

3.2.16
vertical lashing angle
α
angle between lashing device and the horizontal plane

3.2.17
longitudinal lashing angle
β_x
angle between lashing device and longitudinal axis (x-axis) of a load carrier in the plane of the loading area

3.2.18
transverse lashing angle
β_y
angle between lashing device and transverse axis (y-axis) of a load carrier in the plane of the loading area

3.2.19
safety factor
f_S
factor to cover uncertainties of distribution of tension forces for frictional lashing

3.2.20
conversion factor
f_μ
ratio of the dynamic friction factor and friction factor in accordance with Annex B

3.2.21
lashing line
working leg of one or more lashing devices

3.3 Symbols, units and terms

Table 1 — Symbols, units and terms

Symbol	Unit	Term
B	m	Total width of the load section
BC	N	Blocking capacity
F	N	Force
F_B	N	Blocking force
F_R	N	Restraining force of a lashing device
F_T	N	Tension force of a lashing device
F_x	N	Longitudinal force actuated by the load
F_y	N	Transverse force actuated by the load
F_z	N	Vertical force actuated by the load
F_F	N	Friction force
F_{FM}	N	Friction force as result of the vertical force F_z
F_{FR}	N	Friction force as result of the restraining force F_R
F_{FT}	N	Friction force as result of the tension force F_T
F_{LP}	N	Maximum force to which a lashing point is designed
H	m	Total height of the load section
LC	daN	Lashing capacity
S_{TF}	daN	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
f_μ	—	Conversion factor
g	m/s²	Gravitational acceleration
h	m	Lever arm of the lashing moment
i	—	Index for lashing lines
ℓ	m	Length of the load
m	kg	Mass of the load
n	—	Number of lashing devices
N	—	Number of rows

Table 1 *(continued)*

Symbol	Unit	Term
p	m	Horizontal distance from the outer edge of the load to the point where the lashing device acts on the load
q	—	Number of lashing lines
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 device 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
φ	°	Test angle
μ	—	Friction factor
μ_i	—	Internal friction factor

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 load carrier for the specific type of transportation.

Combinations of longitudinal and transverse accelerations occurring during transport are covered by the values of the tables.

In case of combination of different modes of transport the maximum relevant acceleration coefficient, as appropriate, has to be taken into account.

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 lashing devices 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 European Standard which gives a practical and not a scientific view.

Even for cargo with no risk of sliding or tilting, measures (e.g. blocking or lashing) shall be taken to avoid them to be significantly displaced due to vibrations.

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	
	sliding	tilting		sliding	tilting
longitudinal direction	1,0	0,6	—	1,0	1,0
transverse direction	—	—	0,5	0,7	1,0

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/ILO/UNECE, Guidelines for packing of cargo transport units (CTUs).

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 Kristiansand 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.

Load securing devices and aids, as e.g. wedges, web lashing devices 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 restraint device 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 lashing devices. Blocking results in a positive connection in the blocked direction only and therefore is often combined with lashing devices. This is taken into consideration in 5.3, 5.4 and 5.5.

All calculation equations given in this European Standard are based on symmetrical (longitudinal and transverse) lashing methods. If the lashings are made unsymmetrical, this shall be taken into account when calculations are performed; this is not dealt with in this European Standard.

The two basic lashing methods are:

— frictional lashing (see 3.1.8);

— direct lashing (see 3.1.9).

For the design of the direct lashing method a conversion factor f_μ = 0,75 will be used in combination with μ and is included in all appropriate equations.