GRAND-DUCHÉ DE LUXEMBOURG
Administration des douanes et accises

Load Securing

2025 Edition

INTRODUCTION

Photo: News report by television channel SBS6, April 2025

This tragic accident was caused by an emergency braking manoeuvre deliberately triggered by another vehicle. The truck driver, forced to brake violently, was unable to prevent the load from piercing the front wall and entering the cabin. This dramatic case reminds us that the road is no place for settling scores. Truck drivers play a vital role in our daily lives — without them, no goods would ever reach their destination.

Yet, such emergency braking can occur at any moment during a journey — whether in urban areas, on highways, or in roundabouts. Thus, it is essential to emphasize that proper load securing is an absolute priority — all too often neglected. This type of accident brutally underlines the importance of prevention, mutual respect on the road, and a collective commitment to safety, for both drivers and other road users.

Most trucks operate with trailers covered by tarpaulins that protect the load from the weather conditions and also hide its contents and how it is secured. Each time officers from the Customs and Excise Administration carry out an inspection, the same question arises: “What surprise awaits us behind that tarpaulin — or rather, behind that curtain?”

That is precisely why our inspections are so important. Faulty or missing load securing can not only damage the cargo and vehicle but also pose a real danger to the driver and other road users. While general principles govern load securing, each type of cargo presents specific challenges depending on the nature of the goods being transported — their shape, weight, packaging, fragility, and so on.

The time required to properly secure a load is often overestimated. However, when the vehicle is suited to the cargo and the securing equipment is available, it takes little time to fasten the load professionally and efficiently.

During inspections, officers distinguish between minor, major, or critical defects. Often, adding a few extra straps is enough before continuing the journey. However, in some cases, a specialized company must be called in to lift the load, place an anti-slip mat between the cargo and the truck bed, or even

transfer the load onto another truck if the original vehicle is not suitable. These operations can take several hours — even one or two days — and result in additional costs for the carrier wishing to resume transport.

Although a minimum amount of time must be invested to ensure correct load securing, it is better to depart late than to risk an accident. Proper securing from the moment of loading saves time during inspections and ensures that the goods arrive in good condition — while guaranteeing the safety of all road users.

In the Grand Duchy of Luxembourg, in the event of an accident, the carrier (technical manager of the company), the driver, and the loader may all be held liable. To guarantee safe transport, it is crucial that the carrier provides a vehicle appropriate for the type of cargo and the necessary securing equipment. The carrier must also ensure that their personnel is properly trained.

The driver must use the equipment provided, monitor the correct securing of the load, and remain vigilant throughout the journey. The carrier also has a duty to supervise the truck loader during loading operations. It is essential to ensure that the vehicle is not overloaded — whether in total weight or per axle — and that the load is placed as close as possible to the vehicle's centerline.

The quality of the loading and securing is a key factor in road safety. A driver may avoid a roadside inspection, but not the laws of physics in the event of emergency braking or an accident.

Indeed, it is impossible to predict what might happen during transport — even over short distances. At any time, a driver may have to react to their own moment of inattention or to that of another road user.

Almost daily, Luxembourg's radio stations report incidents of lost loads due to inadequate securing. These incidents can cause serious traffic jams, harm the environment, or even endanger the driver and other road users.

This brochure aims to guide the reader in acquiring the necessary knowledge to properly secure cargo — and thereby prevent the load from shifting during hard braking, sudden evasive manoeuvres, on poorly maintained roads, or when starting on an incline.

Jeroen Schaus

Inspecteur principal 1er en rang

Ken Schmitz

Contrôleur adjoint

"Load securing is often based purely on assumptions and the hope that nothing will happen. However, when an incident occurs, it is not the result of a chain of unfortunate circumstances, but rather the consequence of inadequate load securing. No load secures itself."

– Excerpt from the awareness video "Volltreffer", produced by BG Verkehr (2005)

Attention si vous circulez sur l'A13 et l'A4, un camion a perdu son chargement. L'accident provoque des perturbations sur les deux autoroutes.

Selon nos premières informations, l'incident s'est déroulé ce vendredi en milieu de matinée sur l'A13, en direction de la bretelle avec l'A4. Cette dernière est de ce fait temporairement fermée.

Un camion aurait perdu une partie de sa cargaison, qui semble être de la peinture blanche. La police et les services de secours sont sur place.

Plus d'informations à venir.

Disclaimer!

The information in this brochure has been compiled with care and translated with the help of AI. However, errors cannot be ruled out and no guarantee of accuracy can be assumed. This publication provides general guidance on load securing. The authors accept no liability for personal injury, property damage, or financial loss.

TABLE OF CONTENTS

Overview of key points to observe for each transport!

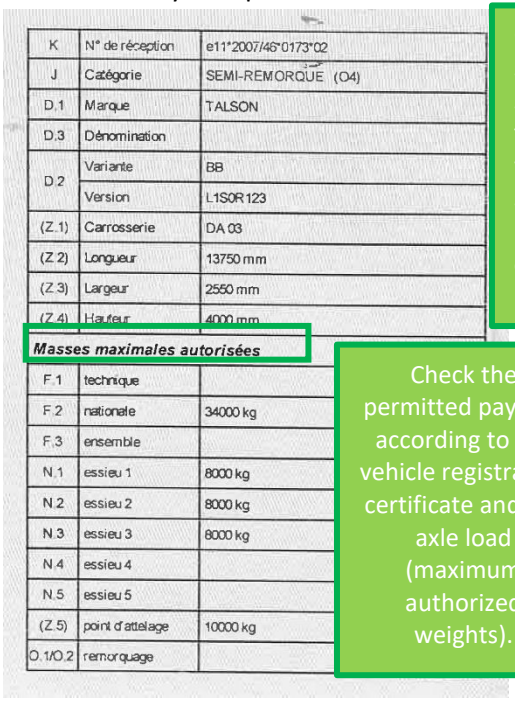
Proper and legally compliant load securing includes the following essential rules.

Load securing begins even <u>before</u> the actual loading process.

The following rules will help ensure safe and effective load securing.

1. Choosing an appropriate vehicle

This is very important. Not all vehicles are suitable for every type of load.



K	N° de réception	e11*2007/46*0173*02
J	Catégorie	SEMI-REMORQUE (O4)
D.1	Marque	TALSON
D.3	Dénomination	
D.2	Variante	BB
	Version	L1S0R123
(Z.1)	Carrosserie	DA 03
(Z.2)	Longueur	13750 mm
(Z.3)	Largeur	2550 mm
(Z.4)	Hauteur	4000 mm
Masses maximales autorisées		
F.1	technique	
F.2	nationale	34000 kg
F.3	ensemble	
N.1	essieu 1	8000 kg
N.2	essieu 2	8000 kg
N.3	essieu 3	8000 kg
N.4	essieu 4	
N.5	essieu 5	
(Z.5)	point d'attelage	10000 kg
O.1/O.2	remorquage	

Check the sufficient strength of the front wall, rear wall, and sideboards (Manufacturer's certificate EN 12642).

Check the permitted payload according to the vehicle registration certificate and the axle load (maximum authorized weights).

Zertifikat zur Ladungssicherung durch den Fahrzeugaufbau
Anforderungsprofil und Ladevoraussetzungen

1. Angaben zum Fahrzeug

Fahrzeughersteller: WECON GmbH
Nutzfahrzeug- Containertechnik
An der Hansalinie 10
59387 Ascheberg

Fahrzeugtyp: Aufbauten für Motorwagen und Anhänger X 610 – 820 NVSGA

Fahrzeug -Identifizierungsnummer:

max. technische Nutzlast : 13.000 kg

Abmessungen außen L / B / H: max. 8.200 / 2.550 / 3.200 mm

Fahrzeugaufbau: Curtainsideraufbau

Der Fahrzeugaufbau erfüllt die Anforderungen der DIN EN 12642 Code *XL*

2. Angaben zur Ausstattung des Fahrzeugs

Der Fahrzeugaufbau ist dann in der Lage, die unter Punkt 4 genannten Ladegüter bei Einhaltung der unter Punkt 3 genannten Ladebedingungen zu sichern, wenn folgende Ausstattungskomponenten vorhanden sind:

Nachgewiesene max. Prüfkräfte (DIN EN 12642)

- **Stirnwand** mit Siebdruckplatte — **6.500 daN**
- **Seitenwände** — **5.200 daN**
  Min. 1 Paar Wecon Rungen
  Palettenanschlagleisten beidseitig
  Einsteckbretter wahlweise aus Holz oder Aluminium
  Plane Schiebeplane Panamaqualität,
  Vertikalgurtabstand max. 600 mm,
  Horizontalgurte Abstand max. 650 mm
- **Rückwand** Heckportal
  Hecktüren mit 4 Scharnieren und 2 innenliegenden Drehstangenverschluß je Flügel — **5.160 daN**
- **Dach** Autocar Schiebeverdeck, wahlweise als Hubdach

Der Zustand des Fahrzeugaufbaus ist gem. VDI 2700 regelmäßig zu überprüfen.

Dieses Zertifikat umfasst 2 Seiten und hat nur in vollständiger Form Gültigkeit.
Stand 06/2009

Those that exceed the permitted payload as indicated on the vehicle registration:

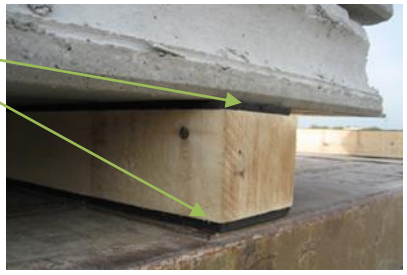
- endanger road safety ;
- can damage the vehicle ;
- damage road infrastructure (especially in cases of axle overload).

2. Cleanliness and good condition of the loading platform

- **no sand, even when using anti-slip mats ;**
- free from oil and grease ;
- free from snow and ice;
- use of anti-slip mats.

Advantage of anti-slip mats:

- increases the coefficient of friction (**µ of 0.6 guaranteed**), even on wet surfaces ;
- fewer securing operations required = fewer straps needed.



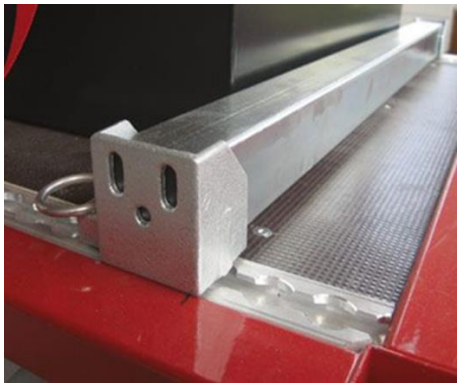
Caution: Anti-slip mats must not be replaced by ordinary rubber mats!

3. No unnecessary empty spaces between the individual loads or between the load and the walls

In the event of emergency braking, cargo generates immense forces. To prevent these forces from developing, the load must be placed tightly against the wall (with a maximum gap of 2 cm). Otherwise, there is a significant risk of the load breaking through the wall, rendering blocking ineffective. Thus, it is essential to eliminate empty spaces and to ensure that the walls and sideboards are strong enough to withstand such forces (refer to the manufacturer's certificate).

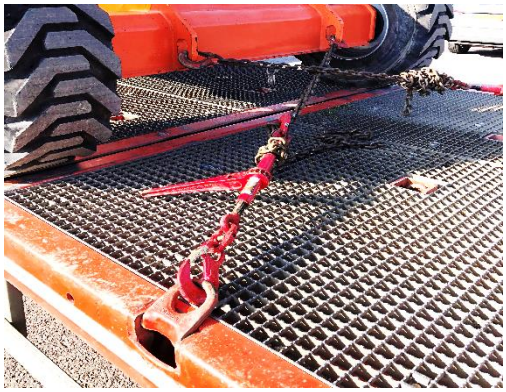
4. The securing method best suited to the load

One must choose the most suitable securing method(s) based on the characteristics of the load (locking, blocking, direct lashing, frictional lashing, or head loop lashing).



Safety securing (Blocking)

Frictional securing / Over-top lashing



Direct lashing

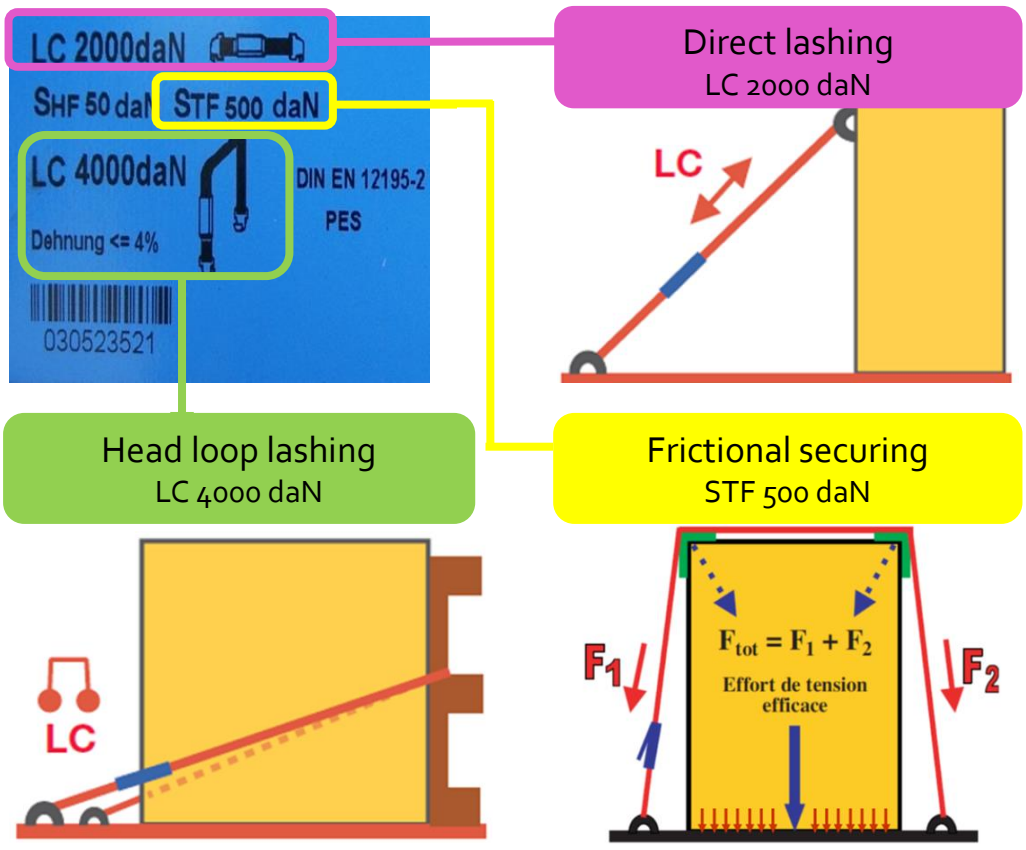
Head loop lashing

Only stable load units can be properly secured using frictional lashing:

In cases, where a load does not have a stable base, the load must be adjusted or an alternative securing method should be used.

5. The number and type of straps and/or chains to optimally secure the load

The actual load capacities of the straps or chains used must be known, depending on the chosen securing method(s). Naturally, the general condition of the securing equipment must also be checked before use (straps, p.39; chains, p.43).



Head loop lashing: LC in loop = LC value × 2

Frictional lashing: It is important to use straps with a high Standard Tension Force (STF). The higher the STF, the fewer straps are needed! Always use at least two straps — this provides additional stability for the load.

6. Optimal use of straps and chains

Use of appropriate angles

The optimal strap angle for frictional lashing, lies between 75 and 90 degrees.

For direct lashing:

– Alpha angle (between the loading surface and the securing device): 20 to 65 degrees

– Beta angle (between the longitudinal direction and the horizontal lashing line): 15 to 45 degrees

Use of edge protectors / corner protectors

A balanced distribution of the tension force is only possible with edge or corner protectors. Additionally, the straps are protected against wear and cutting.

Applying appropriate tension

It is highly recommended to tighten the straps to the last notch in order to achieve optimal tension. Measurement tests have shown that the final notches are crucial for the strap's final tension force.

7. Checking the strength of the lashing points (EN 12640)

One must take care not to load the lashing points beyond their LC (Lashing Capacity).

This is especially important when using direct lashing.

For example:

When transporting a **heavy** machine, the load limit of the lashing points must exceed the minimum required by **EN 12640** in order to withstand the forces involved.

Permissible tensile force of lashing points:	
Vehicles with a GVW between **3.5 t and 7.5 t**	**800 daN**
Vehicles with a GVW between 7.**5 t and 12 t**	**1.000 daN**
Vehicles with a GVW **over 12 t**	**2.000 daN**
Lashing points on the **front wall**	**1.000 daN**

8. The driver and driving behaviour

It is advisable to drive smoothly and **adjust the speed to the circumstances in order to avoid sudden changes in direction or abrupt braking**. This helps to keep the forces exerted by the load to a minimum.

Time and money can be unnecessarily lost if ineffective load securing is detected by customs officers during a roadside inspection, and they insist on:

- The placement of anti-slip mats;
- The transfer of the load onto another truck

The quality of the loading and securing contributes to the safety of all road users.

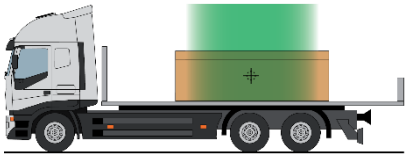
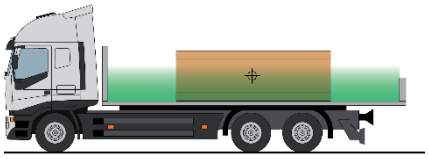
The consequences can be fatal for the driver or for other road users.

Other factors to consider

The centre of gravity

Although positioning the load against the front wall is very important, one must take care to ensure that this does not affect the vehicle's driving stability.

Each time the load is (un)loaded or redistributed, check the cargo for any overloading and/or improper weight distribution before setting off. Make sure the load is arranged so that the center of gravity of the total load is as close as possible to the longitudinal axis and positioned as low as possible: heavier goods at the bottom, lighter goods on top.

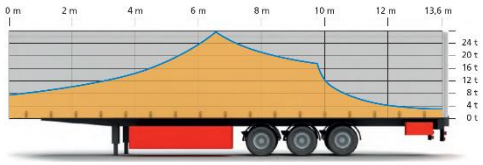



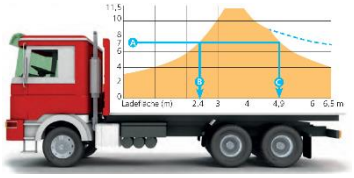

Load distribution

It is advisable to consult your vehicle's load distribution diagram. Each vehicle has a specifically defined distribution plan.

The load distribution diagram provides information on the permitted load weights depending on the position of the centre of gravity measured from the front wall.

This diagram is only valid for one specific vehicle.





Title I – European and national legal provisions

Chapter 1 – European law

DIRECTIVE 2014/47/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 3 April 2014

on the technical roadside inspection of the roadworthiness of commercial vehicles circulating in the Union and repealing Directive 2000/30/EC

Article 13

Inspection of cargo securing

1 During a roadside inspection a vehicle may be subject to an inspection of its cargo securing in accordance with Annex III, in order to ensure that the cargo is secured in such a way that it does not interfere with safe driving, or pose a threat to life, health, property or the environment. Checks may be carried out to verify that during all kinds of operation of the vehicle, including emergency situations or uphill starting manoeuvres:
- loads can only minimally change their position relative to each other, against walls or surfaces of the vehicle;
- loads cannot leave the cargo space or move outside the loading surface.

2 Without prejudice to the requirements applicable to transport of certain categories of goods, such as those covered by the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) (13), cargo securing and inspection of the securing of cargo may be carried out in accordance with the principles and, where appropriate, the standards laid down in Section I of Annex III. The latest version of the standards laid down in point 5 of Section I of Annex III may be used.

3 The follow-up procedures referred to in Article 14 may also apply in the case of major or dangerous deficiencies related to cargo securing.

4 Member States shall provide that personnel involved in cargo securing checks are to be appropriately trained for that purpose.

Annex III of Directive 2014/47/EU.

Principles of cargo securing

1 Cargo securing shall withstand the following forces resulting from accelerations/decelerations of the vehicle:
- in driving direction: 0,8 times the weight of the cargo and
- in lateral direction: 0,5 times the weight of the cargo and
- against driving direction: 0,5 times the weight of the cargo,
- and in general must prevent tilting or tipping of cargo.

2 The distribution of cargo shall take into account the maximum authorised axle loads as well as the necessary minimum axle loads within the limits of the maximum authorised mass of the vehicle, in line with the legal provisions on weights and dimensions of vehicles.

3 During the securing of cargo, the applicable requirements regarding the strength of certain vehicle components, such as the headboard, sideboard, endboards, stanchions or lashing points, shall be taken into account when those components are used for the cargo securing.

4 For the securing of cargo, one or more or a combination of the following restraining methods may be used:

- locking;
- blocking (local/overall);
- direct lashing;
- top-over lashing.

5 **Applicable standards:**

Standard	Subject
— EN 12195-1	Calculation of lashing forces
— EN 12640	Lashing points
— EN 12642	Strength of vehicle body structure
— EN 12195-2	Web lashings made from man-made fibres
— EN 12195-3	Lashing chains
— EN 12195-4	Lashing steel wire ropes
— ISO 1161, ISO 1496	ISO container
— EN 283	Swap bodies
— EN 12641	Tarpaulins - Part 1 Tarpaulins - Part 2
— EUMOS 40511	Poles — Stanchions
— EUMOS 40509	Transport Packaging

Explanatory note on European standards

European standards are non-binding guidelines which specify technical requirements for products, services, and processes. They are developed by the "CEN", the European Committee for Standardization. At the national level, national standardization bodies adopt and publish these standards. In Luxembourg, the competent body is the Luxembourg Institute for Standardization, Accreditation, Safety, and Quality of Products and Services (ILNAS).

Journal officiel du Grand-Duché de Luxembourg

Directive 2014/47/EU of the European Parliament and of the Council of 3 April 2014 is transposed into national law by:

a. LAW of 26 January 2016 amending the amended law of 14 February 1955 on the regulation of traffic on all public roads (Mémorial A – No. 8/2016)

b. GRAND-DUCAL REGULATION of 26 January 2016 amending the amended Grand-Ducal Regulation of 23 November 1955 on traffic regulations on all public roads (Mémorial A – No. 8/2016))

GRAND-DUCAL REGULATION of 23 November 1955 establishing traffic regulations on all public roads

Art. 8. (Code de la route)

1. Without prejudice to the provisions of paragraph 1 of Article 12, the load of a road vehicle **must be positioned and secured—and, if necessary, blocked, locked, or lashed**—in such a way that it does not:

   - **pose a danger to persons or cause damage to public or private property;**
   - **drag on the public road, fall onto it, or compromise the vehicle's handling and stability;**
   - **impair the driver's visibility;**
   - **generate avoidable noise.**

   Removable equipment that forms an integral part of a road vehicle is considered part of the vehicle's load and must therefore be secured according to the same principles.

2 **Dusty, volatile, or vaporizing substances**, as well as animal remains, **must be transported under a closed cover or in sealed packaging.**

These provisions do not apply to materials directly related to agricultural or viticultural activities, or to products derived from such activities.

3 **The load of a road vehicle must be secured using straps, chains, or cables fixed to the loading platform or the side walls, or by means of sliding crossbars, adjustable supports, inflatable bags, or any other anti-slip locking** device that is appropriately and sufficiently effective.

All devices used for blocking, locking, lashing, covering, or protecting the load must be sized to withstand all forces and torques exerted by the load and must hold it tightly to prevent any loss of contents. They must also be securely fastened to prevent loosening during transport. Under no circumstances may they drag on the ground or swing outside the limits of the load. However, snow removal or clearing equipment may touch the road surface.

4 The lashing forces and the minimum number of securing devices required must be calculated in accordance with the provisions of standard EN 12195-1.

Straps, chains, and cables used for securing the load of a road vehicle must comply with the requirements of standards EN 12195-2, EN 12195-3, and EN 12195-4, respectively.

The requirements of this paragraph do not apply to the loads of towed vehicles.

5 Compliance with obligations related to the proper and compliant loading and securing of cargo, as well as the use of appropriate securing equipment, is the responsibility of the owner or holder of the road

vehicle, the driver, and the person who performed the loading. However, if the cargo is taken over on a trailer or in a container that has been preloaded and sealed by a competent national authority, the driver of the vehicle cannot be held responsible for that load.

Art. 50bis.

The provisions of Articles 2 to 50 place obligations on both the owner and the driver.

Chapter 3 – The right to immobilize a vehicle

Art. 17.

Paragraph 1

Officers of the Customs and Excise Administration are entitled to immobilize a vehicle on public roads, either by taking the ignition keys from the driver or by using a mechanical immobilization device, when:

1. the driver of a vehicle who does not have their normal residence in Luxembourg is in breach of road traffic legislation—specifically regarding **the configuration of vehicles and their loads**, license plates, identification numbers, or vehicle documents—or road transport legislation, and fails to pay the on-the-spot fine or, alternatively, to deposit the required guarantee amount; in such cases, **customs officers are also entitled to retain the vehicle's documents until the fine is paid or the guarantee is deposited.**
2. the vehicle either shows a serious irregularity in terms of its documents, exceeds the maximum authorized weight by more than 10%, or has an obvious technical defect likely to seriously endanger road safety.

Title II – Definitions

There are specific types of bodywork for rigid trucks, trailers, or semi-trailers intended for the road transport of goods, namely:

Tautliner (curtainsider, tarpaulin trailer)

This is a system of sliding curtains suspended by rollers running in tracks on the upper structure of the vehicle and secured at the chassis level with tensioning straps. This system allows the full length of the vehicle to be opened for side loading (with a forklift) or top loading (with an overhead crane).

Savoyarde (box body with removable tarpaulin)

This refers to a rigid truck, trailer, or semi-trailer equipped with a steel or aluminium frame covered by a tarpaulin.

Box body (Van body)

This refers to a rigid truck, trailer, or semi-trailer with a fully enclosed body made entirely of aluminium.

Friction coefficient (μ)

The friction coefficient is denoted by μ. **The higher this value**, the greater the resistance to slipping (e.g., anti-slip mat μ = **0.6**).

The friction coefficient depends on the nature of the contact surface between the load and the loading platform.

Estimated friction coefficients (μ) for common goods and surfaces to be used in calculations	
Contact surface material combination a)	**Friction coefficient μ**
Sawn timber	
Sawn timber against Bakelite-coated fabric/plywood	0,45
Sawn timber against grooved aluminum	0,4
Sawn timber against shrink film	0,3
Sawn timber against stainless steel plates	0,3
Planed wood (Pallets)	
Planed wood against Bakelite-coated fabric/plywood	0,3
Planed wood against grooved aluminum	0,25
Planed wood against stainless steel plates	0,2
Plastic pallet	
Plastic pallet against Bakelite-coated fabric/plywood	0,2
Plastic pallet against grooved aluminum	0,15
Plastic pallet against stainless steel plates	0,15
steel and metal frames	
Steel frame against Bakelite-coated fabric/plywood	0,45
Steel frame against grooved aluminum	0,3
Steel frame against stainless steel plates	0,2
concrete surfaces	
Rough concrete – sawn timber battens	0,7
Smooth concrete – sawn timber battens	0,55
Anti-slip mat a)	
Anti-slip mat	**0,6** [b]
Other material	As certified [c]

a) Clean surface, free of oil, frost, and grease.
b) May be used with fμ = 1.0 for direct lashing.
c) When using special materials designed to increase friction—such as anti-slip mats—a certificate is required to confirm the friction coefficient μ

It must be ensured that the friction coefficients used apply to the actual transport conditions. If the contact surfaces are not clean and free of frost, ice, and snow, a friction coefficient higher than μ = 0.2 (or μ = 0.3 for maritime transport) must not be used. Special precautions must be taken for oily or greasy surfaces.

TABLE B1 – EN 12195-1 Standard

IMPORTANT!!

- **No sand, even when using anti-slip mats;**
- **Free from oil and grease;**
- **Free from snow and ice.**

Otherwise, the values in TABLE B1 of EN 12195-1 can no longer be applied!

Various friction coefficients (μ) published by DEKRA (Certification and Audit Organization):

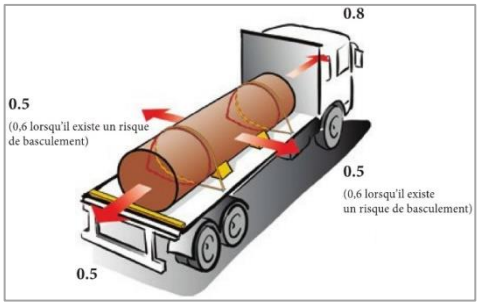
- Tyres on steel loading platform (wet, dirty): μ = 0.15
- Tyres on steel loading platform (dry, clean): μ = 0.45
- Straw bale on wooden floor: μ = 0.45
- Straw bale on straw bale: μ = 0.40
- Crate of beverages on wooden pallet: μ = 0.32
- Stainless steel drum upright on wooden pallet: μ = 0.49
- Welded mesh on welded mesh: μ = 0.2.

Title III – Forces acting on the vehicle

Chapter 1 – The laws of physics

Consequences of physical laws on loading and securing cargo

A heavy load on the bed of a truck may seem impossible to move. This assumption holds true when the vehicle is stationary and a person attempts to move the load manually. However, in reality, the heavier the load, the greater its energy if it begins to move relative to the truck bed. As a result, if the cargo is not firmly secured, it will tend to shift in all directions as soon as the vehicle starts moving. Therefore, it is essential to firmly connect the load to the vehicle.



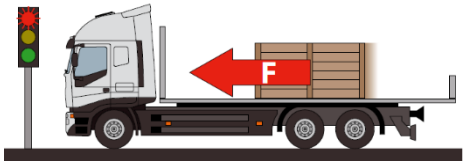
Based on of the gravitational force of the load, the following three values are to be respected:

Forward securing: maximum	**0.8 Fg**	**corresponds to 80% of the weight of the load.**
Lateral securing: maximum	**0.5 Fg**	**corresponds to 50% of the weight of the load.**
Rear securing: maximum	**0.5 Fg**	**corresponds to 50% of the weight of the load.**

Explanation of forces acting on cargo during transport

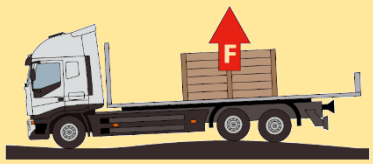
Acceleration force

When the vehicle starts moving, the cargo tends to slide towards the rear.



Deceleration force

When braking, the cargo tends to slide forward. The heavier the load and the harder you brake, the greater the force exerted on the cargo.



Vertical (uplift) forces

Shocks, vibrations, and oscillations generate inertial forces that may cause the cargo to lose contact with the loading platform.

Centrifugal force

Centrifugal forces act on the vehicle and its cargo when going through turns. They tend to push both the vehicle and the load toward the outside of the turn.

Taking a turn at excessive speed exposes the vehicle to extreme stress and risks.

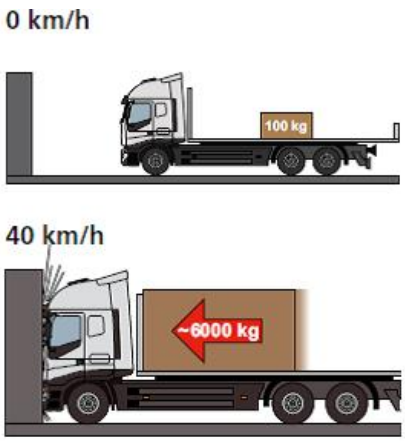
Particular caution is required in the following situations:

- during sudden evasive manoeuvres;
- during rapid lane changes;
- in roundabouts → Half the turning radius = double the centrifugal force;
- on highway exit ramps.

When a load shifts toward the outside of a turn, even at low speed, there is a high risk of the cargo and the vehicle to tip over.

Kinetic energy

It is the energy a body accumulates as it gains speed.
If the mass of a moving object is doubled, its energy is also **doubled**.
However, if the speed of the object is doubled, the stored energy is multiplied **by four**.



Mass m / unité kg

Mass is directly related to the amount of matter contained in a body. Isaac Newton recognized that a body's mass is inert, meaning it resists any change in its state of motion.

Weight force (F_G)	$F_G = m \times g$

The force due to weight acts at the centre of gravity. It is the perpendicular force exerted by the load on the loading surface. It is the product of the mass and the acceleration due to gravity. The weight force is calculated using the gravitational acceleration g = 9.81 m/s².

Mass m = 1kg	F_G = 1 kg x 9.81 m/s² = 9.81 N Simplified Example : (using g = 10 m/s²))
	F_G = 1 kg x 10 m/s² = 10 N = 1daN → **Simplified Rule: 1kg = 1daN**
Example:	F_G = 1000 kg x 9.81 m/s² = 9810 N = 981 daN → **Simplified Rule 1000 daN**

Force due to mass (F)	F = m × a

The force due to mass (F), also called inertial force or centrifugal force, acts at the centre of gravity.
It is the product of the mass and the actual acceleration of the vehicle.
If the vehicle is stationary or moving at a constant speed, then **F = 0**.

Friction force (F_F)	$F_F = F_G \times \mu$

μ = Friction coefficient

The friction force (F_F) resists any movement of the cargo. It depends on the structure of the surfaces in contact and on the weight force (F_G). It is calculated as: $F_F = \mu \times F_G$

The higher the coefficient of friction (μ), the more friction forces contribute to cargo securing. To achieve the maximum friction coefficient, the loading surface must be dry and clean. Any impurities between the contact surfaces (such as sand or abrasion particles) must be removed using appropriate cleaning measures, as they can significantly reduce friction.

Chapter 2 – General principle of load securing

Securing force F_S :	$F_S = F - F_F$

Securing force F_B :	$F_B = F - F_F$

In order to prevent the load from shifting, the sum of all forces at all points must equal zero.

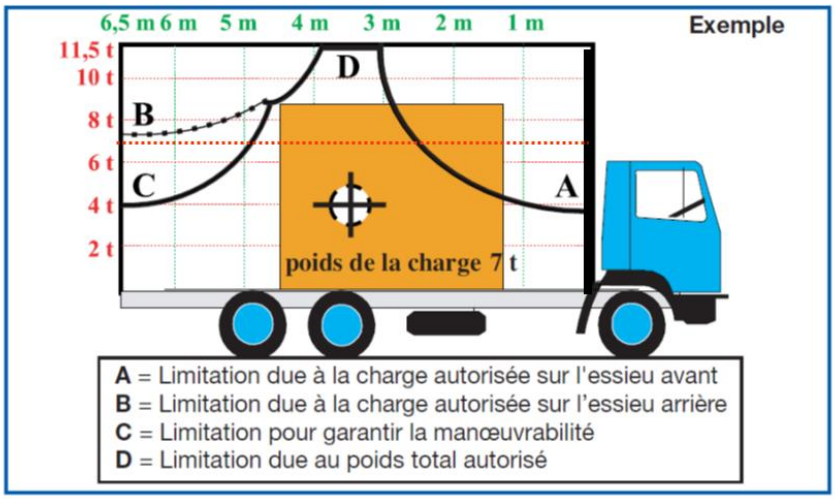
In other words, a residual force must be generated — this is either the required securing force (F_S) or blocking force (F_B).

The securing force (F_S) or blocking force (F_B) must be generated using securing equipment. Load securing is also achieved through the blocking capacity (BC) of the front wall or bulkhead.

The cargo can only remain in position if the sum of the friction force, the securing force, and the blocking force is equal to or greater than the inertial force acting on the load.

Load distribution

Load distribution plan



The cargo must be secured so that the centre of gravity of the entire load is, as far as possible, aligned with the vehicle's central longitudinal axis. It should also be positioned as low as possible to ensure maximum stability. Overloading must be strictly avoided, and proper weight distribution is essential. Even partially loaded vehicles require a balanced and uniform distribution of weight and forces to maintain safe driving conditions and prevent load shifts.

A load distribution plan provides the necessary information to ensure compliant and safe loading of the vehicle.

- A (rough) visual estimation of load distribution is often made when the vehicle is not equipped with a load distribution plan.
- Loading in reverse order of delivery locations may make unloading easier, but it often fails to comply with the proper load distribution plan.

As a result, improperly loaded vehicles may become overloaded, especially on certain axles. Such imbalances have negative effects on braking performance and manoeuvrability, making the vehicle dangerous to operate.

An improper or non-compliant load can cause road accidents, as the vehicle's handling behaviour may change drastically.

The load distribution plan is specific to each vehicle, depending on several technical characteristics, such as axle load limits, maximum authorized total weight, wheelbase

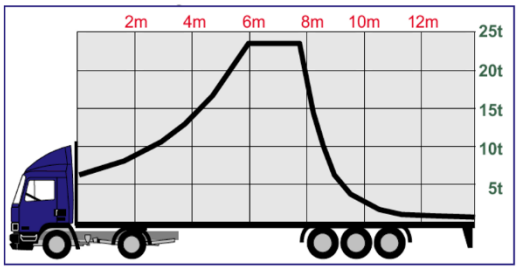
Dimensions and intended use of the loading platform The required load distribution on the platform can vary significantly depending on vehicle body structures, such as a tail lift or a loading crane, because even their own dead weight affects the balance of an unloaded vehicle. Therefore, a dedicated load distribution plan should be available for each individual vehicle.

Improper load distribution can lead to:

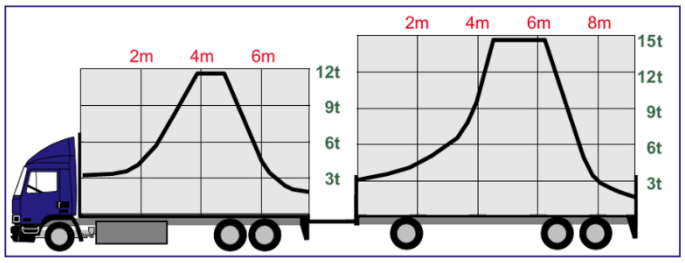
- **Vehicle rollover, even at low speed;**
- **Jack-knifing of the entire vehicle combination;**
- **Loss of directional control during braking;**
- **Difficulty maintaining the intended trajectory.**

The following diagrams provide a simplified representation of load distribution plans for various types of vehicles. They must not be applied directly to actual vehicles under any circumstances.

Véhicule semi-remorque

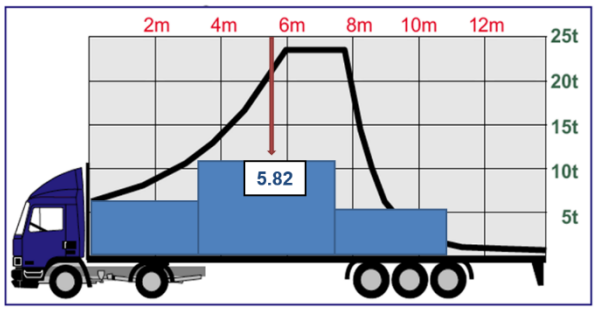


Camion remorque



In practice, drivers and loaders are often required to load packages of varying sizes and weights (groupage freight). In such cases, it is necessary to calculate the position of the center of gravity of the entire combined load.

Véhicule semi-remorque



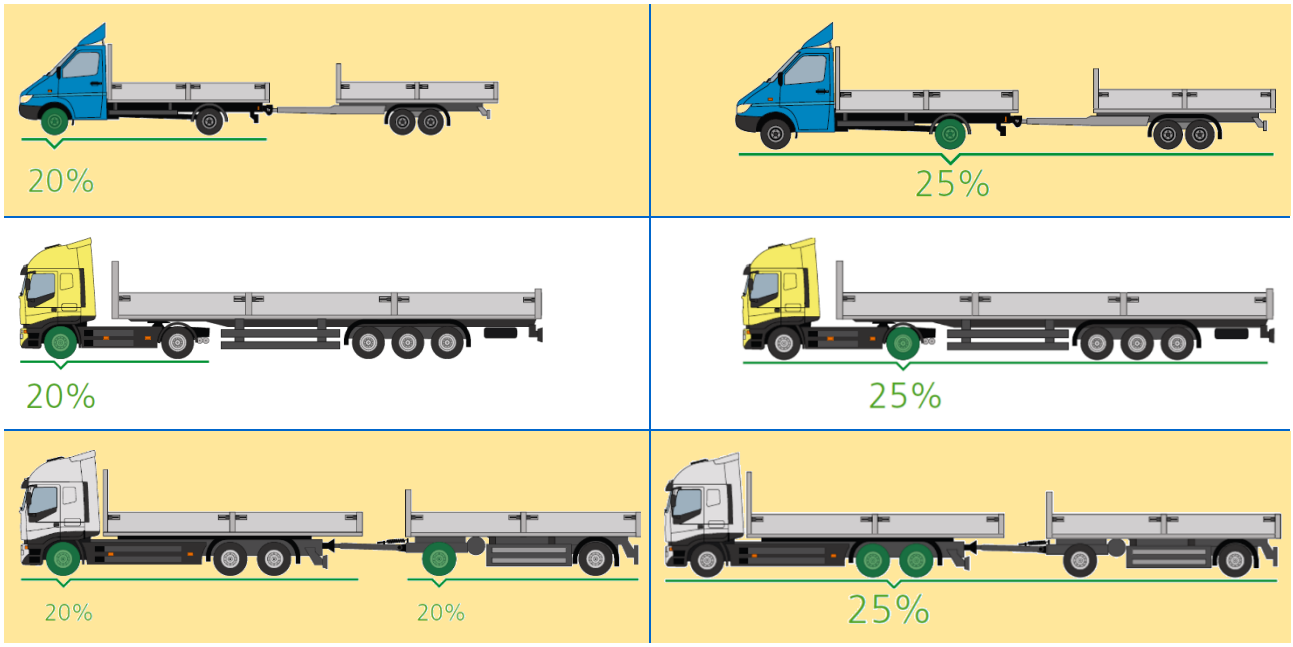
Actual weights and axle loads

Maximum axle loads indicated **on the vehicle registration document** provide information about how the actual weight is distributed across the axles. These too are subject to legal requirements: naturally, the maximum values must be respected.

In addition, the following principles apply to all vehicles, regardless of their size:

- Load on the steering axle(s): **at least 20%** of the vehicle's actual weight. Only under this condition can the vehicle be safely steered in all driving situations.
- Load on the drive axle(s): **at least 25%** of the actual weight, including the trailer. Only under this condition can the vehicle apply sufficient traction or braking force to the road.

There are no specific legal requirements for the minimum load on the rear axles of trailers.



Overload on the rear axle. As a result, the minimum 20% load on the steering axle is not ensured.

The vehicle cannot be steered safely.

Chapter 3 – Lashing points on vehicles (EN 12640)

The EN 12640 standard defines the minimum requirements for lashing points on commercial vehicles intended for the transport of goods with a maximum authorized mass exceeding 3.5 tonnes

Permissible tensile force of lashing points:	
Vehicles with a GVW between **3.5 t and 7.5 t**	**800 daN**
Vehicles with a GVW between **7.5 t and 12 t**	**1.000 daN**
Vehicles with a GVW **over 12 t**	**2.000 daN**
Lashing points on the **front wall**	**1.000 daN**

The standard does not apply:

- **To vehicles that are exclusively designed for the transport of bulk goods;**
- **To vehicles intended for the transport of special goods with specific requirements for load securing.**

The number of lashing points depends, among other things, on the length of the loading platform.

- The maximum distance between the front wall and the first lashing point is 50 cm;
- The distance between two lashing points must be at least 70 cm and no more than 120 cm (up to 150 cm above the axles);
- The front wall must be equipped with two lashing points.

The permissible tensile force (load limit of the lashing points) is determined by the maximum authorized mass of the vehicle.

The lashing points and their permissible tensile force must be marked on the loading platform.

According to standard EN 12640, lashing points may also be designed as lashing rails. There are also other types of **variable lashing point systems**. All of these systems allow the user to anchor the lashing equipment where it is needed on the vehicle to secure the load

IMPORTANT !!

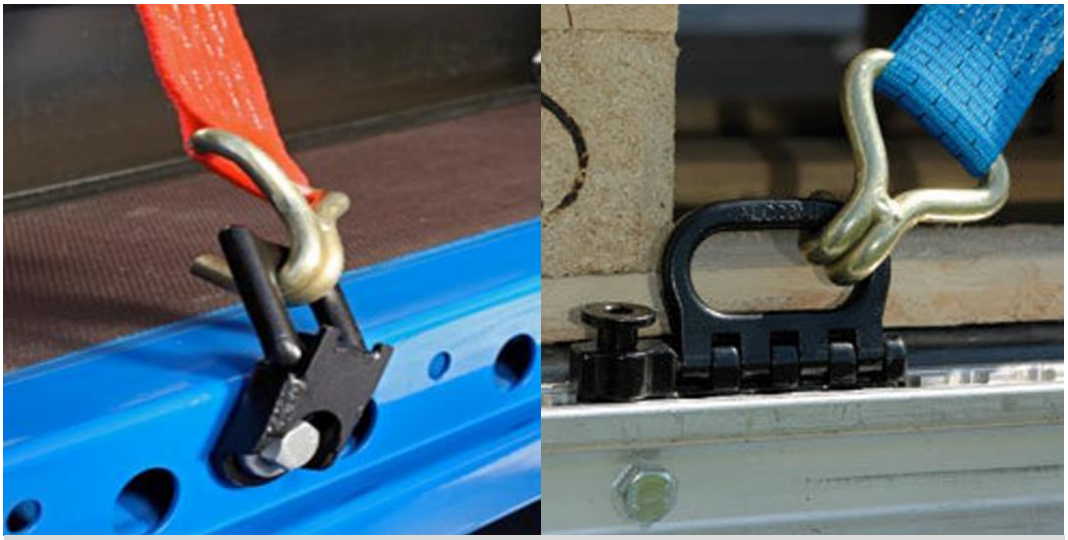
Check the strength of the lashing points according to EN 12640 (see table above)!

Do not overload the lashing points beyond their LC!

This is especially important for direct lashing!

If the capacity of the lashing equipment or the lashing point is exceeded:

- improve the coefficient of friction using an anti-slip mat;
- optimize the lashing angles by changing the lashing points on the flatbed or trailer;
- use lashing equipment with an appropriate capacity;
- secure the load with blocking devices (safety lashing);
- use a trailer with lashing points that exceed the minimum load capacity required (e.g. LC 5000 / LC 8000 / LC 10.000 daN) instead of the 2000 daN required by EN 12640 for vehicles with a gross weight over 12 tonnes.



Examples of variable lashing point systems

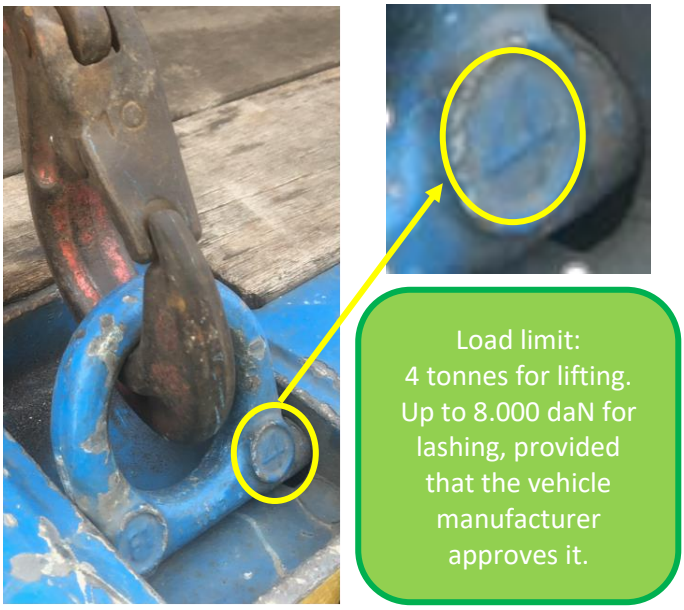
Each hole in the chassis serves as a lashing point. A maximum of 3 lashing points can be used per meter. Each anchoring point has a capacity of 2000 daN.

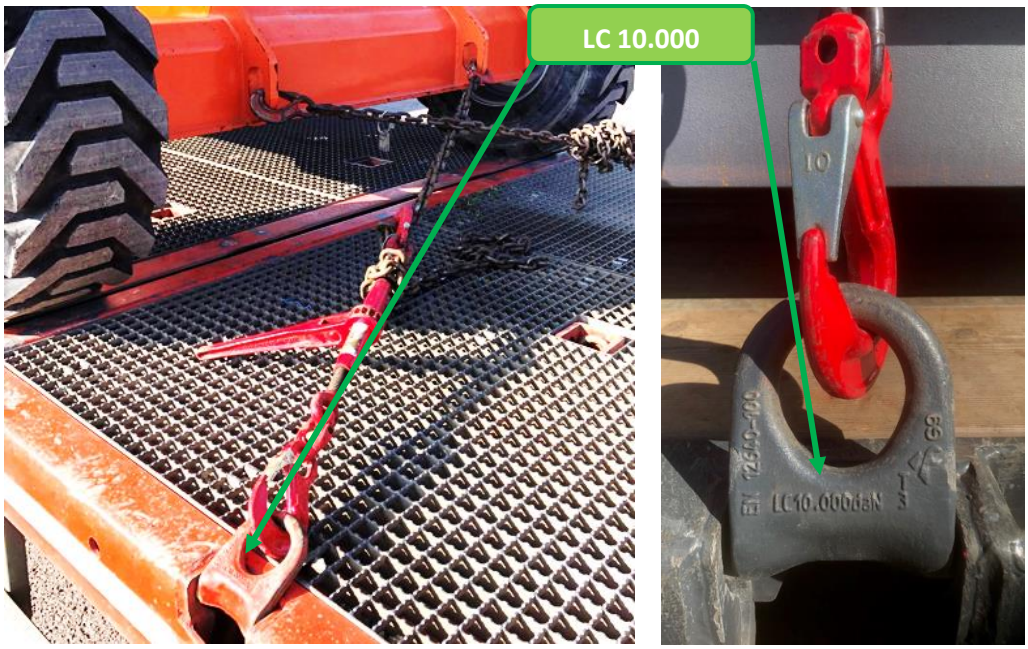
Using multiple hooks on a single lashing point is only allowed if the lashing point (+12t = 2000 daN) is not overloaded and the hooks are used correctly.

Lashing points with an exceptional load limit

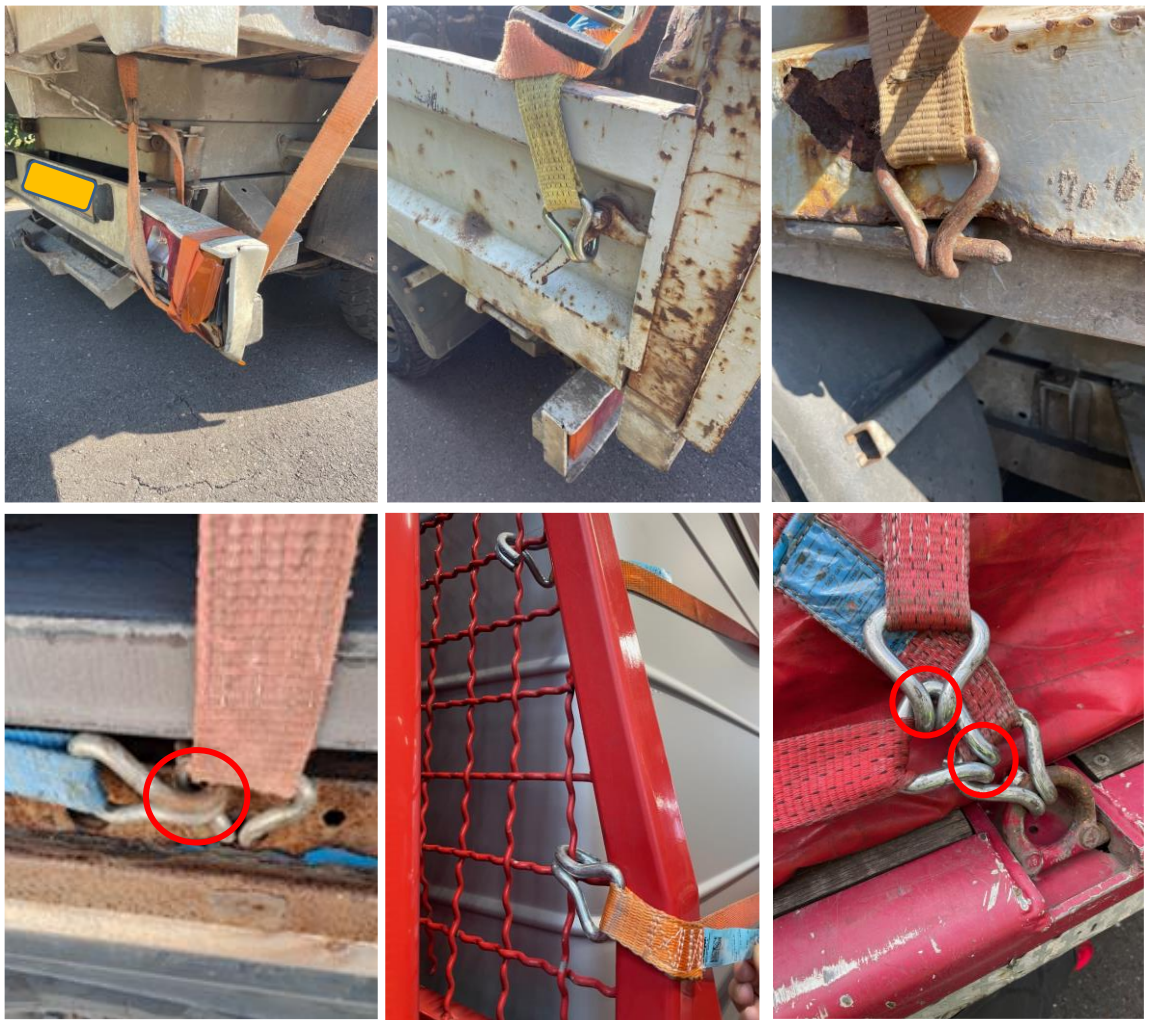
Lashing points with an exceptional load limit are generally used on special-purpose vehicles.

The load limit of these points exceeds the requirement set by EN 12640. Manufacturers often assign them an identification number.





These are not lashing points!



Chapter 4 – Structure of the bodywork of commercial vehicles according to EN 12642

A suitable vehicle is essential for safe transportation. In practice, the following aspects must be considered regarding load securing:

- type of product;
- type of packaging;
- quantity loaded;
- transport route;
- external conditions.

Before loading, it must be checked whether the vehicle is suitable for transporting the given cargo.

In principle, all loads must be secured!

However, there are exceptions:

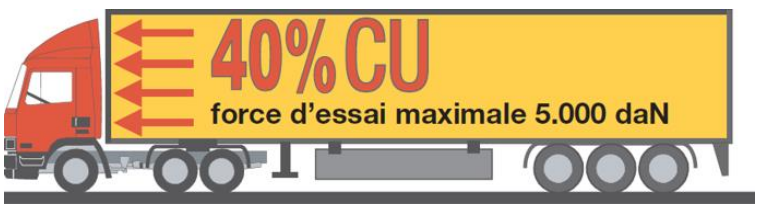
- Bulk products in an open container or in an open tipper. The load **must not** exceed the walls, and the load must not be able to be carried away by the wind;
- Safety securing (page 57) of a load on a vehicle with a sufficiently strong body structure.

EN 12642 - Code L

Trucks and trailers with a maximum authorised mass of more than 3.5 tonnes, built after April 2002, must comply with the body strength requirements of the European construction standard **EN 12642 L.**

The following load limit values are the test criteria of the EN 12642 standard. The body structure must not show any permanent deformation under the test loads.	
• Front wall	• 40 % of the payload, maximum test force 5.000 daN
• Rear wall	• 25 % of the payload, maximum test force 3.100 daN
• Side wall	• 30 % of the payload Fourgon / Savoyarde Tautliners (0%) 1-2007 Tautliners (15%) 1-2017
These values may only be applied in the case of safety (block) load securing!	

Front wall load limit / Front Bulkhead limit

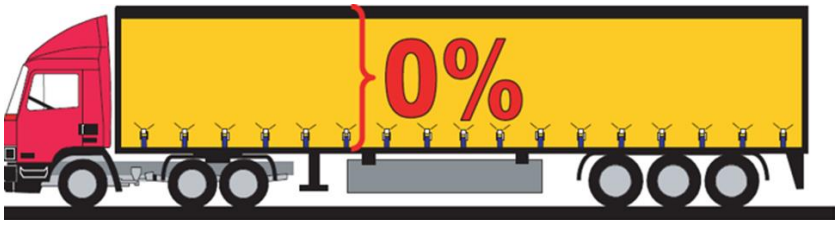


Side wall load limit (Tautliner)

The load limit of the lateral sliding tarp was not regulated by the European standard EN 12642 – April 2002 version. As a result, a sliding tarp is, in principle, not suitable for load securing.

According to EN 12641-2, the tarp is designed solely for weather protection and is not intended to absorb the forces required for securing cargo. In January 2007, standard EN 12642 was revised and supplemented with Code XL.

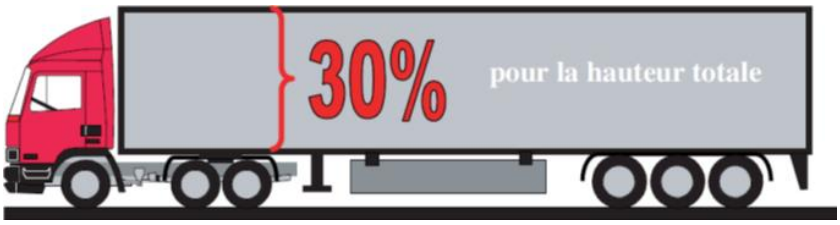
The most recent version dates from January 2017.



EN 12642, 2007 – 2017 version → 0% over the entire height.

EN 12642, from 2017 onwards ► 15% → over ¾ of the height!!

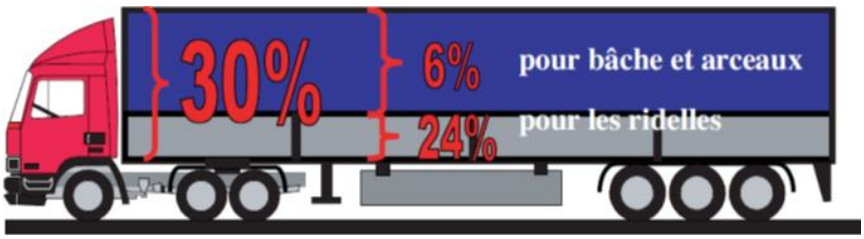
Side wall load limit (Fourgon)



EN 12642 / before 2017 → 30% over the full height

EN 12642 / 2017 → 30% over ¾ of the height!!

Side wall load limit (Savoyarde)



EN 12642 – 2007 et 2017

Note: The above-mentioned values may only be applied in the case of safety (block) load securing.

Rear wall load limit / Rear Bulkhead limit

EN 12642 - Code XL

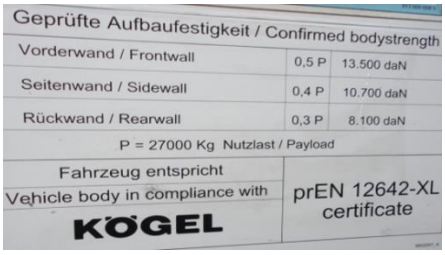
Reinforced body structure of commercial vehicles – EN 12642 "Code XL"

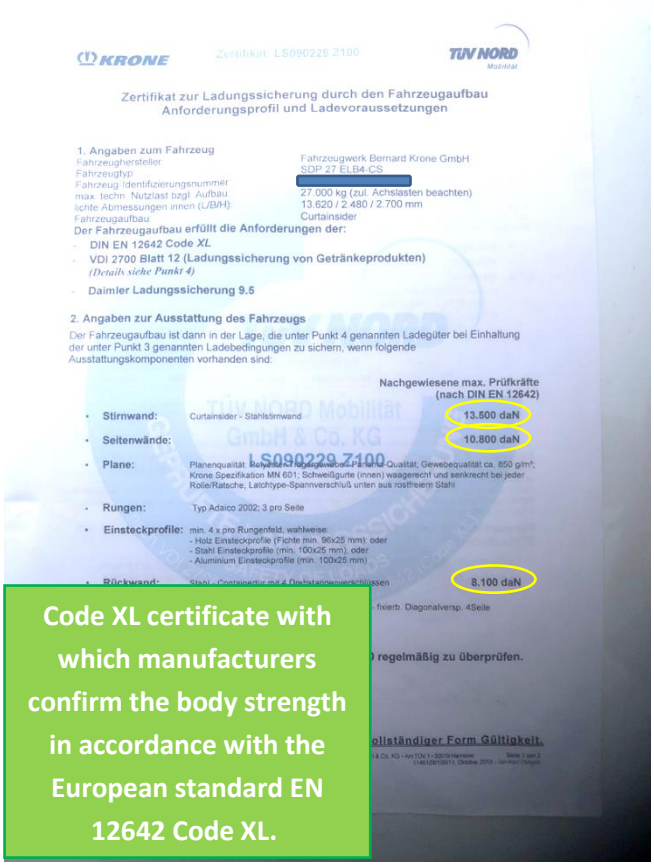
In January 2007, the European standard EN 12642 was revised. Currently, the most recent version is from January 2017.

On this occasion, body structures were divided into two categories:

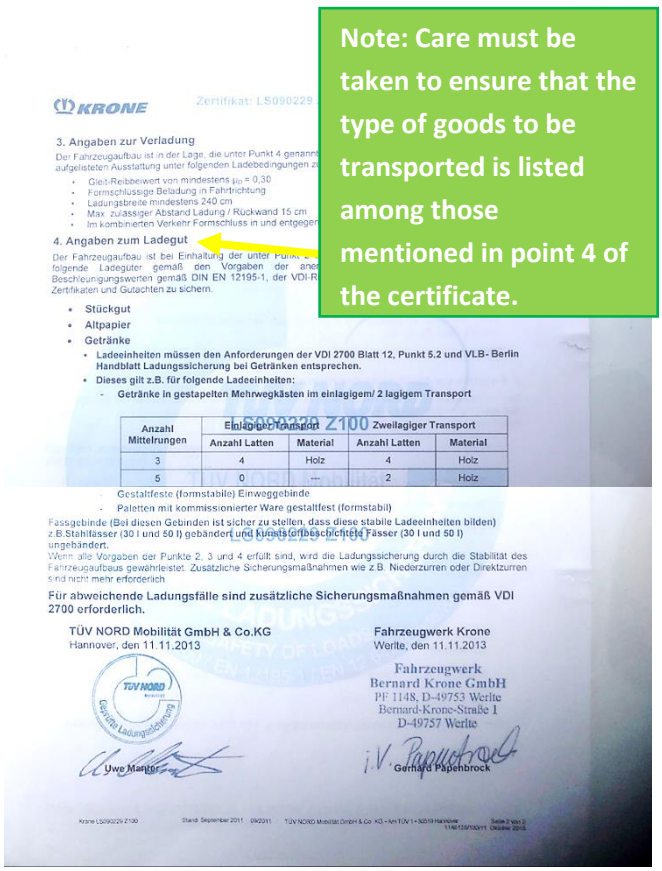
- Code L ➧standard body structures
- Code XL ➧reinforced body structures

Plates by which manufacturers confirm the body structure strength in accordance with the European standard EN 12642 "Code L" and Code XL.





Code XL certificate with which manufacturers confirm the body strength in accordance with the European standard EN 12642 Code XL.



Note: Care must be taken to ensure that the type of goods to be transported is listed among those mentioned in point 4 of the certificate.

Load securing according to Code XL: principles and limitations

All tests carried out by vehicle manufacturers are conducted using a simulated load of 27 tonnes, usually consisting of beverage crates. These crates, equipped with stacking edges, can be stacked to form a rigid and stable loading unit, or even a proper tower.

When this tower tips against the side wall—for example, during a sharp turn—it remains generally coherent thanks to the mechanical interlocking of the crates. The load, estimated at around 10.8 tonnes (40% of 27t to the side), does not exert direct and concentrated pressure on the side wall, since the crates support each other. In such cases, the wall acts as a temporary support without undergoing deformation.

However, this behaviour is only possible if the load forms a non-deformable unit. For this reason, the Code XL can only guarantee effective load retention when dealing with stable, compact, and properly distributed cargo. In addition, lateral, longitudinal, and vertical clearances between the goods and the vehicle's walls should be kept small wherever possible.

Periodic inspection

A vehicle certified XL is, in principle, not subject to a mandatory periodic inspection. However, such an inspection—e.g., annually—is strongly recommended as a good practice, especially in the event of damage or signs of wear. The strength guaranteed by Code XL is only valid if the structural integrity remains intact.

Limitations of the front wall – Code XL

The EN 12642 Code XL standard requires that the front wall withstands a force equivalent to 50% of the payload (e.g., 13.5 t for a total weight of 27 t). Tests are conducted with an evenly distributed load; however, in real-world conditions, an unsecured or poorly positioned load can exert a highly localized pressure that the wall may not be able to withstand—even if it is certified Code XL.

The front wall must absorb the pressure forces that result, in particular, from sudden braking or load displacement. The way this load is distributed over the surface directly impacts the mechanical stress exerted on the wall.

There is a significant difference between applying a 10-tonne load over a one-meter width and distributing it across the entire front wall surface.

<u>Case 1: 10 tonnes over 1 meter width</u>

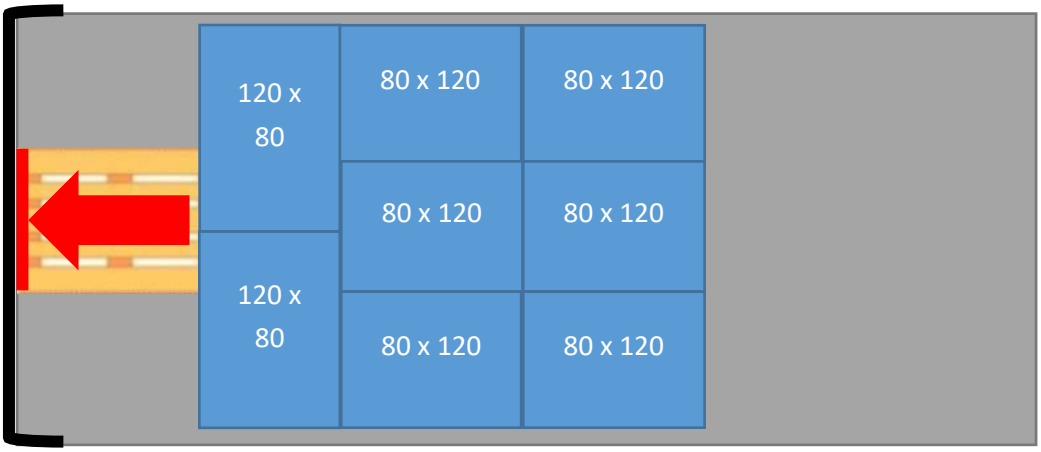
- The load is highly concentrated on a **small surface**;
- This generates **very high local pressure** (force per m^2);
  10 tonnes per meter of width;
- This may cause **deformation, bending, or localized structural failure** of the front wall.

<u>Case 2: 10 tonnes distributed across the entire surface (2.40 m – 2.50 m)</u>

- The load is **evenly spread out**;
- **The stress** on each point of the wall **is reduced**;
  4 tonnes per meter of width;
- The wall can better absorb and distribute the force **without risk of damage**.

A concentrated load is significantly more critical for the front wall than a distributed load.

It is therefore not enough to know the total mass — the load distribution must also be properly managed.



But how can a poorly distributed load like in the previous image be neutralized?

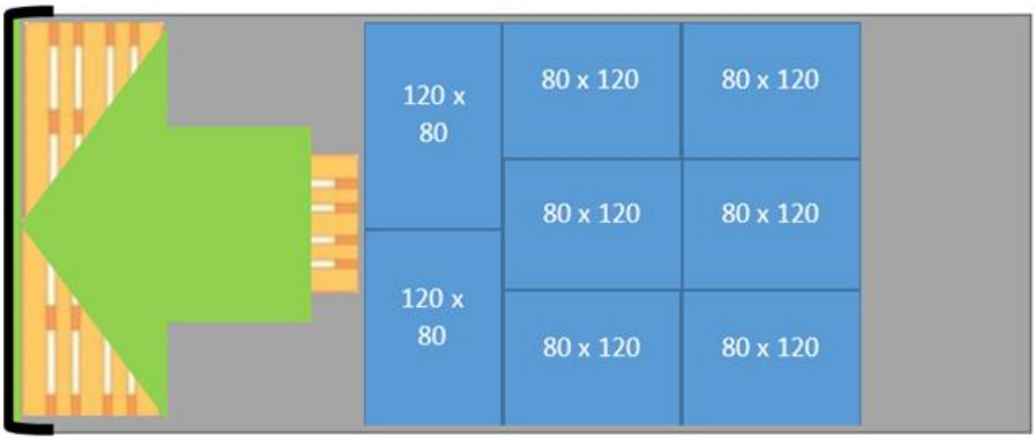
Solution 1

Placing solid wooden pallets across the full width (e.g., 2.5 m) in front of the front wall allows the applied force to be distributed — even if the main load is concentrated over just one meter. The pallets act as a buffer element or a distribution plate:

- They spread the localized pressure over a wider surface;
- The force on the wall is then distributed not over 1 m, but across 2.5 m of wall;
- This reduces the linear pressure (t/m) exerted on the front wall.

Necessary conditions:

- Pallets:
    - in good condition, solid, not damaged;
    - positioned across the full width (≈ 2.5 m) and properly secured;
    - must be in direct contact with the front wall.
- The load must be able to transfer its pressure to the pallets.

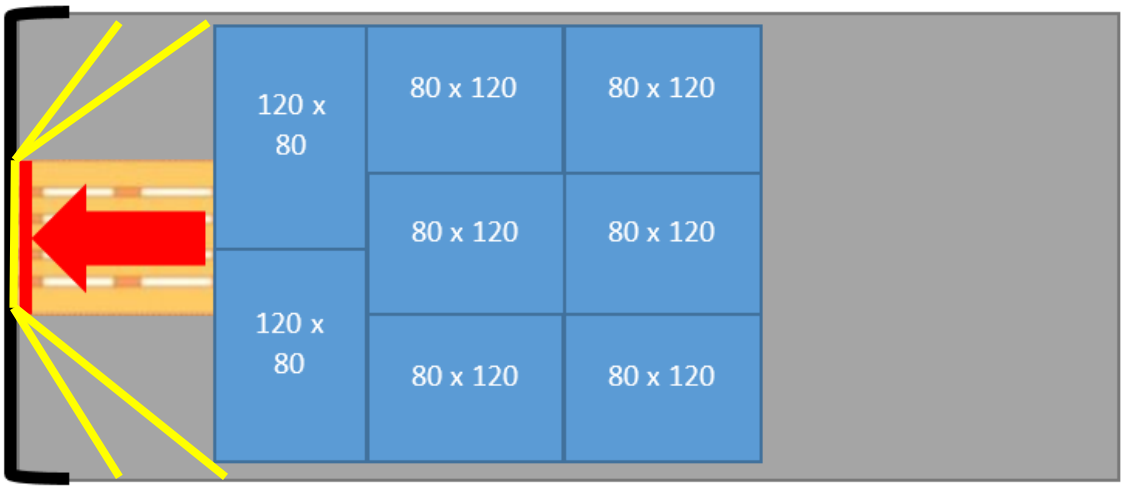


Solution 2:

The "head loop" (known as Kopflashing in German) is indeed a highly effective method in this case. It allows part of the force to be directed toward the vehicle floor via anchoring points, thereby relieving the front wall. The head loop can secure heavy and concentrated loads without exceeding the structural limits of the vehicle.

Warning:

- The coefficient of friction (μ) between the load and the floor must be taken into account.
- The number and angle of the straps must be precisely calculated (based on the weight, center of gravity, and inclination angle). The straps must be secured so that the lashing angle **α** is in any case less than 45°.
- Load securing must be planned during loading, ensuring access to the anchoring points.



Limitations of XL-Certified side curtains

An XL-certified curtain, even when compliant with the standard, cannot restrain individual items such as loosely secured or poorly packaged bags. If these elements shift during transport, the curtain cannot push them back or absorb their kinetic energy. This often results in a visible bulge from the outside, which is an indicator of unstable loading.

XL-certified or not, such deformation points to poor load preparation. It is therefore the loader's responsibility to ensure that the load units are properly wrapped, secured and blocked beforehand.

Take the example of a heavy box weighing around 5 tonnes, poorly strapped or not immobilized at 100%. If this box tips sideways in a turn and hits the side curtain, no XL-certified curtain will be able to hold back such a projectile. The released kinetic energy far exceeds the absorption capacity defined by the standard.

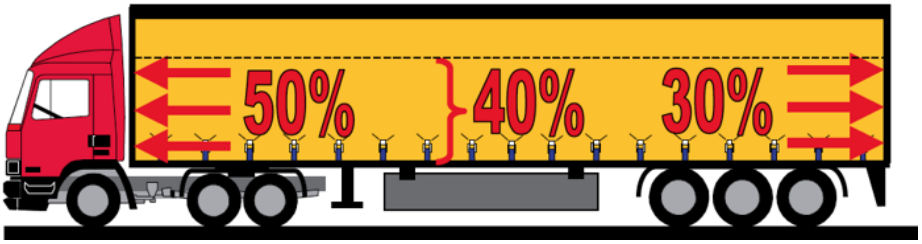
Materials of slats and Code XL compatibility

To meet the requirements of the XL Code, the material of the slats (or locking bars) is not critical as long as the required mechanical performance is achieved. Approximate weights of slats are as follows:

- Wood: approx. 3 kg
- Aluminium: approx. 4 kg
- Steel: approx. 9 kg

For rear load securing, steel slats are the most effective due to their robustness. On the other hand, for forming side walls, aluminium slats offer excellent stability thanks to their tongue-and-groove system, which is significantly more reliable than wood. However, this choice adds about 24 kg of extra weight per wall.

Load limits as a percentage of the payload according to EN 12642 – Code XL:



Characteristics of the reinforced Code XL body structure:

- Rigid roof structure;
- Reinforced front wall;
- High-strength stanchions (vertical supports);
- Reinforced drop sides or insertable slats made of thick wood or aluminium;
- Particularly robust tarpaulin;
- Integrated pallet stops.

No lashing straps are required if the following conditions are met under Code XL:

- Minimum friction coefficient of 0.30 (μ = 0.30);
- Load blocked in the direction of travel over ¾ of the height, for a front wall height > 160 cm (no longitudinal gaps);
- Load width ≥ 240 cm (no transverse gaps);
- ≤ 15 cm gap between the load and the rear doors;
- ≤ 8 cm gap between the load and the side walls;
- The vehicle body must be equipped with all components and fittings as specified by the manufacturer.

No lashing straps needed. All conditions are met. (Code XL)

μ = 0.30

Recessed side boards

Load blocked to the front, sides, and rear.

In this case, one of the conditions was not met, and the trailer loses its "Code XL" status.

The reinforced recessed side boards, made of thick wood or aluminum, are missing.

Reinforced Code XL bodywork without recessed side boards

Since 2018, there have been special tarpaulins from the trailer manufacturer “Krone” called Safe Curtain, which do not require recessed side boards to guarantee a Code XL certificate. Indeed, this system complies with the EN 12642 Code XL standard.

According to the manufacturer, Safe Curtain is designed to save time, increase safety, and simplify handling during loading operations. This system eliminates the need for recessed side boards by using multiple spring steel strips integrated into the tarpaulin. Additionally, it allows for a weight reduction of approximately 60 to 90 kg.

Der Fahrzeugaufbau erfüllt die Anforderungen der:

- **DIN EN 12642 Code *XL***

2. Angaben zur Ausstattung des Fahrzeugs

Der Fahrzeugaufbau ist dann in der Lage, die unter Punkt 4 genannten Ladegüter bei Einhaltung der unter Punkt 3 genannten Ladebedingungen zu sichern, wenn folgende Ausstattungskomponenten vorhanden sind:

			Nachgewiesene max. Prüfkräfte (nach DIN EN 12642)
•	**Stirnwand:**	Curtainsider – Krone-Stirnwand	**13.500 daN**
•	**Seitenwände:**		**10.800 daN**
•	**Plane:**	Ladungssicherungsplane mit Federstahlstreifen "Safe Curtain"; Planenqualität: Polyester-Trägergewebe / Panama-Qualität; Gewebequalität ca. 850 g/m²; Krone Spezifikation MN 601; Schweißgurte (innen) waagerecht und senkrecht bei jeder Rolle/Ratsche; Kippsicherung mit Bremse unten aus rostfreiem Stahl	
•	**Rungen:**	Adaico; 3 pro Seite; gleichmäßig aufgeteilt	
•	**Einsteckprofile:**	nicht notwendig	
•	**Rückwand:**	Krone - Containertür mit 4 Drehstangenverschlüssen	**8.100 daN**
•	**Dach:**	Krone - Schiebeverdeck - Topline II - Krone Diagonalverspannung	

Although a trailer equipped with the Safe Curtain system no longer requires recessed side boards to meet Code XL strength requirements, the loading conditions specified in the manufacturer’s certificate must still be strictly followed.

Difference between a standard body (Code L) and a reinforced body (Code XL) EN12642

	Standard body		Reinforced body
	Code L - 2007	Code L -2017	Code XL
Front wall	40 % max 5000 daN	40 % max 5000 daN	50 % at least ¾ of the height
Side wall Fourgon	30% over the entire height	30% at least ¾ of the height	40% at least ¾ of the height
Side wall Savoyarde	24 % Side panels 6 % curtain	24 % Side panels 6 % curtain	40% at least ¾ of the height
Side wall Tautliner	0 %	15% at least ¾ of the height	40% at least ¾ of the height
Rear wall	25 % max 3100	25 % max 3100	30 % at least ¾ of the height

Example illustrating the difference between a Code L front wall and a reinforced Code XL front wall:

Consider a truck with the following parameters:

Safety restraint **(forward blocking)** / μ = 0.3 / angle = 75° / **Chain STF = 2000 daN**
25 tonnes of steel beams distributed in 3 rows, with wooden chocks placed between each row.

To secure **this load forwards** with a Code L trailer, **8 chains with an STF of 2000 daN** are required.

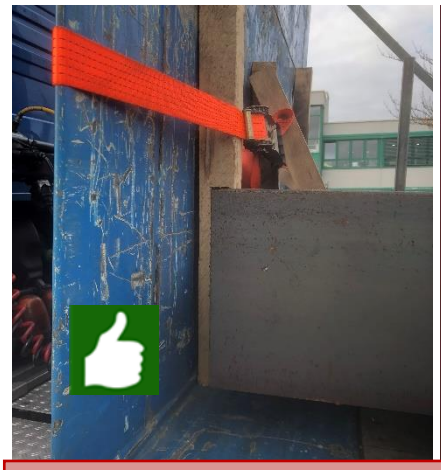
However, to secure **the same load forwards** with a Code XL trailer, theoretically no chains with 2000 daN STF are required — but at least two chains must still be used to counter dynamic forces caused by road bumps or potholes.

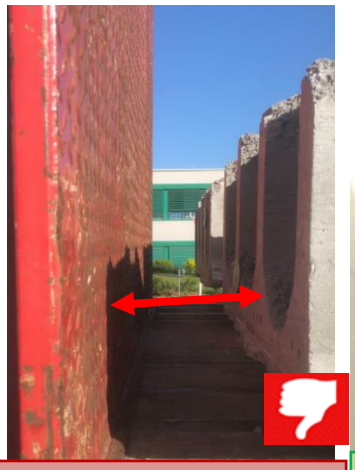
These values only apply in the case of safety blocking (form-fit restraint).

If there is too much empty space between the load and the front wall, **14 chains with STF 2000 daN** are needed to secure the 25-tonne load — whether the trailer is **Code L or Code XL.** In that case, there is no longer any difference between the two trailer types!

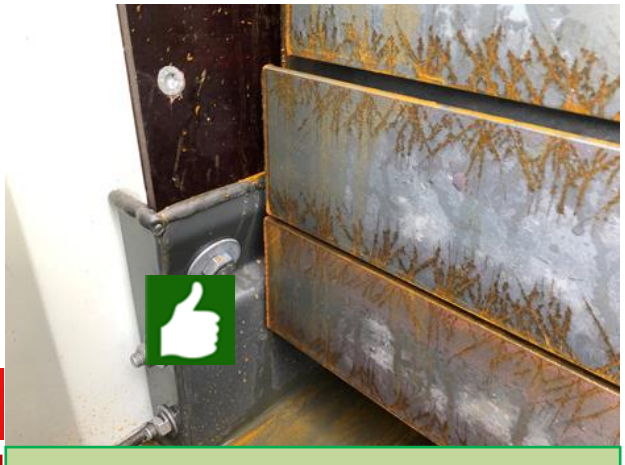
Without forward blocking, without using head loops, and without anti-slip mats (μ = 0.6), it becomes nearly impossible to achieve effective load securing for this type of cargo.

N.B.: This example only considers forward load securing in order to illustrate the great importance of **forward blocking**. Please note that lateral forces must still be secured where applicable.





Front wall Code L standard.



Front wall Code XL reinforced

Illustration of the previous example using calculation software ("LaSiBe")

Front wall Code L (blocking).

Berechnung aktuell nach **DIN EN 12195-1:2010**

STF in daN	Zurrwinkel α in °	Anzahl Zurrmittel
2000	75	0

Ladungsgewicht (kg): 25000 — Zurrpunktbelastbarkeit in daN: 2000

Reibbeiwert (μ): 0,3 — ☐ Ladefläche nicht besenrein

Fahrzeugnutzlast (kg): 27000

☑ Formschluss vorne
☐ Formschluss Seite
☐ Formschluss hinten

Aufbaubelastbarkeit anwenden:
☑ Code-L ☐ Code-XL ☐ Herstellerangabe

Informatorischer Hinweis:
Falls die fehlenden Sicherungskräfte durch Niederzurrung mit Zurrmitteln mit 2000 da Vorspannkraft und 75 ° Zurrwinkel aufgebracht werden sollen, sind folgende Zurrmittel erforderlich:

In Fahrtrichtung:	Zu den Seiten:	Entg. Fahrtrichtung:
8	5	5

Front wall Code XL (blocking.

Berechnung aktuell nach **DIN EN 12195-1:2010**

STF in daN	Zurrwinkel α in °	Anzahl Zurrmittel
2000	75	0

Ladungsgewicht (kg): 25000 — Zurrpunktbelastbarkeit in daN: 2000

Reibbeiwert (μ): 0,3 — ☐ Ladefläche nicht besenrein

Fahrzeugnutzlast (kg): 27000

☑ Formschluss vorne
☐ Formschluss Seite
☐ Formschluss hinten

Aufbaubelastbarkeit anwenden:
☐ Code-L ☑ Code-XL ☐ Herstellerangabe

Informatorischer Hinweis:
Falls die fehlenden Sicherungskräfte durch Niederzurrung mit Zurrmitteln mit 2000 da Vorspannkraft und 75 ° Zurrwinkel aufgebracht werden sollen, sind folgende Zurrmittel erforderlich:

In Fahrtrichtung:	Zu den Seiten:	Entg. Fahrtrichtung:
0	5	5

Front wall Code L (without blocking).

Berechnung aktuell nach **DIN EN 12195-1:2010**

STF in daN	Zurrwinkel α in °	Anzahl Zurrmittel
2000	75	0

Ladungsgewicht (kg): 25000 — Zurrpunktbelastbarkeit in daN: 2000

Reibbeiwert (μ): 0,3 — ☐ Ladefläche nicht besenrein

Fahrzeugnutzlast (kg): 27000

☐ Formschluss vorne
☐ Formschluss Seite
☐ Formschluss hinten

Aufbaubelastbarkeit anwenden:
☑ Code-L ☐ Code-XL ☐ Herstellerangabe

Informatorischer Hinweis:
Falls die fehlenden Sicherungskräfte durch Niederzurrung mit Zurrmitteln mit 2000 da Vorspannkraft und 75 ° Zurrwinkel aufgebracht werden sollen, sind folgende Zurrmittel erforderlich:

In Fahrtrichtung:	Zu den Seiten:	Entg. Fahrtrichtung:
14	5	5

Front wall Code XL (without blocking).

Berechnung aktuell nach **DIN EN 12195-1:2010**

STF in daN	Zurrwinkel α in °	Anzahl Zurrmittel
2000	75	0

Ladungsgewicht (kg): 25000 — Zurrpunktbelastbarkeit in daN: 2000

Reibbeiwert (μ): 0,3 — ☐ Ladefläche nicht besenrein

Fahrzeugnutzlast (kg): 27000

☐ Formschluss vorne
☐ Formschluss Seite
☐ Formschluss hinten

Aufbaubelastbarkeit anwenden:
☐ Code-L ☑ Code-XL ☐ Herstellerangabe

Informatorischer Hinweis:
Falls die fehlenden Sicherungskräfte durch Niederzurrung mit Zurrmitteln mit 2000 da Vorspannkraft und 75 ° Zurrwinkel aufgebracht werden sollen, sind folgende Zurrmittel erforderlich:

In Fahrtrichtung:	Zu den Seiten:	Entg. Fahrtrichtung:
14	5	5

Title IV – Load securing equipment

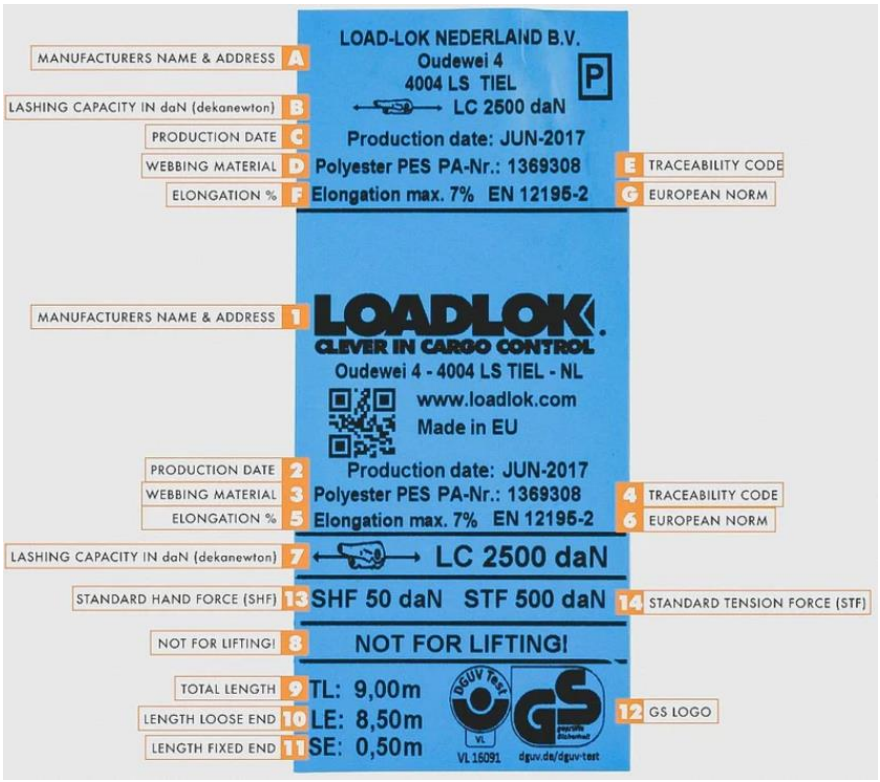
Chapter 1.– Synthetic fiber lashing straps

Lashing straps are woven straps made from synthetic fibres, usually combined with a ratchet tensioner. They can consist of a single element or two parts.

The strap is most often made of polyester and must comply with EN 12195-2. There are also straps made of polypropylene and polyamide.

The tensioner is a mechanical device used to tighten the strap. It applies a tensile force to the lashing system.

The identification label



The illustrated example above shows a typical label indicating the main mandatory information. Among these, the following values can be found:

- **SHF (Standard Hand Force):** The standard manual force applied by the user to tighten the strap. It is set at 50 daN, which ensures proper tensioning without the need for additional tools.
- **STF (Standard Tension Force):** The tensioning force generated by the SHF. This value is essential in top-over lashing, as it determines the clamping force applied to the load.
- **LC (Lashing Capacity)**: The lashing capacity, expressed in daN, indicates the maximum force supported in a straight pull. In the case of loop lashing, this value can be doubled.

The visual presentation, as well as the order of the data or pictograms used, may vary from one manufacturer to another. Thus, the label may be:

- folded in two,
- sewn entirely or partially onto the strap,
- protected in a plastic sleeve or between two fabric layers.

In the event of a serious accident, if the visible labels on the strap are illegible or torn off, it is possible to cut open the end of the strap. An internal label, inserted within the strap, contains key information such as the serial number. This number allows the manufacturer to retrieve the STF value, which may be crucial during a post-accident investigation.

Beware of counterfeits!

- The values on the strap must be indicated in daN, not in kilograms (kg);
- The "CE" marking must not be visible, it is not permitted;
- Make sure that the logos of certification bodies (TÜV, Dekra, etc.) are genuine and not falsified.

Tensioners

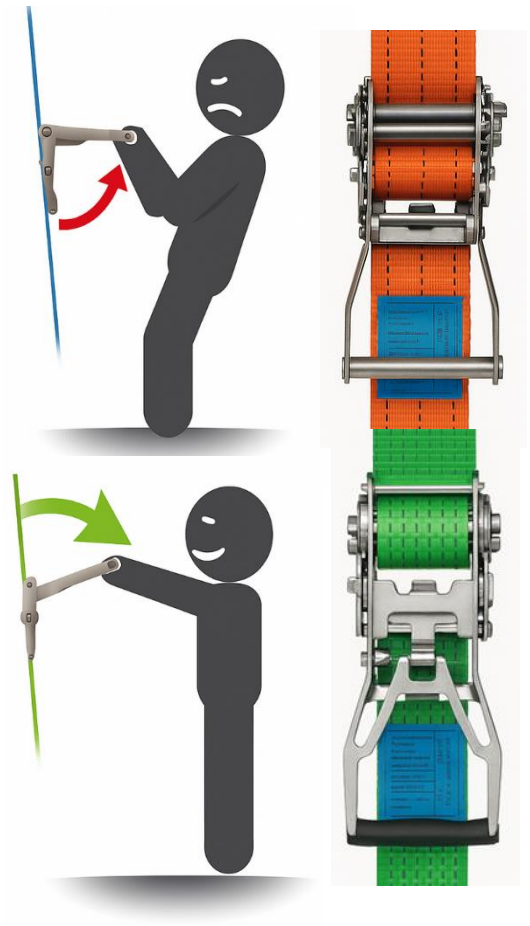
There are two types of tensioners: the standard ratchet tensioner and the long-lever (traction) tensioner.

The **standard ratchet tensioner**, also known as the short-lever tensioner, is operated by pushing the lever outward, i.e., toward the free end of the strap.

This type of tensioner is especially suitable when the user is at the same height as the strap, for example, when standing on the vehicle platform. In this position, the user can easily apply forward or upward pressure to tighten the strap.
It costs less, but has a lower STF (Standard Tension Force), generally up to 500 daN maximum.

The **ergonomic tensioner**, also known as the long-lever or traction tensioner, operates through a pulling motion: the user pulls the lever towards themselves, in the direction of the fixed end of the strap.

This movement is more natural and ergonomic, especially when working from the ground or in a low position beside the vehicle, as pulling downward places less strain on the back than pushing upward.
This type of tensioner is more expensive, but it is also more efficient. A higher STF (Standard Tension Force) can be achieved — up to 1000 daN.



Practical tips regarding the tensioner

If a large amount of strap is wound into the tensioner, it may become impossible to release the mechanism. In the worst case, the strap may have to be cut. It is therefore important to ensure that no more than two to three turns are wound into the tensioner. This way, releasing the strap is usually not a problem.

It is strongly recommended to retighten the straps before driving on public roads, especially after exiting a construction site, field, or forest, or periodically during long journeys.

Vibrations and vehicle movements can cause the straps to loosen partially, thereby compromising the integrity of the load securing.

The Use of Lashing Straps

Warning! A balanced distribution of the tensioning force can only be achieved with edge or corner protectors. Additionally, the straps are protected against abrasion and cutting.

For the use of lashing straps, the following criteria must be met:

- **Only** use **intact** lashing straps;
- **Do not exceed the LC** (Lashing Capacity) of the straps;
- **Do not tie knots** in the lashing straps;
- **Do not use** lashing straps **for lifting loads**;
- **Do not place loads** on top of the lashing strap;
- **Do not tighten** lashing straps **over sharp edges**;
- The strap must have a clearly **legible identification label**. **For two-part straps, each part must have its own label.**

Corner protectors

Edge protectors

Protection sleeve

Lashing straps must not be tightened over sharp edges or rough surfaces.

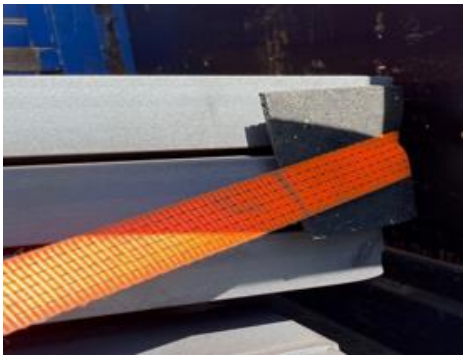
If the goods to be transported have such surfaces or edges, the lashing straps must be protected to prevent abrasion or cutting.

One can use **edge protectors**, **corner protectors**, or **protective sleeves**. These help to distribute the tension force evenly in top-over lashing and thereby allow for a higher overall tensioning force to be safely applied.

The use of **anti-slip mats** (or similar items, such as a fire hose) to protect the straps from abrasion or cutting **is not recommended**, as **the overall tensioning force achieved is lower** than when using edge protectors. However, in exceptional circumstances where no other solution is possible, their use may be tolerated.

Due to the higher coefficient of friction of the rubber mat, the distribution of force is not as even on both sides. Therefore, it is essential to double the number of straps that would otherwise be required to secure the load, and to distribute the tensioners evenly on both the left and right sides.

In head loop lashing, it is possible to protect the straps from damage by using small pieces of anti-slip mat. In head loop lashing, the straps should only be lightly tensioned, in contrast to frictional lashing, where tensioning the ratchet to the final clicks is crucial to achieve the strap's final clamping force.



No protective corners against wear and shear.

No corner protectors.

No blocking in any direction.

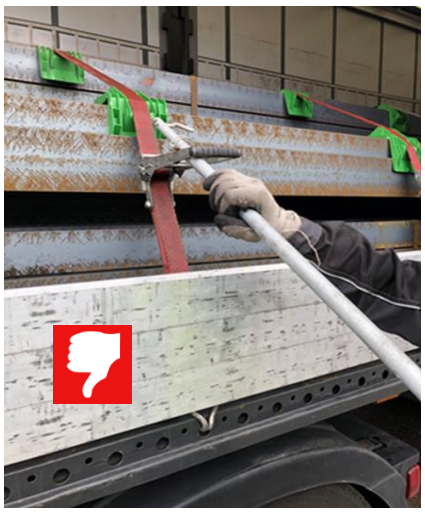
No anti-slip mat.

Missing identification label.

Only 2 straps — clearly insufficient to secure 3 tonnes!

Prohibited:

- **Installing a tensioner** on an edge;
- **Using an accessory not approved** by the manufacturer, which may exceed the 50 daN SHF (hand force).



The replacement of the straps :

Before each use, the straps must be visually inspected to detect any cuts, wear, cracks, or material fatigue. In case of frequent use, a more thorough inspection is recommended at least once a month. If any damage is visible, the strap must be removed and replaced in the following cases:

- If load-bearing fibres are broken or cut, compromising more than 10% of the webbing;
- If there is damage to the retaining stitches, or if deformation has occurred due to heat exposure;
- If there is damage resulting from accidental contact with chemicals;
- If cracks, significant deformations, fractures, or concerning signs of corrosion are present on tensioners or connecting accessories;
- In case of hook throat opening enlargement exceeding 5%, or in case of detectable permanent deformation.

Warning!
If even a single rejection criterion is identified, the strap must no longer be used.

Note: Lashing straps do not have a limited lifespan and no expiration date applies.

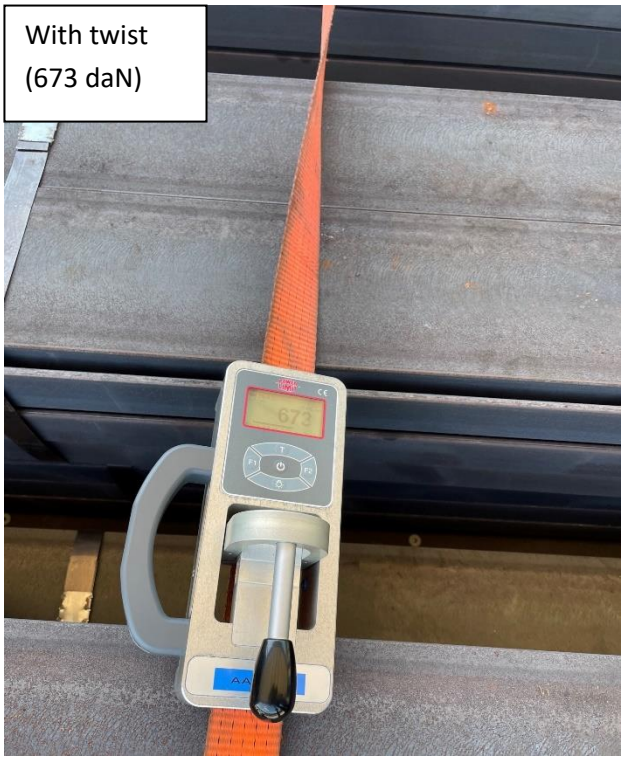
Examples of lashing straps with wear conditions requiring replacement:

Strap twisting

Some drivers prefer to twist the straps to avoid flapping noises caused by airflow on an open flatbed, while others can hardly avoid such twists due to the height of the load, which requires throwing the strap over.
Although it is generally recommended to keep straps untwisted during use, we did not observe any significant differences in tension.
However, twists on the edges of the cargo or on corner protectors should be avoided.
Ultimately, the strap tension achieved through the final clicks of the ratchet is decisive for the effective lashing force.

Without twist
(641 daN)

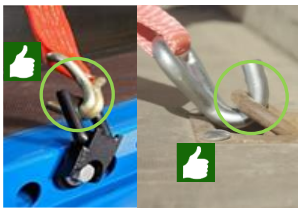
With twist
(673 daN)



Chapter 2 – Hooks

To connect the strap to the vehicle or the load, different types of hooks are used, such as **claw hooks (narrow finger hooks)** or **chassis** hooks (wide finger hooks).
The choice of hook does not affect the STF value, but it must be compatible with the available anchoring point.

Claw hook / Narrow finger hook	Chassis hook/ Wide finger hook
	



The hook can be attached to the anchoring point either from the **outside** or the **inside** of the vehicle's anchoring structure.

What matters most is that the load rests at the **bottom of the hook**, in order to ensure proper force transmission.

Hooking one hook into another to extend the strap is not permitted, as this practice significantly weakens the lashing system.

To extend a strap, special **extension shackles** designed for this purpose must be used, and they must be suitable for the strength of the selected anchoring points.

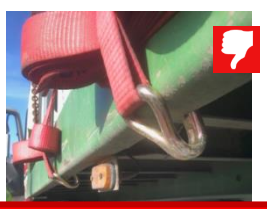
However, it is permissible to connect two hooks together for the purpose of securing goods **grouped** on a pallet.

In the case of direct lashing, the strap's hook must be attached **to a designated anchoring point**, not to the bodywork of the vehicle.

In over-the-top lashing, the strap's hook can be attached to load-bearing elements of the vehicle, such as chassis rails.

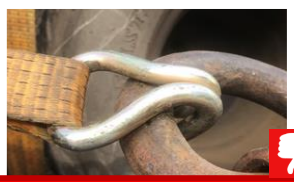
The hook must be loaded at its base, not at the tip.

The outer edge of the loading platform can also serve as an "anchoring point," but this requires the use of straps **equipped with chassis hooks.**



The hook must be loaded at the base, not at the tip.
Use of a claw hook instead of a chassis hook.

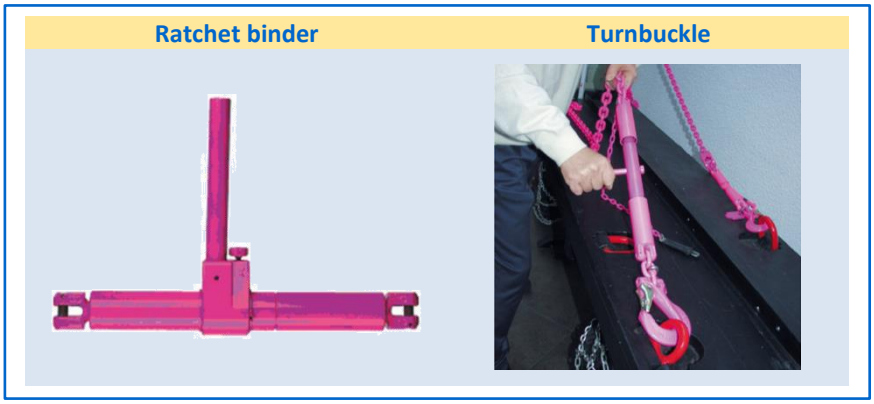
Only the tip of the hook is attached to the chassis.



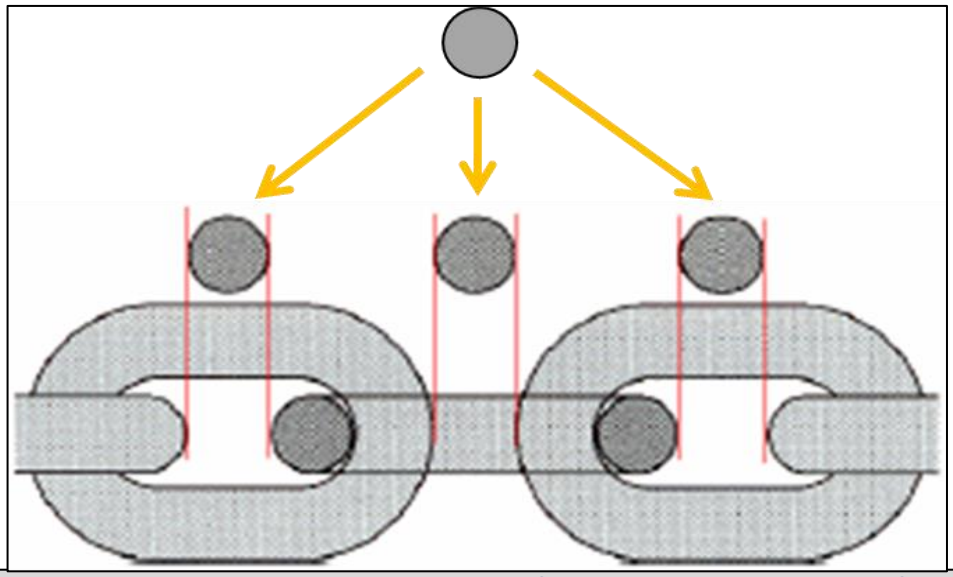
The ring is too large for this hook.
The hook is only engaged at the tip.
In this case, use a shackle instead.

Hook attached to a non-compliant anchoring point.

Lashing chains EN 12185-3



A lashing chain is a round steel chain equipped with either a turnbuckle tensioner or a ratchet binder.
The manufacturing of lashing chains requires steel that meets at least Grade 8 (Class 80) quality standards.
The lashing capacity (LC) of the chain is indicated on the identification tag in the form of "Lashing Capacity."
This capacity is expressed in daN and represents the maximum straight-line load the chain can withstand.
If the lashing chain is used in a loop configuration (e.g., head loop), the LC can be doubled.



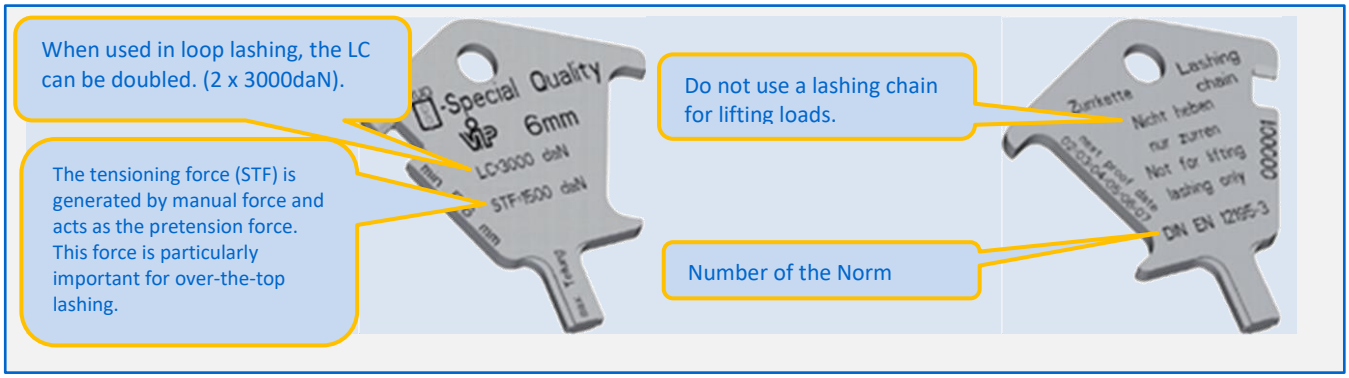
To ensure optimal strength, lashing chains must be made of short links. The inner length of each link must not exceed three times the wire diameter (round section of the link). This requirement ensures an even distribution of loads and helps maintain the structural integrity of the lashing system.

Difference in lashing force between minimum Grade 8 and Grades 10 and 12, expressed in daN

Nominal chain size	Grade 8 – Lashing Capacity (LC) in daN	Grade 10 – Lashing Capacity (LC) in daN	Grade 12 – Lashing Capacity (LC) in daN
6 mm	2.200 daN	3.000 daN	3.600 daN
8 mm	4.400 daN	5.000 daN	6.000 daN
10 mm	6.300 daN	8.000 daN	10.000 daN
13 mm	10.000 daN	13.000 daN	16.000 daN
16 mm	16.000 daN	20.000 daN	25.000 daN

Lashing chain marking

The **Lashing Capacity (LC)** is expressed in daN (e.g. 3,000 daN). It represents the maximum force the chain can withstand in straight-line tension.



Inspection tag

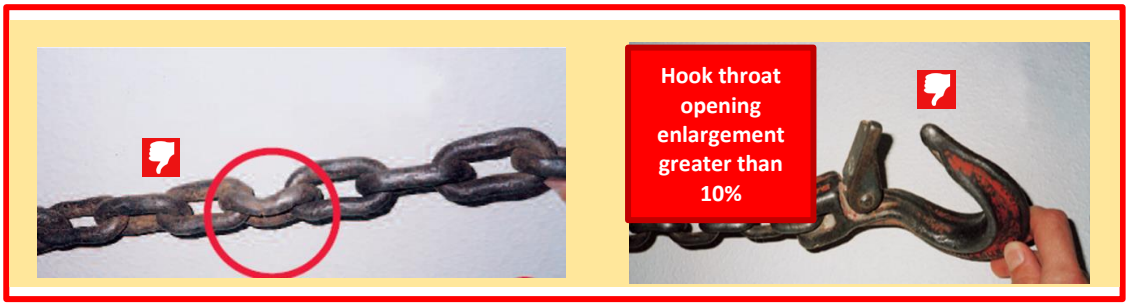
The inspection tag (plate shown on the right in the image) is not mandatory in Luxembourg according to EN 12195-3.However, it is recommended to have the chains inspected annually, especially if transport is carried out on German territory, where the VDI 2700 standard applies.

The use of lashing chains

- Use only intact lashing chains
- Do not load lashing chains beyond their LC (Lashing Capacity)
- Do not knot or twist lashing chains
- Do not use lashing chains for lifting loads
- Do not place loads on top of the lashing chain
- Do not tension lashing chains over sharp edges
- The lashing chain must have an identification marking (tag shown on the left in the image)
- Hooks must not be loaded at the tip

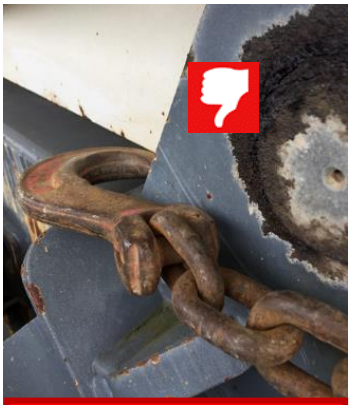
Lashing chains must be replaced when:

- Wear exceeds 10% of the nominal diameter of a chain link
- Elongation exceeds 3% of a chain link's pitch (only in case of an accident)
- There are cracks, deformations, or significant corrosion on tensioners or connecting accessories
- There is a hook throat opening enlargement greater than 10%



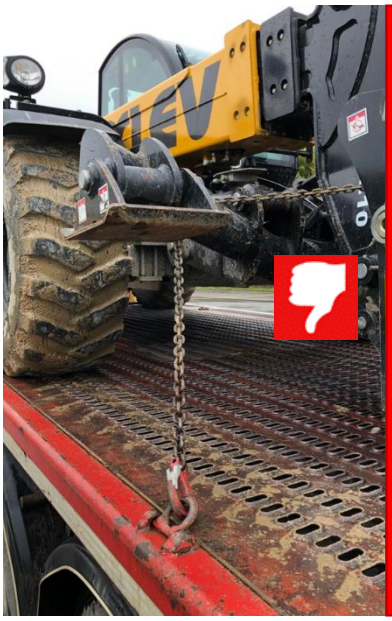
Incorrect use

Shortening hook attached to the chassis.
For direct lashing, the chain hook must be secured to an anchorage point on the vehicle.



Hook improperly attached to the machine (only on the tip of the hook).

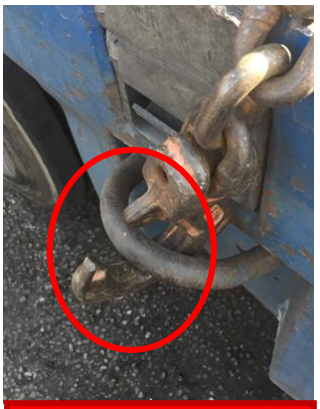
The chain hook must be attached directly to the lashing point.



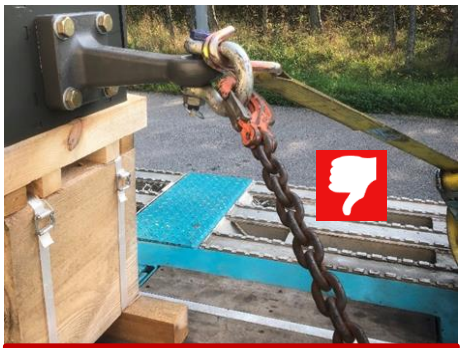
A heavy machine must be secured with direct lashing using 4 chains (2 at the front and 2 at the rear).

This chain is incorrectly placed.

In both cases, only one chain was used to secure the machine.



Missing safety latch.



Different lashing systems (chain, strap) must not be used to secure the same load, as their behavior and elasticity vary when under stress.

The chain is not secured and can move within the coupling.
For diagonal lashing, 4 chains must be used: 2 at the front and 2 at the rear.

Steel lashing cables / EN 12195 - 4

The lashing capacity (LC) of a finished steel lashing cable depends on the number of wires and strands used. It is referred to as "Lashing Capacity." This capacity is expressed in daN and represents the maximum force the cable can withstand in a straight-line pull. If the lashing cable is used in a loop configuration, such as a head loop, its LC may double.

Nominal diameter of the steel lashing cable Ø in mm	Lashing Capacity (LC) in straight pull in daN
8 mm	1.120 daN
10 mm	1.750 daN
12 mm	2.500 daN
14 mm	3.500 daN
18 mm	5.650 daN
22 mm	8.500 daN

Use of Steel Lashing Cables

- Only use intact (undamaged) steel lashing cables;
- Do not load steel lashing cables beyond their LC (Lashing Capacity);
- Do not tie knots in steel lashing cables;
- Do not use steel lashing cables for lifting loads;
- Do not place loads on steel lashing cables;
- Do not tension steel lashing cables over sharp edges;
- The use of wire rope clips (also known as clamp screws) to form loops on steel cables intended for load securing is prohibited.

Wire rope clips are not permitted.

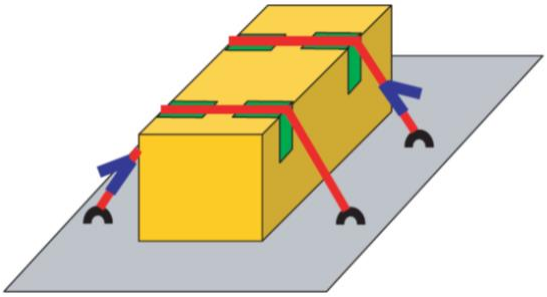
Cable end with ferrule and thimble

Steel lashing cables must be replaced in the following cases:

- In case of damage to the ferrule or splice;
- In case of severe wear or abrasion of the steel cable exceeding 10% of the nominal diameter;
- In case of crushing of the steel cable exceeding 15%;
- In case of cracks, breakage, or severe corrosion on the tensioners and connecting accessories.

Title V – Lashing methods

Chapter 1 – Friction lashing / over-the-top lashing

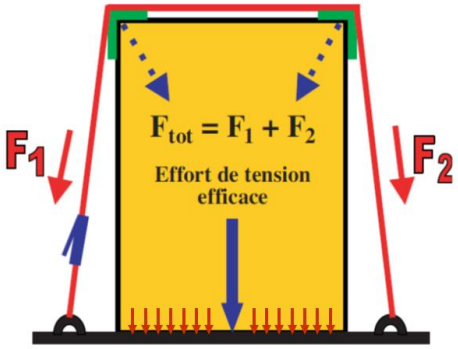


In friction lashing / over-the-top lashing, the load is pressed down onto the loading platform by the lashing equipment. This compression increases the friction force, which prevents the load from sliding.

The lashing equipment does not secure the load directly but increases and maintains the friction force (friction lashing / over-the-top lashing) that holds the load in place.

The lashing device is passed over the load and hooked onto lashing points on both sides, then tensioned using a tensioner (e.g., ratchet tensioner).

To ensure an even distribution of the tension force, friction lashing should use edge protectors (slip blocks), and the tensioners should be placed in alternating directions.

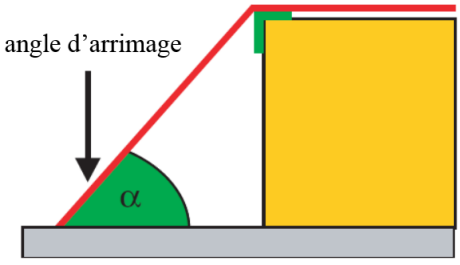


Effective tensioning force in over-the-top lashing

The conditions for optimal tensioning force include:

- High STF (Standard Tension Force) of the ratchet tensioner;
- Use of slip blocks / edge protectors (green);
- A lashing angle close to 90°;
- A non-deformable load.

Influence of the lashing angle alpha (α)



α = 90° → 100% of the STF is used to press the load onto the platform.

α = 30° → Only 50% of the STF is used to press the load onto the platform.

Influence of the lashing angle alpha (α)

α = 90 °→ 100% de S_{TF}

α = 60 °→ 85% de S_{TF}

α = 45 °→ 70% de S_{TF}

α = 30 °→ 50% de S_{TF}

α = < 30 °→ 0% de S_{TF}

If the lashing angle alpha is small, it is essential to use anti-slip mats.

Difference between a lashing angle α of 90° and 30°

Example 1:

Angle α	90 °	30 °
Mass	4 tonnes	4 tonnes
Friction Coefficient (μ)	0.3	0.3
S_{TF}	500 daN	500 daN
Required Straps	9	17

50% Loss of Capacity in Case of 10% Tear

Up to 75% Loss of Capacity in Case of a Knot in the Strap

Due to the poor lashing angle of 30°, 17 straps are required, whereas only 9 straps are needed if the lashing angle is 90°

30° Angle → 50% Loss of Tension

Warning!

When lashing without anti-slip mats:

→ Maximum pre-tensioning force is required.

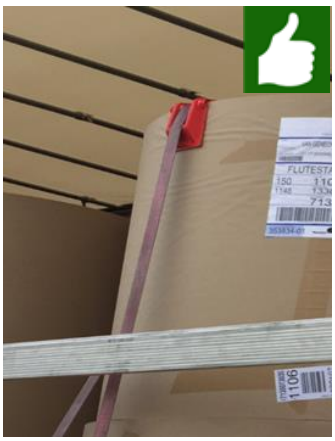
Example 2:

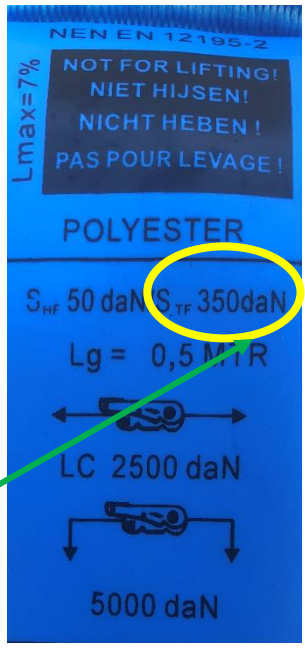
Angle α	90 °	30 °
Mass	4 tonnes	4 tonnes
Friction Coefficient (μ)	0.6 (anti-slip mat)	0.6 (anti-slip mat)
S_{TF}	500 daN	500 daN
Required Straps	2	4

Even with a poor lashing angle of 30°, **only 2 additional straps are needed** when an anti-slip mat is used.

Load suitable for over-the-top lashing

Loads secured by friction must not deform under the tension applied by the lashing equipment. This method is only effective if the tensioning force is transmitted through the load, increasing the pressure on the contact surface and, as a result, the friction coefficient.





Value for over-the-top / friction lashing calculation

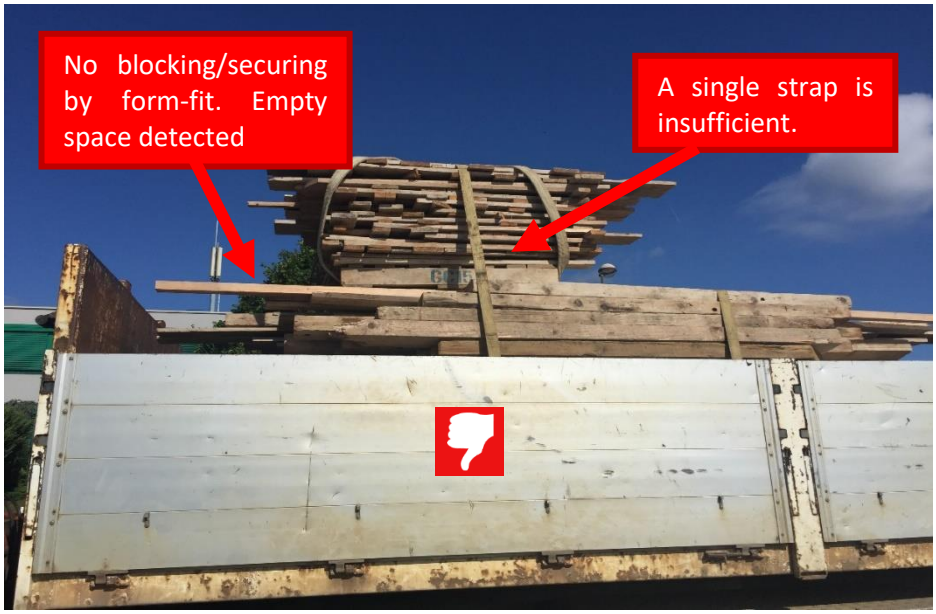
This strap has an STF (Standard Tension Force) of 350 daN.

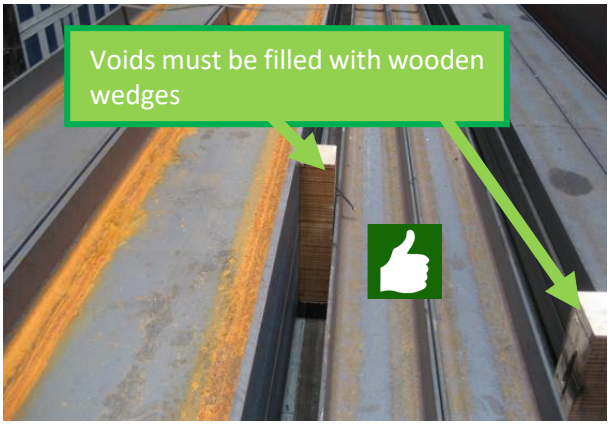
Load not suitable for top lashing without edge protectors.

Use of edge protectors is mandatory! No tension was measured on the strap by our tension meter.

Pallets can also be used instead of edge protectors to avoid deformation and to stabilize the goods.

Non-compliant top-down lashing.





Voids must be filled using pallets, wooden beams, chocks, dunnage bags, or by loop lashing.

For form-fit (blocking) securing, the distance between the front wall and load components such as sheet piles, beams, or concrete slabs must be minimized (maximum 2 cm) to prevent impact against the front wall. Blocking is considered the most effective securing method.

Effective top-down lashing

Sliding and corner protectors

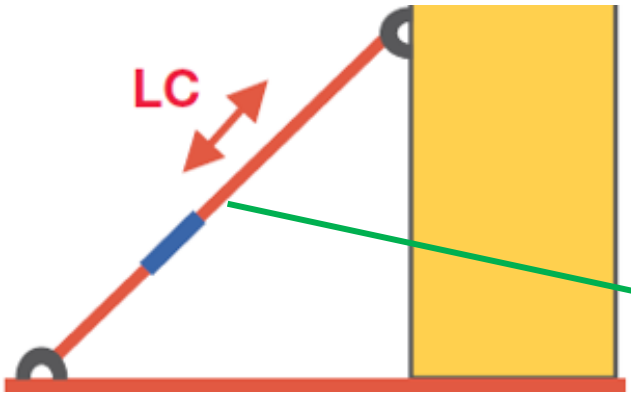
The empty space between the concrete blocks and the front wall has been filled with wooden pallets:
1. To enable effective form-fit (blocking) securing.
2. To distribute the load evenly.

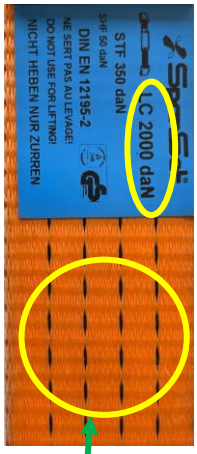
Lashing angle: 90° – Strap with Standard Tension Force (STF) of 750 daN

Anti-slip mat µ 0.6

Sliding and corner protectors
Lashing angle 90 ° / Strap S_{TF} 500 daN
Anti-slip mat µ 0.6"

Chapter 2 – Direct lashing

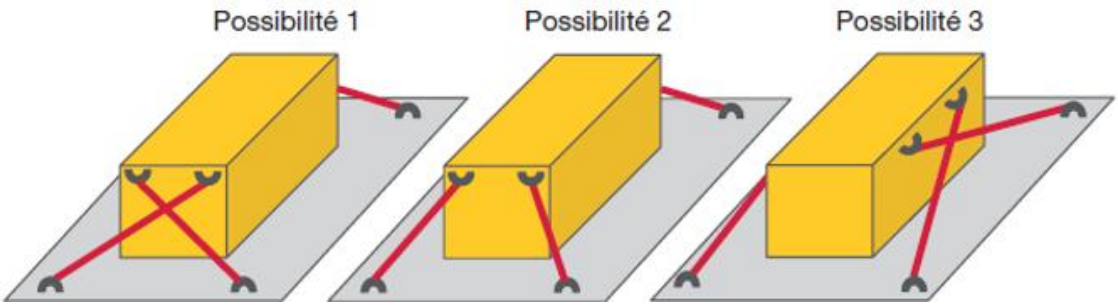




Direct lashing is a form of safety securing. In this case, the Lashing Capacity (LC) — the securing capacity of the lashing equipment — is the decisive factor. **For this strap, the LC for direct lashing is 2500 daN.**

Some manufacturers indicate the tensile strength of their straps **using woven dotted lines** — with each line representing 500 daN of securing capacity. For example, a strap with four dotted lines would indicate a tensile strength of 2000 daN.
However, this marking system is not used by all manufacturers, and therefore it is not reliable to assess a strap's strength based solely on the number of lines.
The safest method is to check the technical label on the strap directly for accurate information.
In direct lashing, the securing equipment holds the load in place.

Diagonal lashing = 4 lashing devices



Options 1 and 2 can be combined.

The lashing equipment does not need to be crossed.

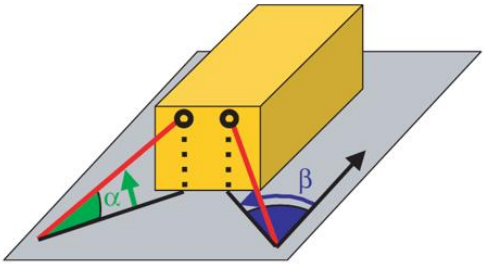
The lashing angles alpha and beta are determined by the way the lashing equipment is positioned.

Influence of lashing angles alpha and beta

Lashing angles are important, as each lashing device restrains the load in two directions.

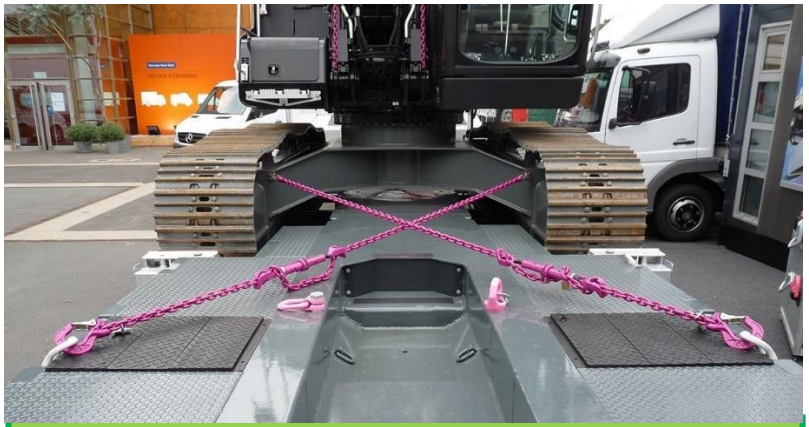
For diagonal lashing, the following angle ranges are recommended:

Alpha: **20° to 65°** Beta: **15° to 45°**



- For proper lashing calculation, both lashing angles must be measured for each lashing device.
- Unfavourable lashing angles require a higher Lashing Capacity (LC) to secure the load effectively.

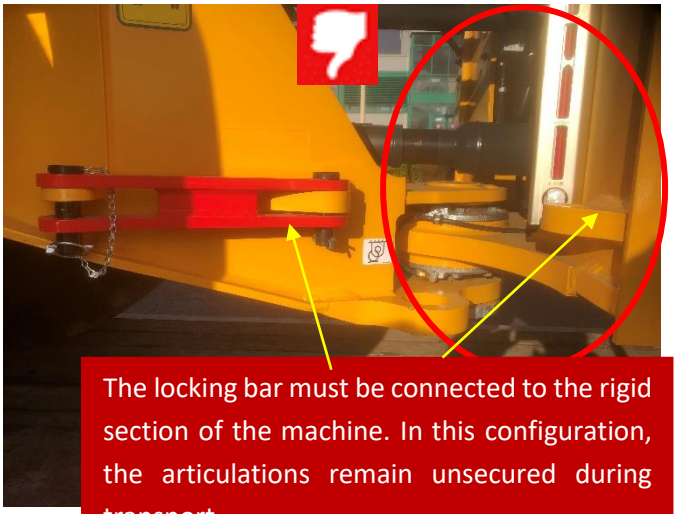
Example of Diagonal Lashing



Tracks must not be used as attachment points for chain or strap hooks unless explicitly authorized by the manufacture.

If the chain hook cannot be fixed directly to the machine, suitable shackles should be used. Shackles come in various strength classes, and must be selected according to the rated capacity of the chosen lashing point.

During transport, the articulated joints of the machine must be secured with a locking bar (red).



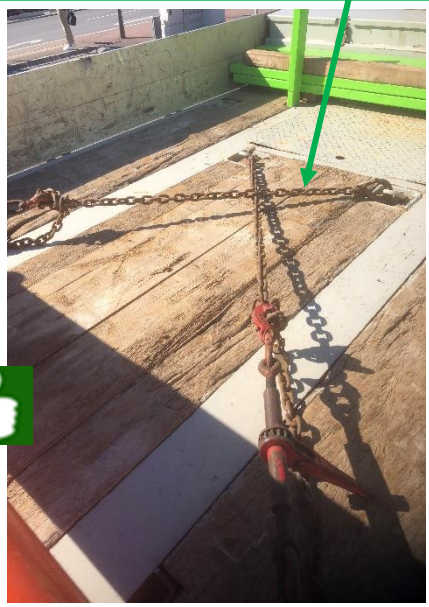
The locking bar must be connected to the rigid section of the machine. In this configuration, the articulations remain unsecured during transport.

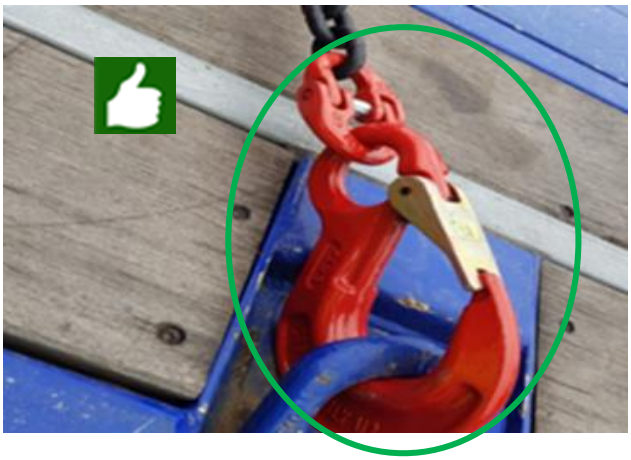
A heavy machine is to be secured by direct lashing using four chains — two at the front and two at the rear.

The lashing angles are within the recommended ranges.

The chain must not be attached using the shortening hook.

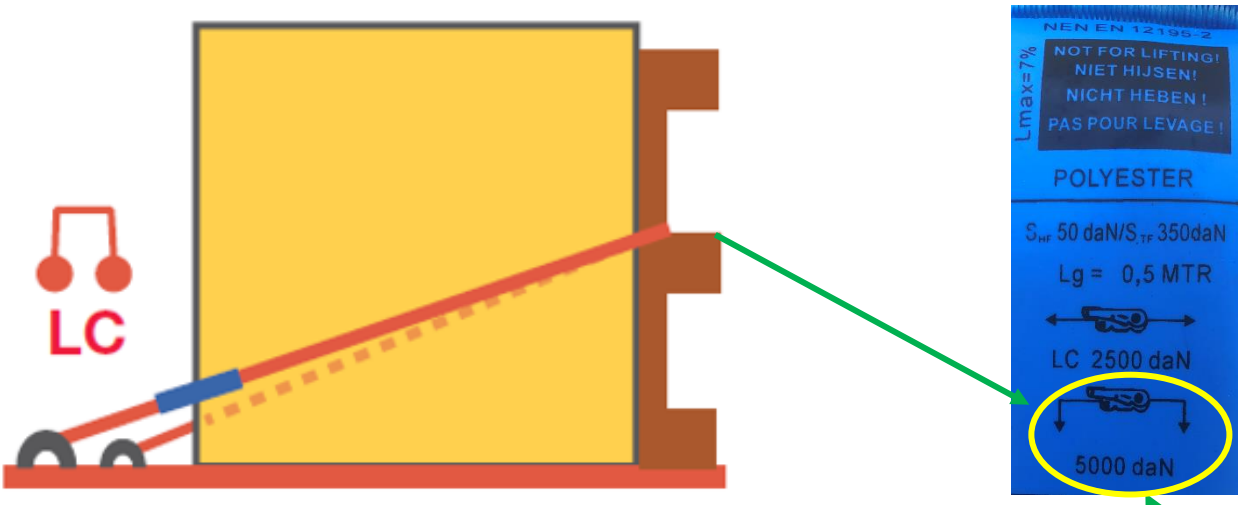
Additionally, the lashing angles fall outside the recommended ranges.





Chapter 3 – Loop lashing

Loop lashing is a form of direct securing method used to restrain loads.



- In loop lashing, no direct attachment point on the load is required. The decisive factor is the Lashing Capacity **(LC) in loop configuration. For this strap, the LC in loop lashing is 5000 daN.**
- For all direct lashing methods, the lashing equipment should only be lightly tensioned.
- In loop lashing, the lashing equipment is arranged in loop form at the front, rear, or sides and secured to the lashing points on the vehicle.

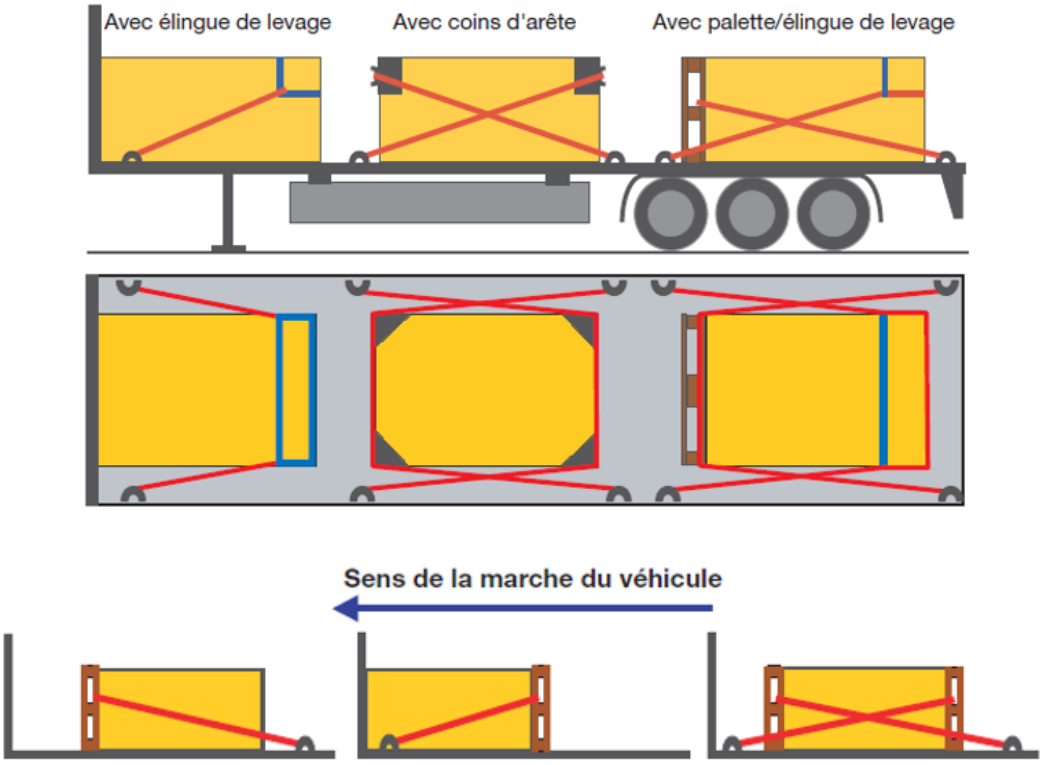
Loop lashing

The head loop is used to replace the front or rear wall when the load has not been secured longitudinally, due to load distribution constraints for example.

A head loop can secure the load either in the direction of travel or against it.

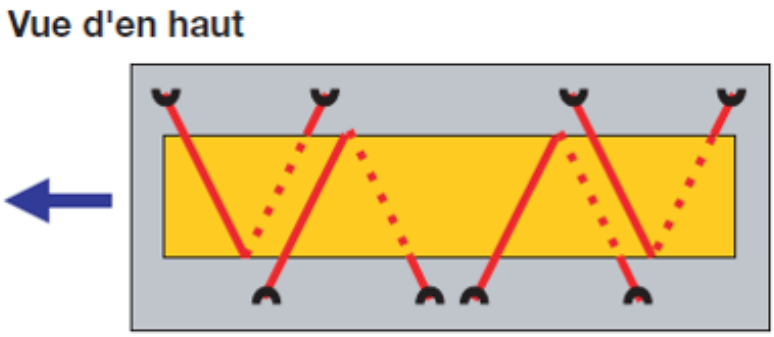
When installing a head loop, the lashing equipment is held in position in front of or behind the load using accessories. The lashing equipment must be securely fastened to the vehicle's lashing points.

Different Head Loop Securing Methods



A head loop may be positioned in the direction of travel, opposite to the direction of travel, or in both directions simultaneously, depending on the securing requirements of the load.

Lateral loop lashing

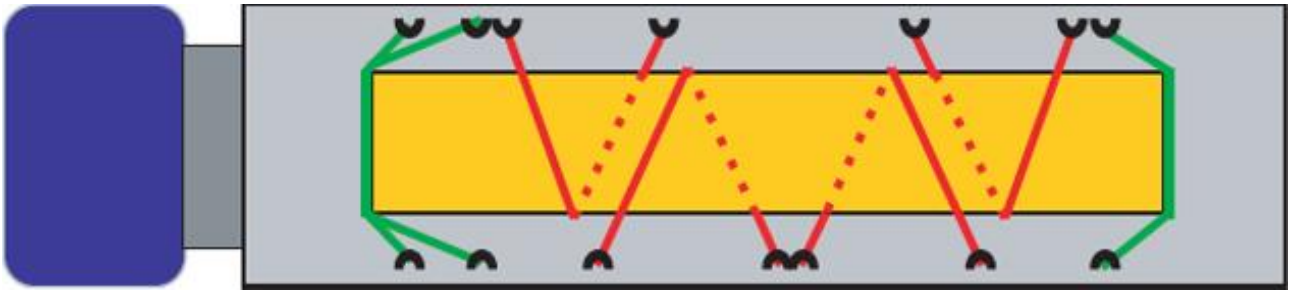


The side loop is used to replace the sideboard when lateral securing of the load is not possible.

In the case of side loop lashing, the equipment is placed around the load and attached to lashing points on the vehicle (red straps).

The side loop can only secure the load sideways.

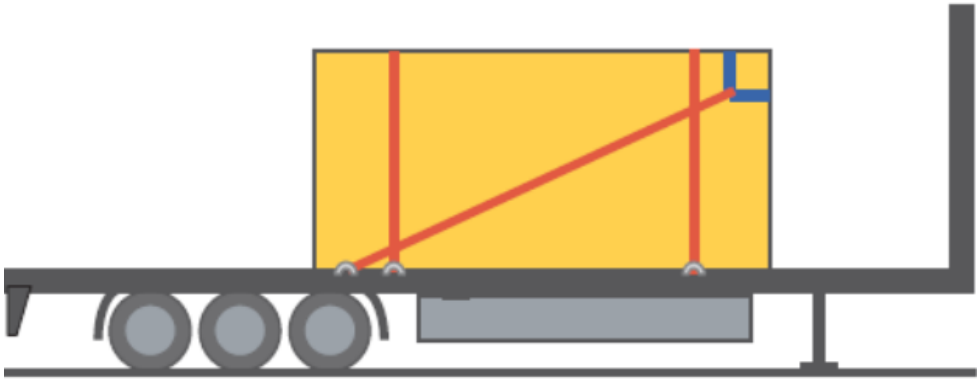
Securing in the direction of travel and against the direction of travel must be carried out separately (green straps).



Head loop + frictional lashing in combination

Combined Load Securing:

- Head loop
- Frictional lashing
- Anti-slip mat



Chapter 4 – Safety securing / by blocking

"Safety securing" means to load the goods against the front wall, the rear wall, and the side walls. If the entire loading platform is completely filled without gaps, a sufficiently strong body structure can ensure the safety of the load.

A platform with solid walls, Code XL, is completely filled with consolidated cargo on Euro-pallets.

Blocking boards/beams to secure towards the rear.

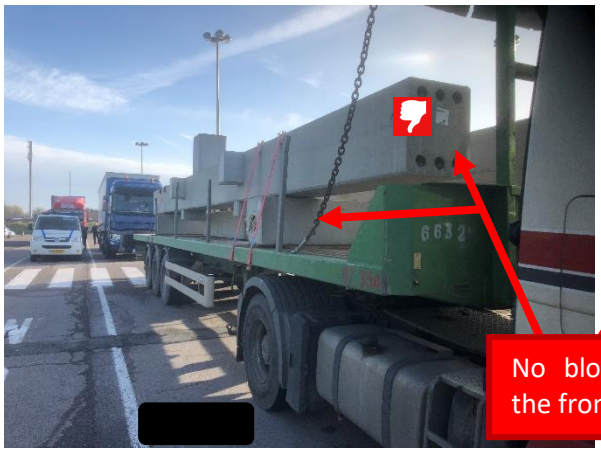
Combined securing:

Securing by friction.

Securing by blocking to the front, to the rear, and to the sides.

Blocking with an inflatable bag between the two big bags.

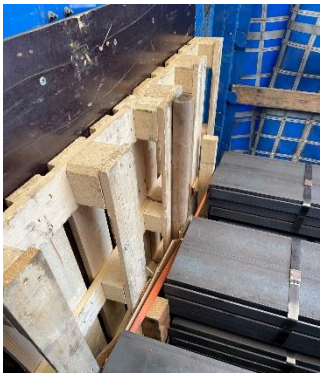
Removable stanchions for blocking.



Tools for filling gaps

Tools for filling gaps are intended to fill intermediate spaces and prevent the load from shifting.

Blocking board



Empty pallets

Wooden beams

Inflatable bags

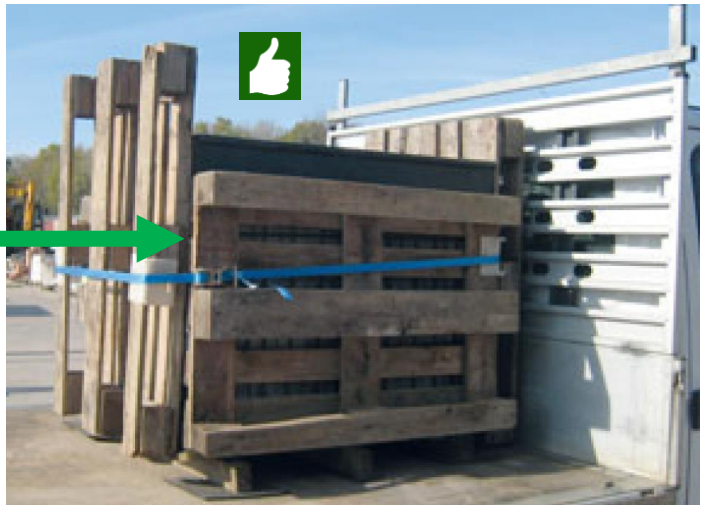
Adjustable chocks

Packaging of the goods.

Certain goods, such as bricks transported on pallets, are held together with strapping bands. However, these bands alone are not sufficient to ensure a stable load unit, particularly during emergency braking. For this reason, this type of goods requires special packaging, which can be achieved using edge protectors, stretch film, pallets, and straps.

When using stretch film (or edge protectors) for packaging, care must be taken to ensure that they also cover the pallet on which the goods are placed. The objective is to create a single, stable load unit.

Good packaging using edge protectors and shrink film, also wrapping the pallet. Friction/loop securing still needs to be carried out!



Chapter 5 – Nets and tarpaulins

Nets and tarpaulins are flexible securing tools. They can be used for over-the-top securing as well as for blocking loads..

Lashing nets.

- Lashing nets are sewn from synthetic fibre straps and manufactured in various sizes, with different load limits.
- They can be used to secure heavy loads.
- The lashing capacity of the nets may vary and should be confirmed with the manufacturer.

Cover nets.

Cover nets are suitable for securing **light loads**. They are primarily used on flatbed vehicles to secure insulating materials, work tools, or small items.

Lashing tarpaulin.

Lashing tarpaulins can be used to secure **heavy loads**. The lashing capacity should be obtained from the manufacturer.

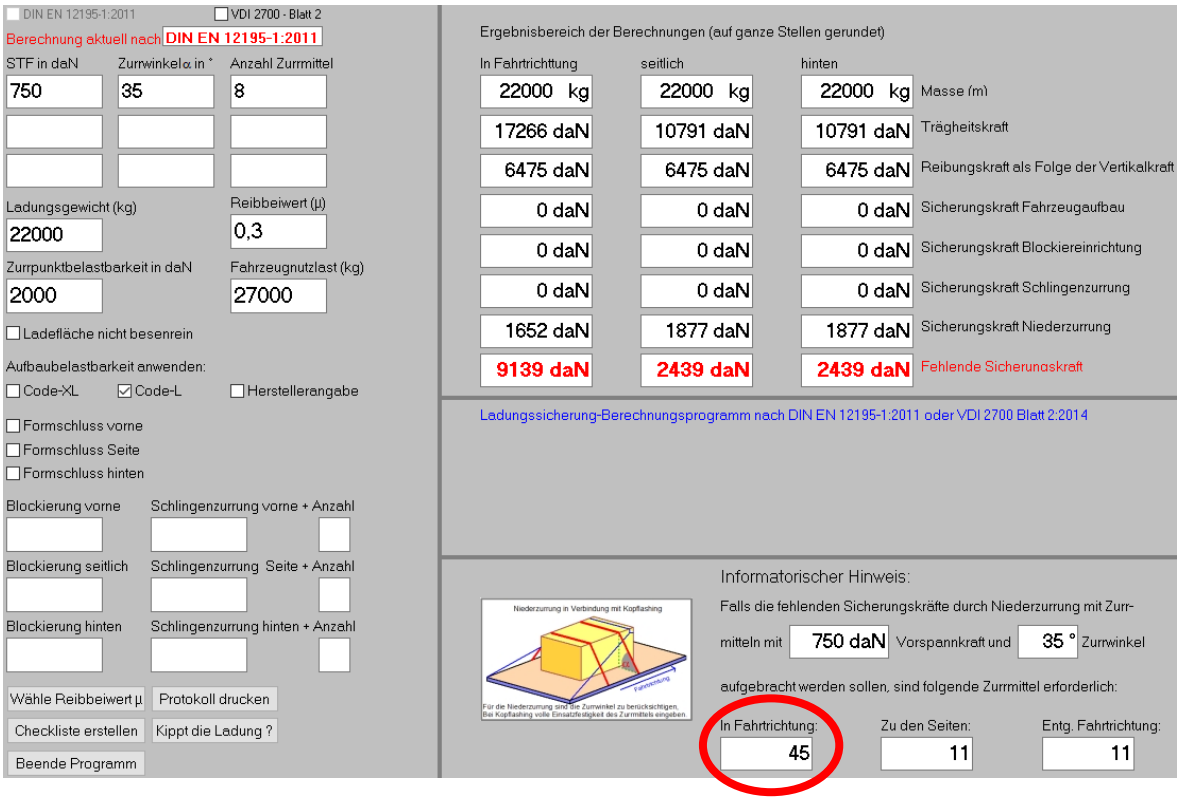
Cover tarpaulin.

Cover tarpaulins can be placed over containers or open skips transporting, for example, sand or recycling materials. **The tarpaulins prevent these products from being blown away by the wind.**

Chapter 6 – Practical case: how to correct insufficient securing on-site?

Let's take the example of the transport below with insufficient securing:

Load	22 tonnes of steel beams.
Applied straps.	8 straps with an STF of 750 daN, α angle of 35°
Blocking(s) present.	No blocking in the direction of travel, laterally, or to the rear
Trailer strength.	EN 12 642 – Code L
Estimated friction coefficient.	0.3 µ (no anti-slip mat).
Vehicle payload.	27 tonnes
Strength of the trailer's lashing points.	2000 daN
Available equipment.	2 pallets, 8 straps (STF 750 daN, LC 2500), a few pieces of wood.

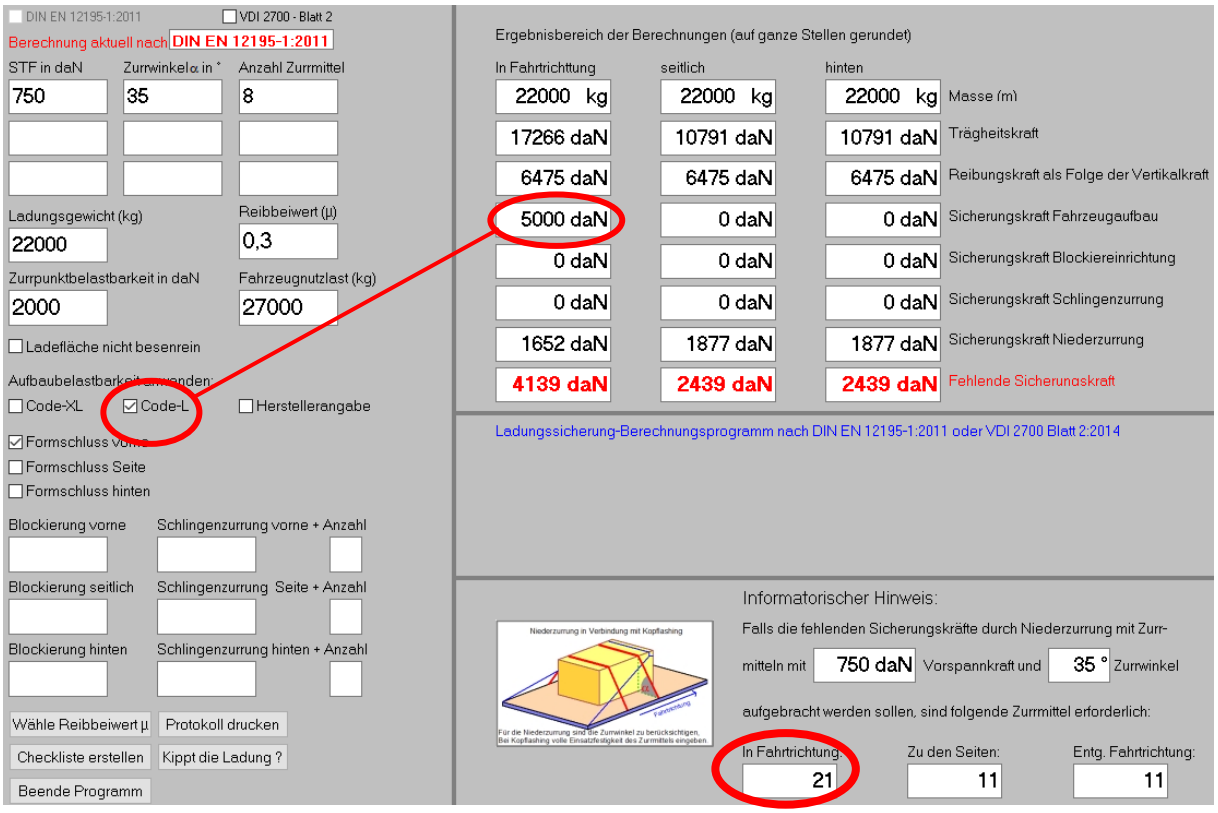


After entering the values into the load securing software, we note a shortage of 45 straps to secure the remaining forces in the direction of travel and 11 straps laterally and to the rear. It should be recalled that in the direction of travel, the inertial force represents 80% of the weight, while laterally and to the rear it amounts to 50%. Obviously, applying 45 straps is very difficult in practice, not only due to the limited number of lashing points but also because of the lack of such a quantity of straps on board of the vehicle.

The considerable shortage of straps required can be explained in particular by the lack of blocking to the front with the front wall (a free space of 20–30 cm) and by the unfavourable strap angle of 35°, which is very flat and not optimal. Such an angle greatly reduces the effectiveness of the applied tension, leading to a significant increase in the number of straps needed.

First attempt at a resolution – blocking the load

Since the main problem is the free space between the load and the front wall, we first attempt to correct the lack of securing by applying a block to fill the aforementioned gap. To confirm that our approach is correct, we enter the data into the load securing software:



Safety securing (blocking) is the most important and effective load securing method for all types of cargo, and it should be used whenever possible, particularly for beams or other very heavy loads. Indeed, one needs to ensure that **the load is properly distributed** and that **the trailer has the necessary structural strength!**

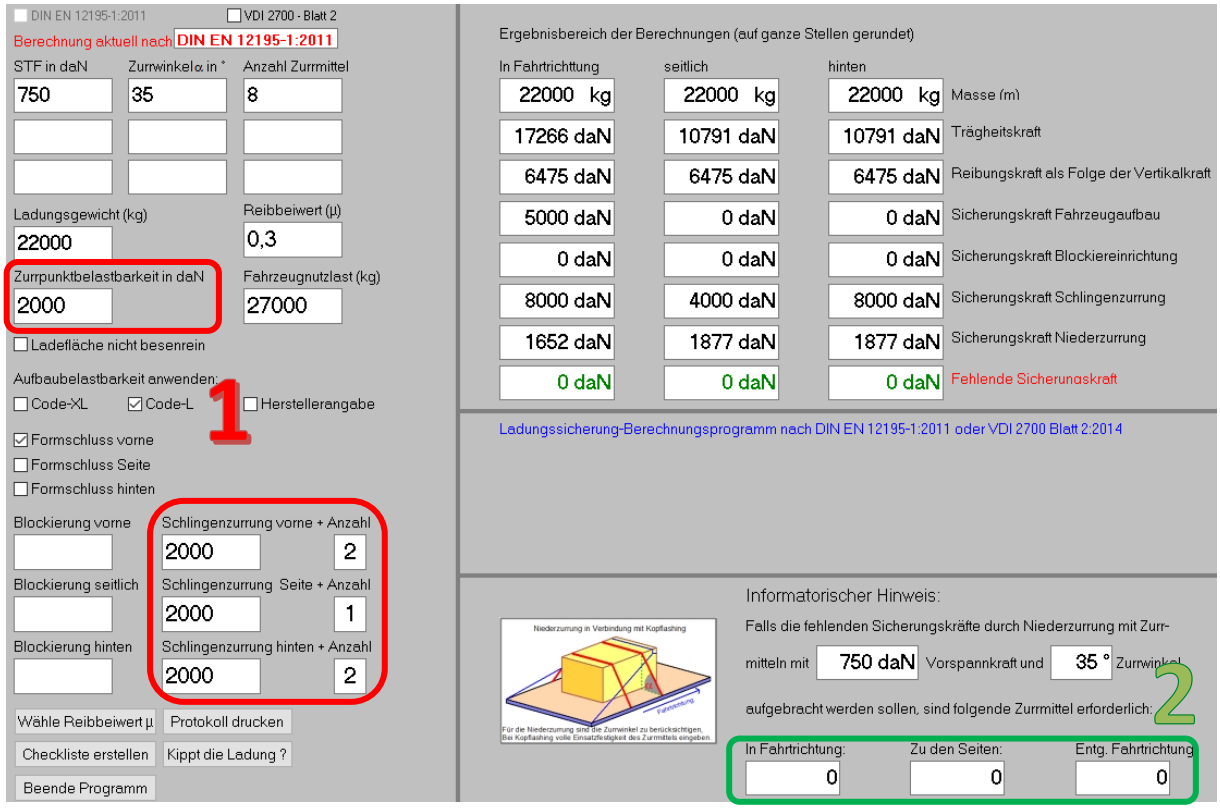
In this case, load distribution does not play a role, so we proceed with structural strength. In the event of blocking in the direction of travel using the front wall of a Code L-type trailer, a maximum of 5000 daN can be deducted from the forces to be secured. This 5000 daN represents the maximum strength of the **Code L**-type front wall. Thus, despite the blocking, according to the software, **21 straps** are still required in the direction of travel.

Second attempt at a solution – head loop lashing

Since the software shows that blocking alone is not sufficient to control the forces to be secured in the direction of travel, as well as the remaining lateral and rear forces, we consider the additional installation of head loop lashings. It should be noted that two straps are used to the front and to the rear, due to the fact that there are two rows of beams. The intended configuration is as follows:

- 2 straps to the front;
- 2 straps to the rear;
- 1 strap to the left;
- 1 strap to the right

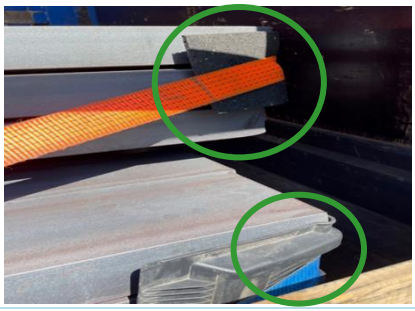
Here is the entry of the strap data in our load securing calculation software:



1. Although the strap has an LC of 2500 daN, the strength of the lashing points is only 2000 daN. Indeed, calculations should always be based on the lowest of the two values.

2. It appears that the securing is now sufficient to restrain the beams in all directions.

We therefore proceed with the installation of the securing means discussed. In the end, we obtain the following combined securing:

Lashing method	Tools and equipment used
Blocking and bracing	Forward blocking using two Euro-pallets and lateral blocking with wooden pieces placed between the beams. 
Friction lashing	8 top-over lashings with an STF of 750 daN, already in place. 
Head loop lashing	6 lashing straps with an LC of 2500 daN (2 forward, 2 rearward, and 2 lateral).  

Thanks to this configuration, we secured the steel beams twice in the forward direction: once by a double head loop lashing and once by creating a blocking. **This combination of securing methods should be used particularly for trailers with a body structure Code L according to Standard EN 12642**, as these have only a front wall that can withstand up to 5000 daN according to the standard.

A double head loop lashing in the forward direction can withstand up to 8000 daN (2 × 4000). This value can be further increased if the lashing points on the trailer have a capacity greater than 2000 daN.

Caution: Always use the lowest value for calculation, and ensure that multiple head loops are not attached to the same lashing points if their LC can only withstand a single loop. Of course, if the LC of a lashing point is high enough to withstand multiple loops, there is no restriction**.**

As can be seen, retroactively correcting the securing once the load has already been placed on the vehicle can be difficult. The best approach is to prevent this scenario by ensuring that blocking is in place from the start (if possible) and by using anti-slip mats during loading. In fact, in this case, if blocking had been applied, no additional straps would have been necessary and, even without blocking, only three additional straps would have been required.

Title VI – Truck transport and required cargo securing

Chapter 1 – Bulk Material Transport

Here is a list of products of natural, artificial, and various origins that must or needn't be covered during transport. The list is not exhaustive; it includes a large portion of materials transported in bulk. If the material to be transported is dusty or prone to volatilization, it must, in accordance with the traffic code ("Code de la Route"), be covered.

The Sectoral Training Institute for Construction has published this list in collaboration with the Customs and Excise Administration, the Grand Ducal Police, the MAWI Continuing Education Organization, the Contractors' Association, the Federations of Construction and Civil Engineering Companies, and the Council for the Development of Economic Construction.

Natural products

MATERIALS		Nature / Type	TRANSPORT MODE	
			Covered	Uncovered
Unwashed Sands	0/1, 0/2, 0/3, 0/4	Limestone	x	
		Dolomite	x	
		Jurassic Sandstone	x	
		Porphyry	x	
		Basalt	x	
Washed Sands	0/1, 0/2, 0/3, 0/4	Alluvial	x	
		Limestone	x	
		Dolomite	x	
		Porphyry	x	
		Basalt	x	
Unwashed Gravel	4/8, 4/16, 8/11, 8/16, 8/22, 8/32, 11/16, 16/22, 16/32	Limestone	x	
		Dolomite	x	
		Jurassic Sandstone	x	
		Porphyry	x	
		Basalt	x	
Washed Gravel	2/8 4/8, 4/16, 8/11, 8/16, 8/22, 8/32, 11/16, 16/22, 16/32	All types	x	
		Alluvial		x
		Limestone		x
		Dolomite		x
		Jurassic Sandstone		x
		Porphyry		x
		Basalt		x
Gravel Aggregate	0/8, 0/16, 0/22, 0/32, 0/45, 0/100, 0/150, 0/250	Alluvial	x	
	0/250 TOUT-VENANT MOSELLE			x
Gravel Aggregate	0/8, 0/16, 0/22, 0/32, 0/45, 0/100, 0/150, 0/250	Limestone	x	
		Dolomite	x	
		Jurassic Sandstone	x	
		Porphyre	x	
		Basalt	x	
Various Natural Materials	Screened Topsoil 0/16		x	
	Screened Topsoil 16/80			x
	Unscreened Topsoil		x	
	Compost Soil		x	
	Humus-rich Soil		x	
	Clay and Marl (cohesive soils)			x
	Loose Soils (sandy)			x
	Non-dusty Excavation Spoil			x

Artificial Products

MATERIALS		Nature / Type	TRANSPORT MODE	
			Covered	Uncovered
Unwashed Sand	0/2, 0/3, 0/4	Blast Furnace Slag	x	
		Granulated Slag	x	
Unwashed Gravel	4/8, 4/16, 8/11, 8/16, 8/22, 8/32, 11/16, 16/22, 16/32	Blast Furnace Slag		x
		Electric Arc Furnace Slag		x
Washed Gravel	4/8, 4/16, 8/11, 8/16, 8/22, 8/32, 11/16, 16/22, 16/32	Blast Furnace Slag		x
		Electric Arc Furnace Slag		x
Washed Gravel	0/16, 0/22, 0/32, 0/45, 0/100, 0/150, 0/250	Blast Furnace Slag	x	
Slag Gravel	0/32 (always humid)			x
Recycled Concrete Aggregate	0/32 (always humid)			x

Products of various origins

Miscellaneous Bulk Materials	TRANSPORT MODE	
	Covered	Uncovered
Wood Bark Chips	Tarpaulin	
Green Waste	Tarpaulin / Fine Mesh Net	
Shredded Wood	Tarpaulin	
Wood Sawdust	Tarpaulin	
Wood Chips	Tarpaulin	
Fertilizer	Tarpaulin	
Cereals	Tarpaulin	
Paper Waste	Mesh Net	
Cardboard Waste	Mesh Net	
Plastic Waste	Mesh Net	
Polystyrene Waste	Mesh Net	
Styrodur Waste	Mesh Net	

Requirements for bulk transport

Technical requirements

The dumpster must close tightly.

The rear tailgate and the sideboards must provide sufficient sealing to prevent the load from escaping from the dumpster and falling onto the roadway.

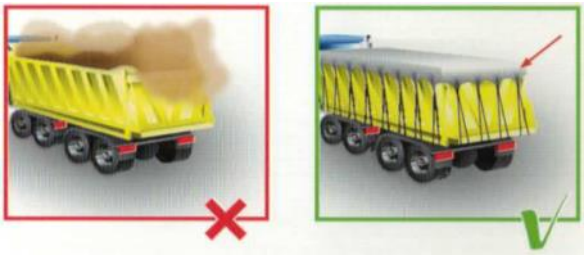
The locking and securing mechanisms of the tailgates and sideboards must be functional and prevent any unintentional opening.

The tailgate is tight and closes properly.

Cleanliness requirements

After loading or unloading the vehicle and before entering a public road, the driver is required to:

- Remove any dirt that may have accumulated on various parts of the vehicle, such as mudguards, bumpers, sideboards, drawbar, chassis, etc., and which could fall onto the roadway due to wind or vibrations, using a brush or a shovel;
- Cover the load if it contains material that could be carried away by the wind.



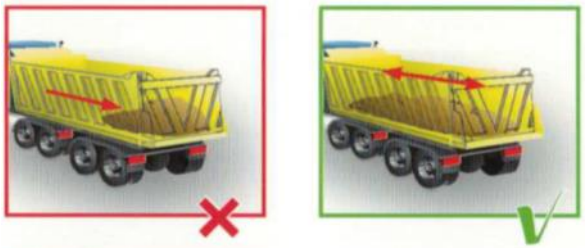
Loading requirements

The usable capacity (volume) of the tipper body must not be exceeded.

The GVWR (Gross Vehicle Weight Rating) must not be exceeded. The maximum permitted axle loads must likewise not be exceeded and must remain below the specified limit.

The loads center of gravity must be positioned on the vehicle's longitudinal axis and as low as possible.

Even for partial loads, care must be taken to ensure proportional weight distribution across the axles.



Chapter 2 – The anti-slip mat

Anti-slip mats are black mats made of rubber granulate. They are composed of old shredded tyres and granulate fibres, compacted using a polyurethane binder.

The quality of an anti-slip mat is determined by the shape and quantity of the fibers, as well as the quality and quantity of the binder.

Advantages of the anti-slip mat

- Increases the coefficient of friction (μ 0.6 guaranteed even on wet surfaces);
- Requires less securing material, resulting in lower expenditure for securing equipment;
- Reduces the load on the lashing points;
- Reduces the time required to perform friction securing.

Important information

- Economical and reusable (up to 40 times depending on quality);
- Available in various thicknesses from 0.2 to 30 mm. The thickness of the mat depends on the weight of the load or the loading equipment.

Smooth surface or low weight = less thickness.

Rough surface, heavy weight, or sharp edges = more thickness.

Caution!

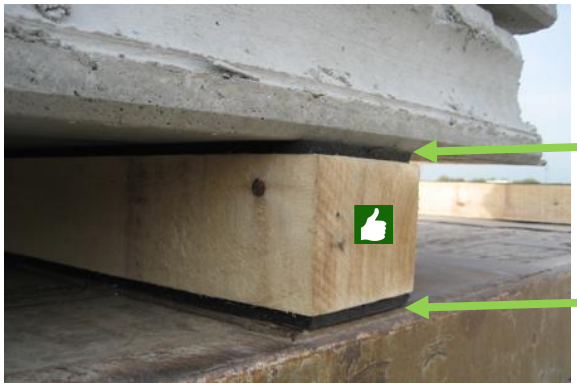
– A single load unit can never be secured using only anti-slip mats. Due to dynamic forces caused by vehicle movement, the friction force can be significantly reduced. Therefore, additional safety measures are necessary. The load should be blocked or secured by friction lashing.

– The loading surface must be clean (no sand, free of oil and grease, and free of snow and ice).

Otherwise, μ can drop to 0.1 even with anti-slip mats.

Less load slippage = fewer accidents

It is not necessary to use the anti-slip mat over the entire surface. However, the anti-slip mat must fully separate the load from the platform to achieve the higher friction value.



Anti-slip mats must also be placed between the different elements of the load.

Anti-slip mat between the loading surface and the wooden beam.

The middle of the pallet is in contact with the loading surface. Instead of µ 0.6, only µ 0.3 is achieved.

No anti-slip mat between the loading surface and the beam, and also between the beam and the concrete block.

Chapter 3 – Securing long and short timber / wood

Securing of long timber

Long timber is defined as tree trunks with a length exceeding 6 metres.

Checklist for securing long timber:

- The bottom layer of trunks must be placed on conical laths or toothed laths;
- The centre of the logs located at the upper ends of the load must not exceed the height of the stakes;
- The load must be secured with at least double lashing at each pair of stakes to ensure safety in case one of the lashings fails. Each strap must have a pretension force of at least STF = 750 daN. For the pair of stakes located at the front and the pair located at the rear, the pretension forces required are at least 1000 daN.

Securing of short timber – stacked longitudinally

- Each section or piece of outer timber must be supported by at least two pairs of vertical supports (stakes, stanchions) with sufficient strength to prevent any increase in the vehicle's width resulting from a lateral acceleration of 0.5 g;
- Any piece of timber shorter than the distance between two vertical supports must be placed in the centre of the load;
- The ends of the timber must extend at least 30 cm beyond the stakes;
- The centre of the logs located at the upper ends of the load must not exceed the height of the stakes;
- The top piece of timber located at the centre of the top layer must be higher than the lateral pieces in order to crown the load and allow proper tensioning of the securing devices;
- If the load is intended to be blocked in the forward direction, the vehicle must be equipped with a sufficiently sized front wall. The load must not be higher than the front wall.

The centre of the logs located at the upper ends of the load must not exceed the height of the stakes.

At least two pairs of vertical supports (stakes) are required for compliant securing. The ends of the timber must extend at least 30 cm beyond the stakes.

The top piece of timber is higher than the lateral pieces, the load is crowned, and correct strap tensioning is possible.

If the load is secured by blocking

• At least 1 lashing if a single stack consists of timber with bark, up to a maximum length of 3.3 metres;

• At least 2 lashings if the length of single stack exceeds 3.3 metres, or regardless of the length if the bark has been removed.

If the load is secured by top-over lashing (without blocking, without front wall)

- 3 straps for loads up to 3 metres in length
- 5 straps for loads up to 5 metres in length
- 6 straps for loads up to 6 metres in length

If there is snow and/or ice on the timber, additional lashings are required due to the reduced friction.

Stacked transversely

Timber stacked transversely on a flatbed vehicle cannot be properly secured using conventional restraint measures. Experience has shown that, in the event of emergency braking, transversely stacked timber behaves in the same way as a liquid load. Passing securing straps or chains from the front to the rear of the vehicle over the top of the load is not considered an acceptable load securing method.

When timber is transported transversely, only rigid side walls or side grids should be used. In the latter case, no piece of timber must be able to pass through the openings in the grid. In the longitudinal direction, the load must be subdivided into sections equipped with rigid partitions or stakes. No section shall be longer than 2.55 m.

Mobile machines

Measures to be observed for safe transport, using vehicles allowed to circulate without restriction in the EU (without ministerial authorisation for exceptional transport):

- **Construction machines on wheels or tracks;**
- **Cranes;**
- **Bulldozers;**
- **Road rollers;**
- **Scrapers;**
- **Forklifts.**

On public roads, transporting a load on the forks or in the bucket of a mobile machine does not comply with legal load securing requirements. This constitutes a danger to others!

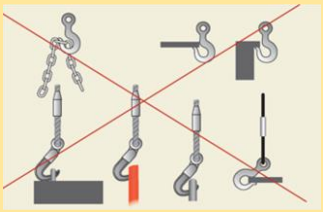
To be verified before driving:

- The weight of the machine to be transported – its weight is decisive for determining the securing forces;
- The lashing angle alpha and the angle beta between the machine and the low-loader. The alpha angle must be between 20° and 65°, and the beta angle between 15° and 45°;
- The capacity of the lashing points on the low-loader;
- Whether the chains have been attached to the lashing points on the machine as specified by the manufacturer;
- In the absence of manufacturer's recommendations, securing or fastening devices can only be attached to parts of the construction machine that have sufficient strength to withstand the stresses they are likely to be subjected to;
- One must use **at least four lashings**;
- Chains or straps must be fixed to a lashing point on the low-loader, not to the body of the low-loader;
- Do not use different types of accessories to secure a machine (for example, chains and straps), as their behaviour and elasticity differ when loaded;
- Accessories must never be used when they are knotted;
- Only securing accessories that are clearly marked and labelled may be used;
- Machine joints must be locked;
- Do not use the tracks as attachment points for chain or strap hooks, unless authorised by the manufacturer;
- Long-link chains must not be used to secure machines, even if compliant with EN 12195-3 (they are intended for limited use in timber transport);
- Lashing chains must not pass over sharp edges and must never be used when knotted.

When the capacity of the accessory or the lashing point is exceeded

- Improvement of the coefficient of friction by adding an anti-slip mat;
- Optimisation of the lashing angles by changing the lashing points on the low-loader;
- Replacement of the accessories with ones of appropriate capacity;
- Wedging of the machine.

Warning!



Incorrect hook positioning on a low-loader.
The hook must never be loaded on its tip.

Use of tippers for excavator transport

In principle, the transport of excavators in tippers isn't prohibited. In such cases, direct securing with 4 chains/straps should be carried out. However, tippers often lack sufficient lashing points, or these are not designed to withstand heavy excavators.

Furthermore, depending on the machine being transported, there may be insufficient space in the tipper to apply securing devices. One needs to pay attention, that the maximum legal height of 4 metres is not exceeded, since an authorisation issued by the Ministry of Transport would be required. For this reason, the use of a loading platform instead of a tipper is recommended.

Transport of cars

It is strongly recommended to use only car transporters designed for this purpose. The transported cars must have their parking brake engaged and be in first gear (or in position P for automatic transmissions).

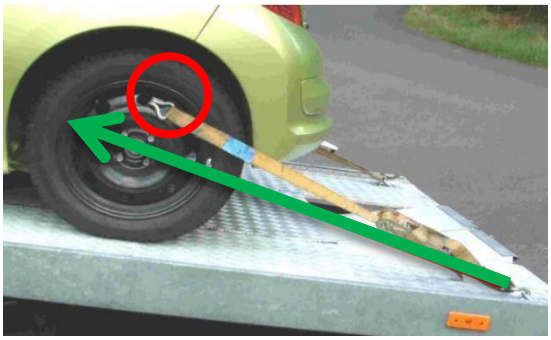
With regard to the attachment point:

- Cars are mainly secured by fastening to the **rims**. However, One must ensure that the manufacturer of the rims guarantees their stability for such fastening without causing any damage.
- An alternative method of fastening is to pass the strap **over the top of the tyre** using a three-point strap.

- Under no circumstances should the securing device be applied to the bodywork or to a towing eye. Fastening to the bodywork could create vibrations that may cause the strap to loosen. Fastening to a towing eye does not allow it to withstand the forces that may occur during transport.
- For the attachment points on the transport trailer, One must ensure that only the lashing points provided by the manufacturer are used.

With regard to the securing devices:

- In principle, vehicles must be secured with **three-point lashing straps** equipped with adjustable strap tensioners, in combination with wheel chocks on the transport vehicles.
  When using "standard" **two-point straps** for direct lashing, 4 straps must be applied. In addition, one must guarantee that the straps cannot rotate their respective wheel, creating a rotational moment.

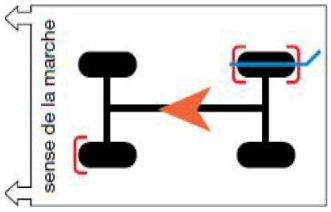


- In this photo, the attachment point has been poorly chosen because a twisting movement could cause the strap to loosen. The strap should pass through the centre of the wheel (green line).
- If special chocks are fitted on the trailer, ensure they are properly secured and used. Using a large number of them is recommended.

Throughout the journey, it is strongly recommended to make regular stops to check the tension of the straps.

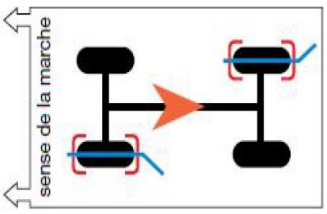
Car carrier

Securing of motor vehicles loaded from the front without cavity or bracket



1. A wheel chock placed in front of and behind any one of the rear wheels;
2. Additional securing of this rear wheel with a three-point lashing strap;
3. Diagonally opposite to it, a wheel chock placed in front of the corresponding wheel.

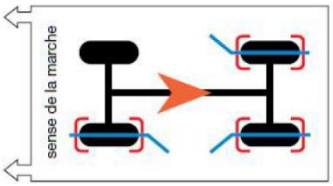
Securing of motor vehicles loaded from the rear without cavity or bracket

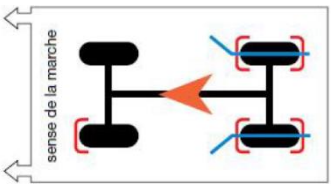


1. A wheel chock placed in front of and behind any one wheel;
2. Diagonally opposite to it, a wheel chock placed in front of and behind the corresponding front wheel;
3. Additional securing of both wheels respectively with a three-point lashing strap.

Additional securing of the last motor vehicle without cavity or bracket

Regarding the last motor vehicle loaded behind the trailer's rearmost axle, or in the case of vehicles loaded behind the rear axle, it is essential to additionally secure the rear axle at the wheels with two chocks and a three-point lashing strap on each side.





Chapter 5 – Graphic symbols

Fragile cargo

Loads bearing this symbol must be handled with particular care. In particular, shocks should be avoided during loading and unloading, and of course also during transport.

This side up

Goods bearing this symbol must be loaded with the arrows pointing upwards.

Lift or secure load here

This symbol on the goods indicates the lines along which they can be lifted using lifting straps or similar equipment.

Keep dry

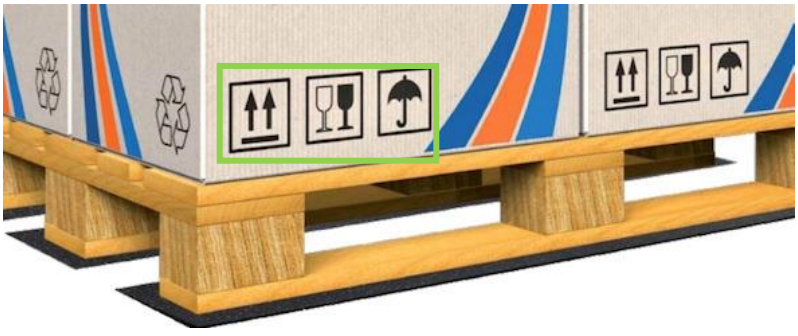
Loads bearing this symbol should not be exposed to moisture. They should therefore preferably be transported in closed bodies or otherwise protected from rain.

Protect from heat

Goods bearing this symbol should not be exposed to high temperatures. Such temperatures can occur, for example, when the vehicle is parked in the sun for an extended period.

Centre of gravity

These symbols are placed on crates or heavy construction elements whose centre of gravity is not located in the middle. This indication must be considered not only when lifting the items but also when positioning them on the loading deck. The permissible axle loads must be observed.

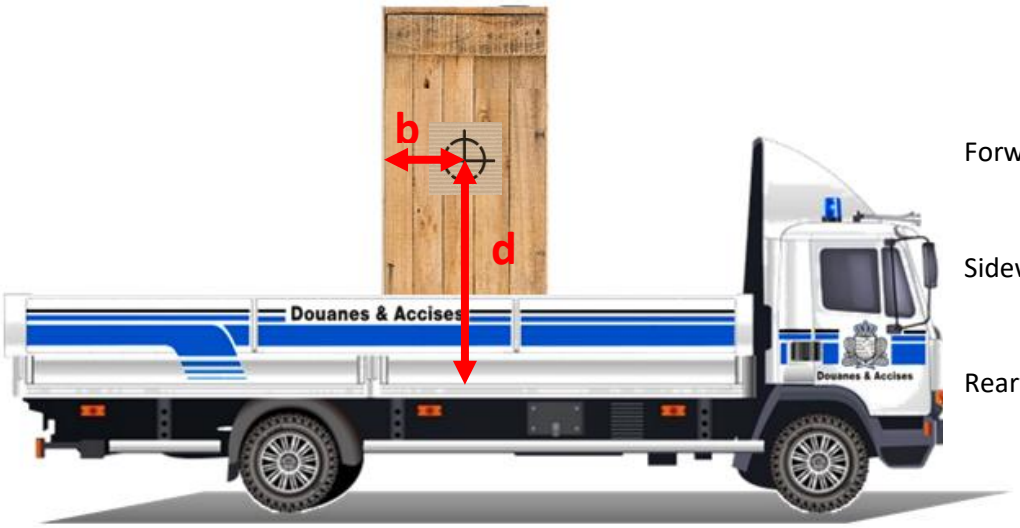


Chapter 6.- The risk of tipping over

If a load has a high centre of gravity, there will not only be a risk of shifting but also a risk of tipping over. However, how does one determine whether a given load is at risk of tipping or not?

It is necessary to know the position of the centre of gravity as well as the dimensions of the load.

Indeed, a tipping risk can be calculated using the following formulas:



Forward: $\frac{b}{d} \geq 0{,}8$

Sideways: $\frac{b}{d} \geq 0{,}5$

Rearward: $\frac{b}{d} \geq 0{,}5$

As an example:

Consider a truck transporting a box with a centre of gravity height of 150 centimetres, positioned in the middle of the width (100 centimetres):

Forward: $\frac{b}{d} = \frac{100cm}{150cm} = 0{,}66 < 0{,}8$

Sideways: $\frac{b}{d} = \frac{100cm}{150cm} = 0{,}66 > 0{,}5$

Rearward: $\frac{b}{d} = \frac{100cm}{150cm} = 0{,}66 > 0{,}5$

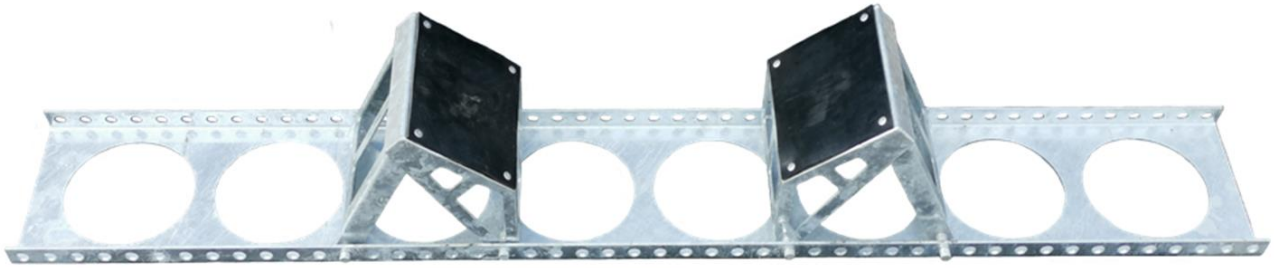
Therefore, the box is unstable in the forward direction but stable sideways and rearward. It can be seen that a tipping risk, particularly forward, is quickly reached when the load is taller than it is wide. It is therefore recommended to use additional securing methods, for example by applying a head loop lashing forward, a forward blocking, or, if these are not possible, a friction securing method, with the number of straps determined by a calculation using a mobile application.

Chapter 7 – Securing and calculation tools

Consult specialised dealers! For each transport of goods and/or equipment, there are suitable products to ensure safe and effective securing.

Also consult your dealer when purchasing a new transport vehicle!

Vehicle specially designed for the transport of large cable drums.



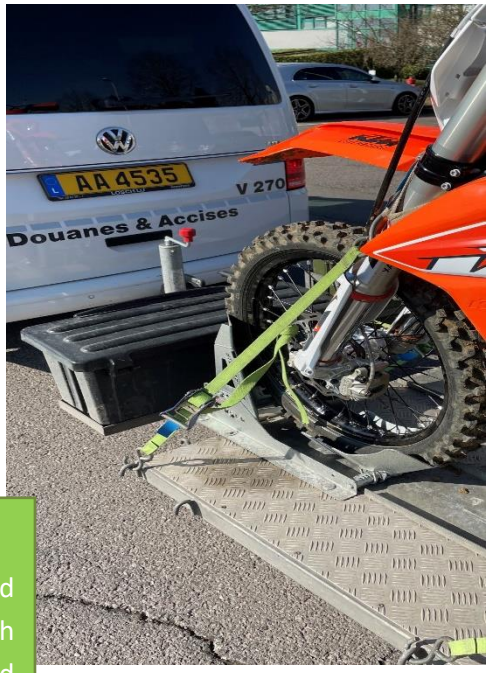
A special chock placed on an anti-slip mat to secure the large cable drum.

Semi-trailer with adjustable decks.

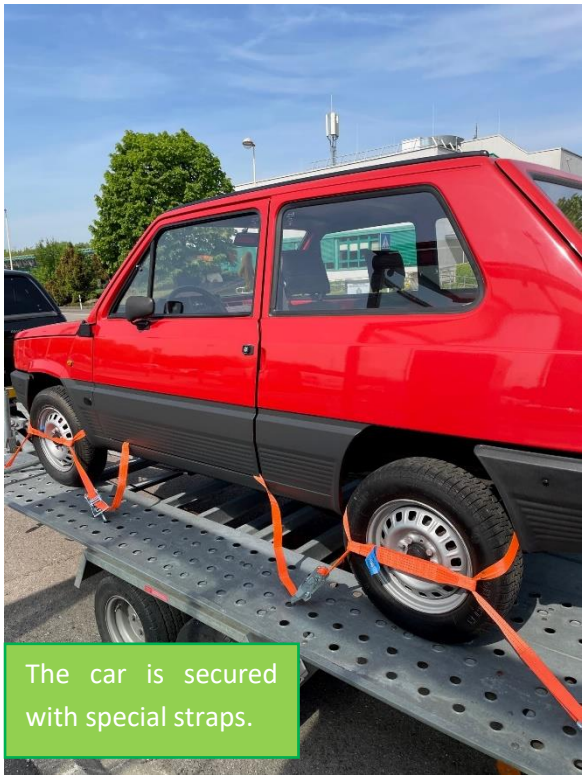
Load blocking with bars.

The load is secured with a lashing net.

Removable stanchions can be used on the trailer wherever needed for load blocking.

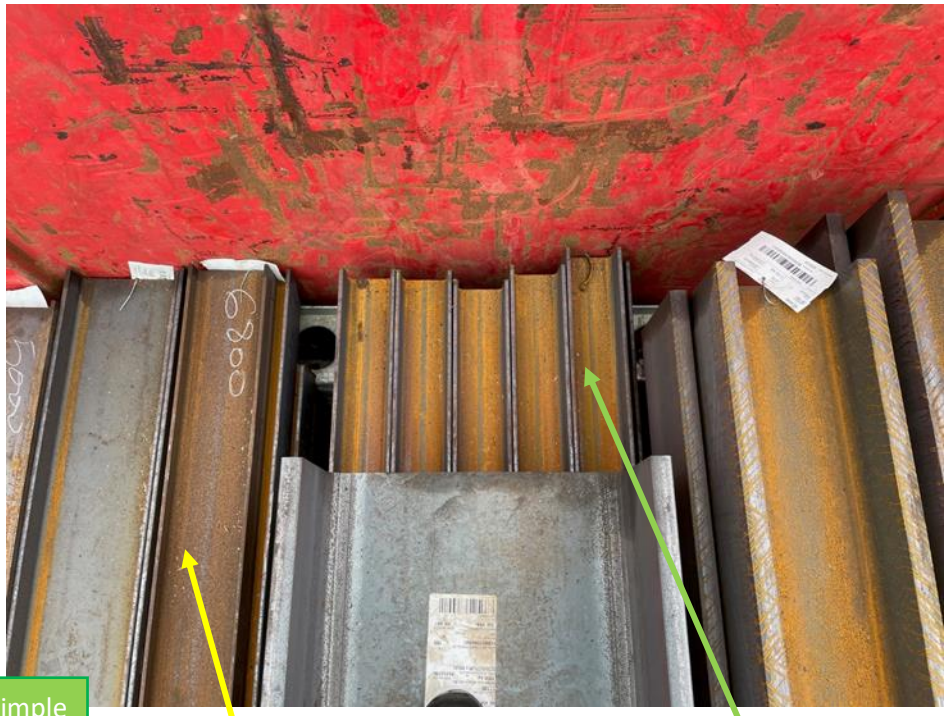


Motorcycles are blocked forward with a chock and secured by direct lashing.



The car is secured with special straps.

Semi-trailers specially built for hay transport.

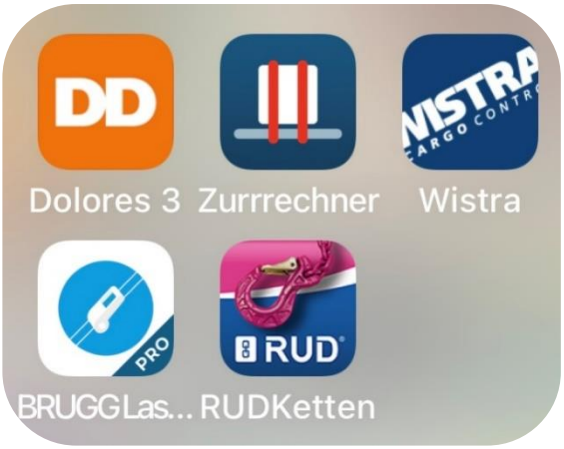


Even simple wooden beams (green circle) or pallets can be used to fill gaps and optimise securing without high costs.

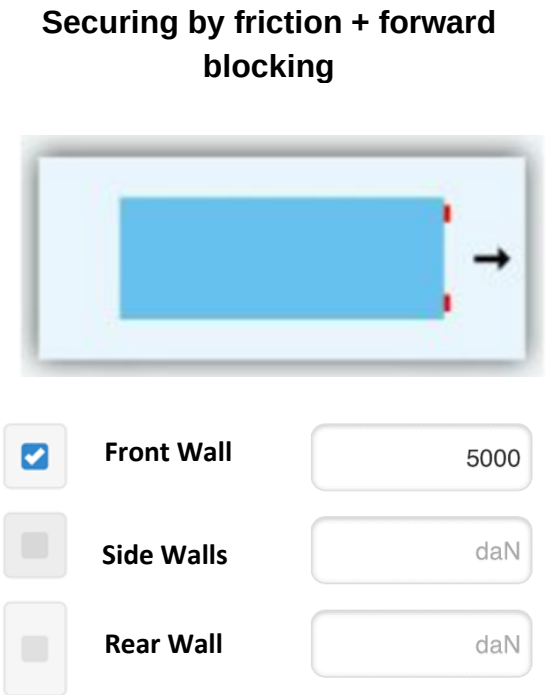
Calculation tools

There are numerous mobile applications available for determining the number of securing devices required for a given load and vehicle. Manufacturers of securing equipment offer various mobile applications with widely varying calculation capabilities.

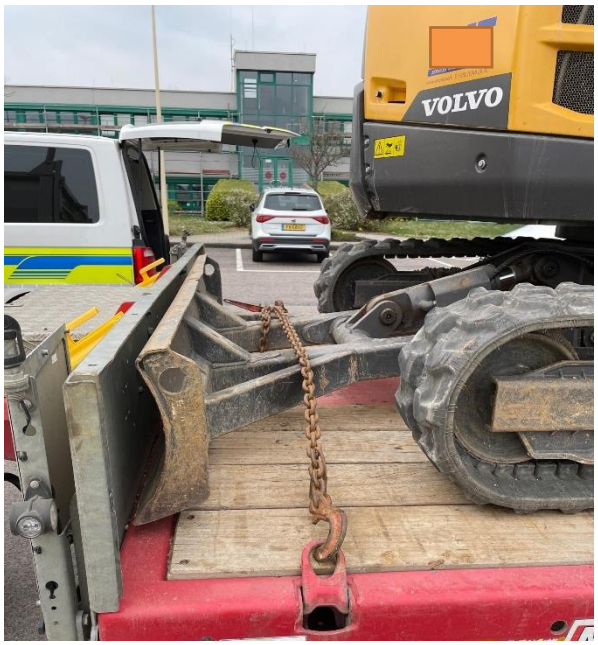
If blocking of goods against walls is to be taken into account, it is important to ensure that the application includes this function for each applicable direction.

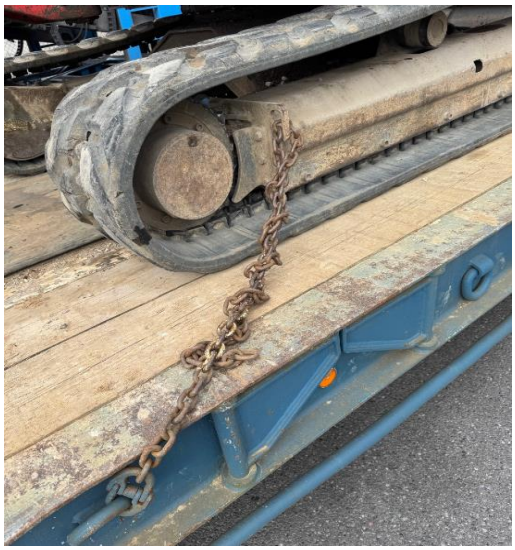


Below is an illustrative example of a calculation using a mobile application: a truck transporting a 2-tonne load on a loading surface with a coefficient of friction μ of 0.3 requires 2 straps (with STF 500 daN) applied at an ideal angle of 90° with forward blocking, and 5 straps without such blocking.



Chapter 8 – Examples and consequences of poor load securing






DOUANES
DOUANES
ZOLL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Oberhausen


RLF

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