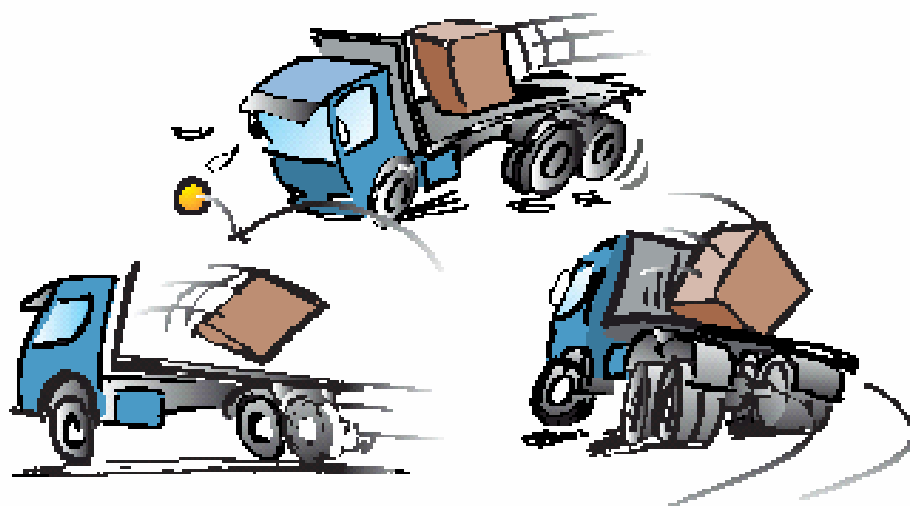


European Best Practice Guidelines on Cargo Securing for Road Transport



EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

Preface by

Mr Jacques Barrot, Vice-President of the European Commission, Commissioner in charge of transport

Road freight transport is the backbone of European transport and logistics. Europe needs not only efficient, but also safe road freight transport. Securing cargo properly is essential to achieve even safer road freight transport.

It has been estimated that up to 25% of accidents involving trucks can be attributable to inadequate cargo securing. Rules on cargo securing exist in several Member States, but they often differ in content and scope, making it very difficult for international transporters to know what the minimum cargo securing requirements are for a given cross-border transport operation.

Starting end of 2002, industry, Member States and the Commission took a practical step towards more road safety by developing the guidelines on cargo securing, which I have the pleasure to present in the current form. The present document is the result of the experts' collective work over three years and I thank all experts involved in this exercise for sharing their expertise and dedicating much time to what I think is a useful and practical reference book.

It deserves to be read all over the European Union. In this context, I am grateful to the International Road Union (IRU), for their valuable support in translating this book into a maximum of Community languages.

May the Guidelines be read and applied all over Europe, to help our common goal of making traffic safer.

Signed

Notes

1. These best practice guidelines have been prepared by an Expert Group created by the Directorate-General for Energy and Transport and comprising experts designated by the Member States and the Industry. The document was presented to the Road Safety High Level Group, which gave a positive opinion concerning its content and scope.
2. These best practice guidelines can be a reference for all public or private parties directly or indirectly concerned by cargo securing. This document should be read and used as a help for the application of safe and tried practices in this area.
3. It is not binding in the sense of a legal act adopted by the Community. It simply presents the accumulated knowledge of European experts in this field. It was developed with and received the agreement of Member States' government experts and other concerned parties. These best practice guidelines are intended to ease cross border transport operations in so far as cargo securing is concerned. Adherence to the principles and methods described in these guidelines should be recognised by enforcement authorities as leading to the adequate safety level required to perform international transport operations. **When using these guidelines, one must ensure that the methods used are adequate for the particular situation at hand and where appropriate take further precautions.**
4. It is important to bear in mind that Member States might have specific requirements relative to cargo securing not covered in these best practice guidelines. It is therefore always necessary to consult the relevant authorities to enquire about the possible existence of such specific requirements.
5. This document is publicly available. It can be downloaded free of charge at the European Commission website¹.
6. Inevitably, as a result of further experience and a continuous development of cargo securing systems and techniques, these guidelines will need to be periodically reviewed and amended as necessary. It is not possible to give an agenda for this revision process at the time of writing. The reader should refer to the web site of the European Commission for information about the latest available edition of the Guide. Any suggestions for improving or adding to its content are very welcome and should be sent to the address in footnote². General enquiries regarding these guidelines should be sent to the same address.

¹ Web Link: http://ec.europa.eu/transport/roadsafety/vehicles/best_practice_guidelines_en.htm

² European Commission, Directorate-General for Energy and Transport, Road Safety Unit, 200 rue de la Loi, BE-1049 Brussels. E-mail: tren-mail@ec.europa.eu.

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0. Quick reference: the ten most important commandments for cargo securing

The following is a short list of important basic rules which are always valid whatever the cargo transported and which should be remembered or respected when performing a transport operation. This list is not self standing. It must be complemented by the more detailed explanations that can be found in the bulk of the document.

Remember that if a cargo is not secured adequately, it can be a danger to others and yourself. Inadequately secured cargo could fall off the vehicle, cause traffic congestion and others could be hurt or killed. Inadequately secured cargo could hurt or kill you during strong braking or a crash. The steering of a vehicle can be affected by how the cargo is distributed and/or secured on the vehicle, making it more difficult to control the vehicle.

Some of the following ten commandments are primarily targeted at the driver, because he is the one physically transporting the cargo to its destination and therefore directly exposed to the hazards involved in the transport operation:

- Before the vehicle is loaded, check that its load platform, bodywork and any load securing equipment are in sound and serviceable condition.
- Secure the cargo in such a way that it cannot shove away, roll-over, wander because of vibrations, fall off the vehicle or make the vehicle tip over.
- Determine the securing method(s) best adapted to the characteristics of the cargo (locking, blocking, direct lashing, top-over lashing or combinations of these).
- Check that the vehicle and blocking equipment manufacturers' recommendations are adhered to.
- Check the cargo securing equipment is commensurate with the constraints it will encounter during the journey. Emergency braking, strong cornering to avoid an obstacle, bad road or weather conditions have to be considered as normal circumstances likely to happen during a journey. The securing equipment must be able to withstand these conditions.
- Each time cargo has been (un)loaded or redistributed, inspect the cargo and check for overload and/or poorly balanced weight distribution before starting. Ensure that the cargo is distributed in such a way that the centre of gravity of the total cargo lies as close as possible to the longitudinal axis and is kept as low as possible: heavier goods under, lighter goods above.
- Check the cargo securing regularly, wherever possible, during the journey. The first check should preferably be done after a few kilometres drive at a safe place to stop. In addition the securing should also be checked after heavy braking or another abnormal situation during driving.
- Wherever possible, use equipment which supports the cargo securing such friction mats, walking boards, straps, edge beams, etc.
- Ensure that the securing arrangements do not damage the goods transported.

- Drive smoothly, i.e. adapt your speed to the circumstances so as to avoid brisk change of direction and heavy breaking. If you follow this advice, the forces exerted by the cargo will remain low and you should not encounter any problems.

1. General

1.1. Introduction

Legal requirements and common sense demand that all loads carried on vehicles are secured, whatever the journey. This is to protect the people involved in loading, unloading and driving the vehicle, together with other road users, pedestrians, the load itself and the vehicle.

Loading and unloading should be carried out by appropriately trained staff that are aware of the risks involved. Drivers should also be aware of the additional risk of the load, or parts of the load, moving when the vehicle is being driven. This applies to all vehicles and to all types of load.

From a legal point of view, the liability for the loading/unloading operations should be assumed by the driver, within his responsibilities, and the person(s) who have executed them. In practice quite often the driver has to couple to a pre-loaded trailer or pick up a pre-loaded and sealed container. Another frequent situation is where the loading operation is carried out by the shipper's employees, even obliging the driver to wait elsewhere until the loading of the vehicle has been completed.

Therefore, all involved parties must be aware of their respective responsibilities. One cannot state that in all circumstances the driver is the sole person responsible for the load carried on his vehicle.

In some Member States the legal obligations of the other participants involved within the transport chain are already accounted for within their national regulations.

The purpose of these guidelines is to provide basic practical advice and instructions to all persons involved in loading/unloading and securing a cargo on vehicles, including carriers and shippers. They should also be useful for enforcement bodies and courts. It could also serve as a basis for Member States when taking the necessary steps for putting into practice the training of drivers in accordance with Directive 2003/59/EC on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers. The guidelines aim to provide a guide for adequate cargo securing for all situations that may occur in normal traffic conditions. The reader should also be aware that there are additional specific national legal requirements in some Member States. The guidelines should also serve as a common basis for both practical application and enforcement of cargo securing.

More detailed Information is given by IMO/ILO/UNECE, Guidelines for packing of cargo transport units and IMO Model course 3.18, as well as in standard EN12195 "Load restraint assemblies on road vehicles", part 1: "Calculation of lashing forces", part 2: "Web lashing made from manmade fibres", part 3: "Lashing chains" and part 4: "Lashing steel wire ropes". The information to

these lashings is an integrated part of these guidelines; see Sections 1, 2 and 3.

The majority opinion of the Expert Group is that either the IMO/ILO/UNECE or CEN methods should be accepted as giving a safe level for cargo securing in cross border operations; both methods should be recognised by the controlling authorities for International Transport, leaving to the haulier or the loader the choice of which method to apply. Some Member States could however impose one of the two methods or specific rules for transports on their roads.

The guidelines do not address only the load being carried by the vehicle; they also cover any vehicle equipment on the vehicle, including loading equipment and devices carried or mounted on the vehicle such as loader cranes, landing legs, tailgates etc. All of these must be stowed and secured according to manufacturer's instructions so as not to be a danger to the driver, passengers, operating people, other road users, pedestrians and the load itself.

Planning is the key to achieving efficient, reliable and safe transportation of cargo. "Be wise before the event"- in other words, plan your operations well and you will avoid many unpleasant surprises. Major savings can be gained through planning the stowage and the securing of the cargo. Choosing the correct type of load carrier, and securing the cargo with consideration given to the forces the cargo will be subjected to during transportation is of extreme importance.

Always find out how the cargo will be transported, the means of transport that will be used, whether it will be a combined transport operation and then choose a load carrier appropriate to the cargo and to the means of transport used during the full itinerary. (More information on planning in Annex 8.10).

1.2. Purpose of the guidelines

Most Member States have legal requirements that cargo must be placed on the vehicle so that it can neither endanger persons nor goods and can not drag or fall off the vehicle. Every year road incidents and accidents occur on EU roads because of cargoes which have not been properly stowed and/or secured. Although comprehensive rules exist on cargo securing in some Member States they may differ in content and scope and thus make it very difficult for international carriers to determine what the different national requirements in this field are.

Regarding the Road Transport of dangerous goods, international legal requirements laid down by the ADR-agreement make the securing of dangerous goods mandatory.

1.3. Need for cargo securing

The very basic physical principal behind the forces exerted by a cargo on its environment is that a moving object, if no forces are exerted, will keep on moving in a straight line at the same speed.

The speed of an object can be represented by an arrow: the arrow's length is proportional to the object's velocity; the arrow's direction shows the straight line the object would follow if no forces are exerted.

To change the object's speed, i.e. to change the length and/or direction of the arrow representing it, will generate forces.

In other words, the only situation where a cargo does not exert any force on its environment (except for its weight of course) is if you are driving in a straight line at a constant speed.

The more you are deviating from this situation (e.g. heavy braking, strong acceleration, hard cornering on roundabouts, rapidly changing lanes, etc.), the stronger are the forces that the cargo exerts upon its environment. For road transport these forces are mainly horizontal. In these situations friction alone is seldom sufficient to stop unsecured cargo from sliding. It would be incorrect to assume that the weight of the load will be sufficient to keep it in position. During heavy braking for instance, the force exerted by the cargo towards the front of the vehicle can be very high and nearly equal the weight of the cargo. So, during heavy braking, a 1 tonne load will "push" forward with a force of nearly 1000 daN (i.e. 1 tonne in everyday's language; see following Section for clarification on mass and weight). However, greater forces may be encountered if the vehicle, for example, is involved in an accident. The principles of cargo securing should therefore be regarded as the minimum requirements.

To summarise, when a vehicle brakes the load strives to continue to move in its original direction. The harder you brake, the harder the load will "push" in the forward direction. If the cargo is not properly secured (see Chapter 3), it will continue to move in the forward direction independently from the vehicle!

The general advice is: Always secure cargo properly and ***drive smoothly, i.e. only deviate slowly from the straight line/constant speed situation***. If this advice is followed, the forces exerted by the cargo will remain low and you should not encounter any problems.



Picture 1: During heavy braking, the badly secured steel tubes made their way through the headboard and the drivers cab.

1.3.1. Mass and weight

Even though they are frequently confused, mass and weight are different in nature. It is important to grasp the difference in order to understand the principles of cargo securing.

Mass is a property of matter. Any object (be it a feather, a log, a brick, a truck etc.) has got a mass, which is intrinsically linked to the quantity of matter it contains (i.e. its density). The mass of an object does not depend upon its environment; it is identical on earth, the moon or in outer space...

Weight is a force due to gravity. Gravity is the property by which all masses attract each other. For instance the earth and the moon attract each other because of gravity and therefore stay coupled, gravitating around each other. The gravity force attracting objects towards each other is proportional to their masses and diminishes with the distance separating them (actually by the square of the distance: the attraction force between two objects twice further apart diminishes by a factor of 4 etc...). Thus because of gravity, the earth attracts any objects in its vicinity, including of course any objects on its surface, which is more of interest to us.

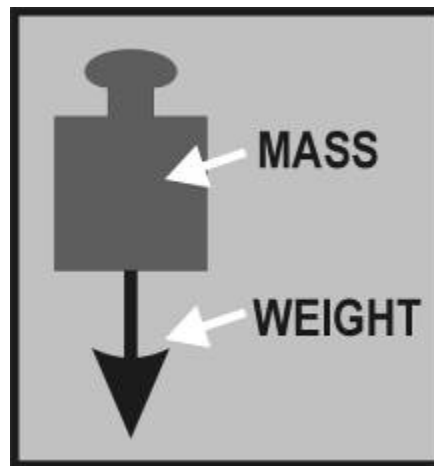
The weight of an object is the force by which the earth attracts this object.

Nowadays, in the modern international system of units (the metric system), masses are measured in gram (abbreviation: g) or its (sub)multiples like the kilogram (kg) or the tonne (t). Forces, like weight, are measured in Newton (abbreviation: N). The weight of a mass of 1 kg is about 9,81 N at sea level,

which for all practical purposes can be rounded to 10 N or 1 deca-Newton (abbreviation: daN).

Therefore, simplified for the purpose of cargo securing:

The weight of 1 kg of mass is 1 daN.



Picture 2: Mass versus weight

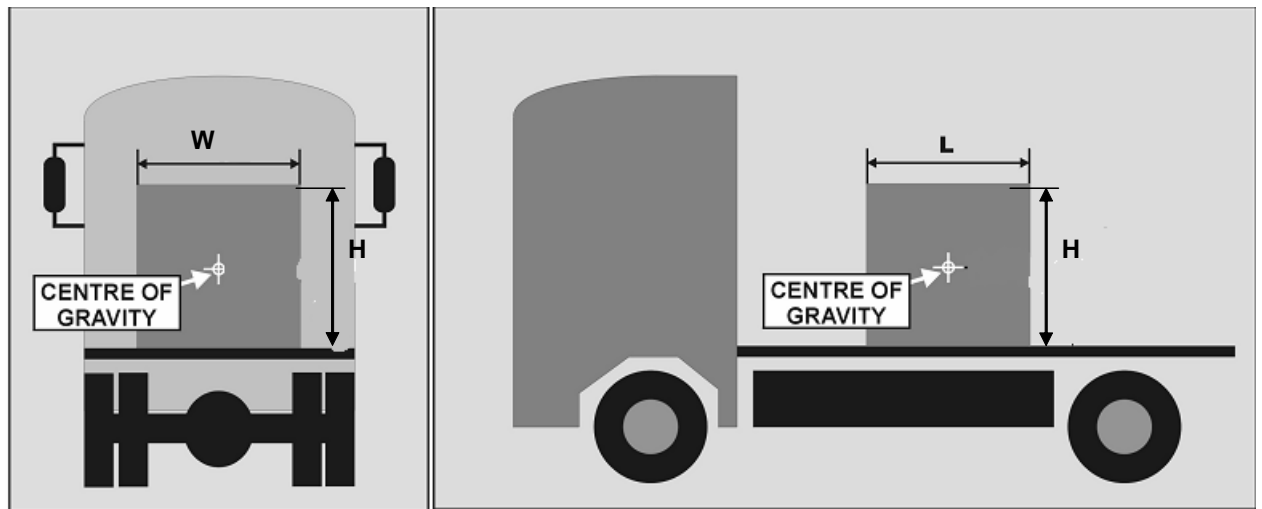
As previously stated, the weight of an object is proportional to its mass, so the weight of 1 tonne (1000 kg) mass is 1000 daN, of 2 tonne mass is 2000 daN, etc

1.3.2. Centre of Gravity

The **centre of gravity** of an object is the average of the mass distribution within that object. If the mass of an object is evenly distributed, the centre of gravity of the object is identical to its geometrical centre (e.g. the centre of gravity of a homogeneous cube or sphere would be the centre of that cube or sphere).

If the mass of an object is not evenly distributed, its centre of gravity will be closer to where the object is heavier. To give an extreme example, if an object would be made of a steel part glued to a cardboard part, its centre of gravity would certainly be somewhere in the steel part because this is where its mass is concentrated.

The centre of gravity of an object is not necessarily within the object. For example, a homogeneous boomerang-shaped object would have a centre of gravity located somewhere at mid distance between the “boomerang” extremities, outside the object.



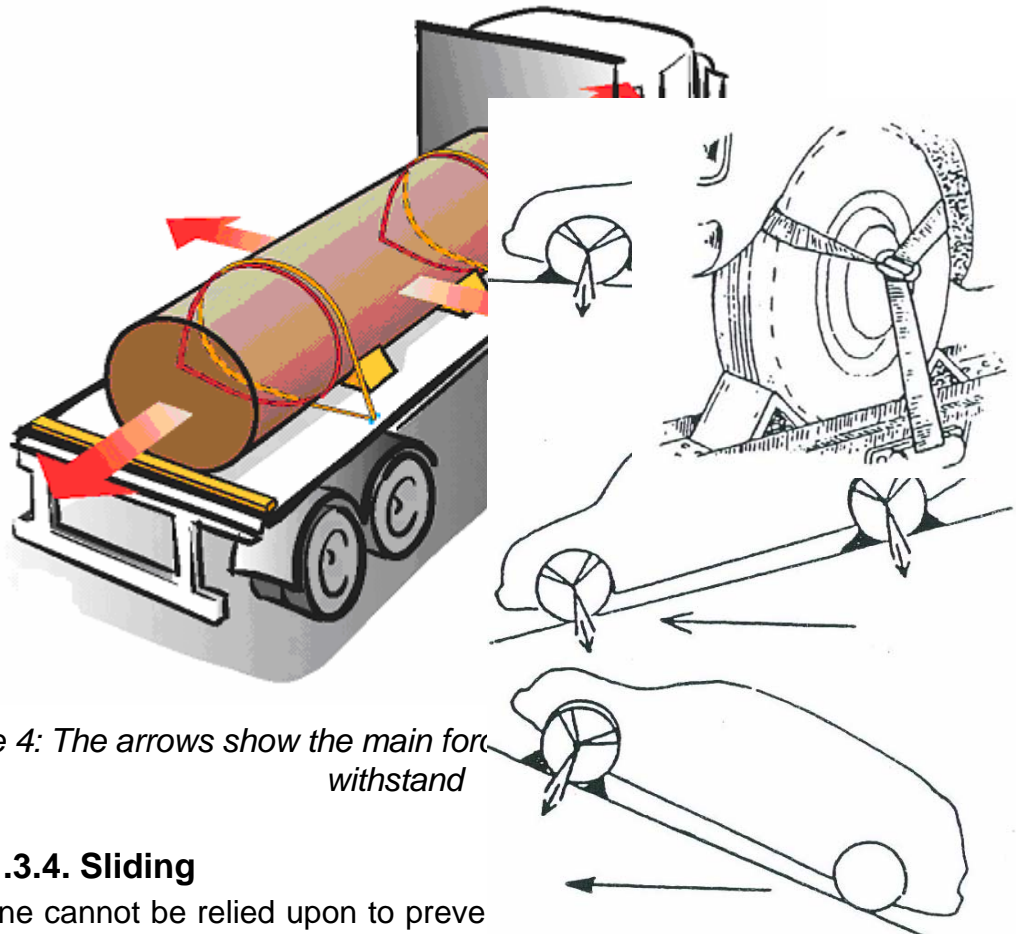
Picture 3: Centre of gravity

Relevance to cargo securing:

The higher the centre of gravity of a cargo, the more it tends to tip over when subjected to horizontal forces. If the centre of gravity of a cargo is vertically off centre relative to the cargo's "footprint", the cargo will tend to tip over in the direction where the centre of gravity is closest to the footprint limits. For very heavy cargo, the centre of gravity position may be important for correctly positioning and securing this load on the vehicle to ensure an adequate load distribution.

The higher the centre of gravity of the vehicle/load combination considered as a whole, the more likely the combination is to roll over.

1.3.3. Acceleration forces exerted by the cargo



Picture 4: The arrows show the main force withstand

1.3.4. Sliding

Friction alone cannot be relied upon to prevent sliding. When the vehicle is moving, vertical movements caused by bumps and vibrations from the road will reduce the restraining force due to friction. Friction can even be reduced to zero if the load momentarily leaves the bed of the truck. Top-over lashings or other restraining methods, in addition to friction, contribute to adequate cargo securing. The friction forces depend upon the mutual characteristics of the cargo and truck bed surfaces in contact (see friction table in Annex 8.2).

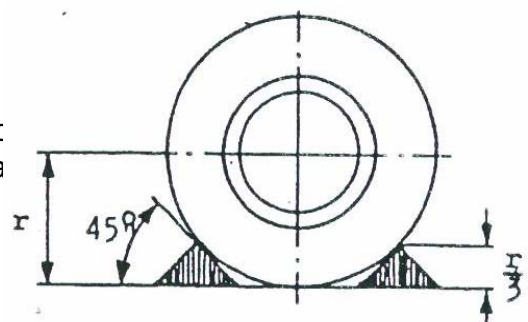
1.3.5. Tilting and Tipping

Even if the cargo is prevented from sliding by blocking, additional restraining methods may be necessary to avoid tilting. The risk for tilting depends upon the height of the centre of gravity and dimensions of the cargo section. (See Annex 8.6)

When calculating the risk of tipping, the height (H), the width (W) and the length (L) are used (picture 4 above). Beware if the centre of gravity is not in the centre.

1.3.6. Rigidity of the cargo

The rigidity of the cargo has a big influence upon the method chosen for its securing. If transported upon a flat surface,



made as rigid as possible. If the cargo is not considered rigid enough to adequately apply lashings (sacks or big bags for example) the rigidity may be improved by the use of filler material, boards, walking boards and supporting edge profiles. The amount of material needed to perform the blocking/supporting will depend upon the rigidity of the goods.

1.3.7. Load distribution



*Picture 5: Incorrect load distribution.
Funny things might happen...or it can have dramatic results.*

When any load is placed upon a vehicle, the maximum authorised dimensions, axle and gross weights must not be exceeded (see Annex 8.1: Load distribution guidance). Minimum axle loads should also be considered to ensure adequate stability, steering and braking.

Difficulties with the load distribution on the vehicle occur if the vehicle is partly loaded or unloaded during its journey. The effect on gross weight, individual axle weights, securing and stability of the load must not be overlooked. Although removal of part of the load will reduce the gross vehicle weight, the change in weight distribution may also cause individual axles to become overloaded (known as the diminishing load effect). The centre of gravity of both the cargo and the vehicle/cargo combination will change accordingly; therefore all aspects should be considered when the vehicle is loaded.

Vehicle rollover is one of the most frequent accidents encountered due to incorrect load distribution.

Detailed guidance on load distribution can be found in annex 8.1.

1.3.8. Choice of vehicle and loading of the vehicle

The design and construction of the vehicle and its bodywork should be suitable for the loads that it is likely to carry, particularly in terms of the characteristics and strengths of the materials used.

Before the vehicle is loaded, it should be checked to ensure that its load platform, bodywork and any load securing equipment are in sound and serviceable condition. A check of the following is recommended

It should be ensured that

- The load platform is clean and dry;
- The platform bed is in good condition, without any broken boards, protruding nails, or anything that can damage the securing equipment or the cargo;
- The headboard is in serviceable condition;
- The curtainsider support is serviceable, with all laths in position;
- In case of containers or swap bodies, that all twist locks and fittings are intact and in serviceable condition;
- Securing equipment is intact, clean and in serviceable condition – NOTE any wear and corrosion of the lashing points should receive special attention;
- There is an adequate number of lashing points available on the vehicle for the cargo being carried.

1.3.9. Multimodal Transport Operations

If a vehicle is also intended to use sea or rail transport, a restraint system suitable for the road will not necessarily be adequate for the sea or rail leg of the journey due to different forces encountered. Therefore, the international codes of practice for rail (UIC, Annex 2) and sea transport (IMO/ILO/UNECE, Guidelines for packing of cargo transport units [CTUs]) should also be considered.

For the purpose of these guidelines CTU means a road freight vehicle, a freight container, a road tank vehicle or a swapbody.

Multimodal transport is the transport of a cargo transport unit (CTU) by different modes of transport in the transport chain. The most frequent multimodal/combined modes of transport are: road, rail, inland waterway or sea.

CTUs transported by different modes of transport will be subject to forces of different magnitudes depending on the mode used.

In road transport, the highest forces arise during heavy braking – these forces are directed towards the front of the vehicle.

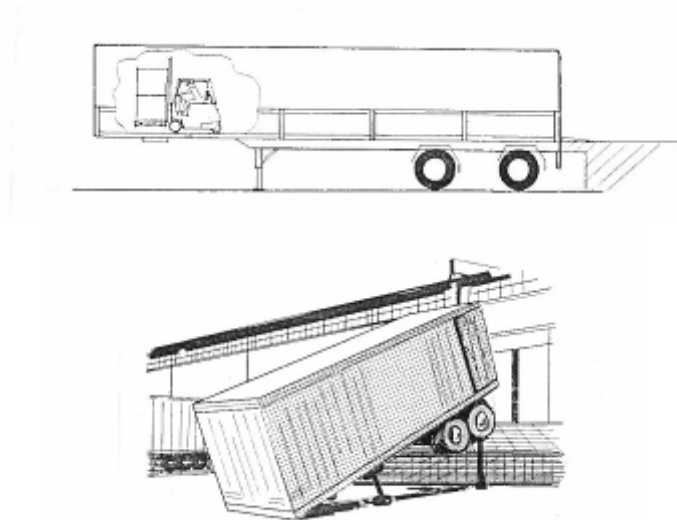
In rail transport, extremely high forces may arise in the longitudinal direction of the wagon. The highest forces occur during marshalling, when wagons run into each other after being rolled from side tracks to compose new trains.

At sea, forces can occur in any direction. The highest forces are normally perpendicular to the ship's longitudinal axis; when it rolls, for example. These

forces are directed towards each side of the ship alternately, and occur regularly, often for long periods of time. The ship may also pitch in rough sea, which will cause extremely high vertical forces. It is therefore always important to find out how the cargo will be transported, in order to choose the appropriate type of CTU.

The following handling/stowage/securing precautions should be considered when loading/unloading a multimodal/combined CTU:

- The CTU should be protected against tipping. If a stand alone CTU on a chassis is loaded/unloaded with a forklift, the CTU should be supported (by placing additional support legs at its extremities for example).



Picture 6: CTU should be protected against tipping

- The cargo inside the CTU should be secured in such a way that the cargo can neither slide nor tip.
- Do not load heavy cargo on top of light cargo. Wherever possible the centre of gravity of the loaded container should be below the mid-point in its height;
- With cargo of regular shape and size a tight stow from wall to wall should be sought;
- If void spaces (see Section 3.1) occur, cargo should be secured by using dunnage, folded cardboard or other suitable means;
- The load should be evenly distributed (as a general rule for containers there should not be more than 60% of the total cargo mass located in one half of the container, either longitudinally or laterally);
- Steps should be taken to ensure that the load and dunnage will not fall out when the doors are opened;
- There are specific provisions for the stowage of dangerous goods.

For the limit values of forces exerted during different modes of transport, see Annex 8.11.

1.3.10. Training on Cargo Securing

Directive 2000/56/EC on driving licenses and Directive 2003/59/EC on training for professional drivers make some provisions for the training of drivers in cargo securing but these regulations are only applicable to a minority of the current truck driver population and do not apply to personnel carrying out the loading and unloading of vehicles or planning transport. It is therefore strongly recommended that additional measures are taken to improve the knowledge of the personnel mentioned above on cargo securing, both in the form of initial qualifications and a system of regular retraining.

It is recommended that companies introduce training measures or provisions are made within national legislation to set up a system of initial training and regular retraining for all personnel involved with loading, unloading and securing of cargo in the road transport chain. Furthermore, it is advisable for member states to have specifically trained staff within enforcement bodies to verify and enforce the correct application of cargo securing standards and by that improve road safety.

A further recommendation is that provisions are made regarding the qualifications of instructors for cargo securing training, e.g. educational background, verifying their qualifications, regular retraining, quality management for training and instructors and regular updating of the syllabuses used.

In most cases, it is not necessary for all personnel to know every aspect of cargo securing and it is therefore advisable to have a common introductory course supplemented with additional specialist courses which would take into account the branch, the types of vehicles used, the function of the people being trained and the type of cargo transported for example. The common introductory course should provide guidance on

- legislation on cargo securing, responsibilities and technical rules,
- national and international technical standards for cargo securing,
- other information sources,
- physical principles, weights and forces,
- use of securing equipment,
- basic principles and methods of cargo securing and
- restraining material.

And all training courses should include a significant part of practical training.

Appropriately trained staff is the only reliable basis for protecting drivers, other road users, the vehicle and the load from the dangers that incorrect cargo securing poses.

For more detailed information see Annex 8.15.

2. Vehicle body structure and equipment suitable for blocking on vehicles

The technical characteristics of vehicles and blocking equipment have to be a matter of consideration. There are European standards covering these subjects but vehicles and blocking equipment are not always built in compliance with these standards. It is important to check whether the vehicle and the components fulfil the relevant standards requirements. Compliance with the relevant standards should be a key factor in selecting a vehicle and any blocking equipment. Extreme caution must be applied if conformity to standards can't be verified. Documentary evidence of compliance with standards (declaration of the manufacturer, certificate of conformity issued by a notified body...) should be carried on board at all times.

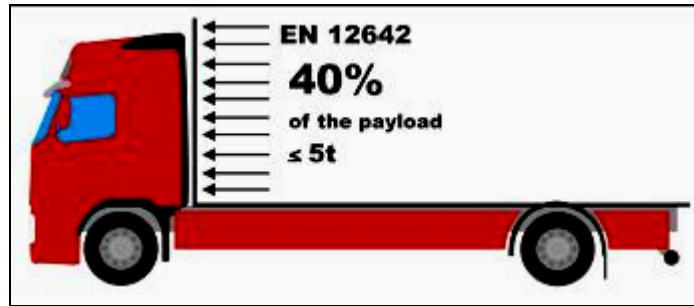
The driver should check the properties of his vehicle before loading commences and both the vehicle and blocking equipment manufacturers' recommendations must be adhered to.

The endwalls and sidewalls fitted to vehicles, if adequately constructed, will provide restraint to movement of the load. The strength of the body structure on a vehicle should be based on standard EN12642 or equivalent requirements. The related requirement for swap bodies is contained in standard EN283. The standards (for blocking) specify minimum requirements ensuring the body structure's ability to secure the cargo if it is not fixed by lashing equipment. It is important to check the vehicles properties and whether they fulfil requirements for forming part of cargo securing arrangements. It is important that any forces exerted by the load are evenly distributed as much as possible over the lowest possible part of any blocking device. High spot loadings should be avoided, i.e. forces concentrated on relatively small portions of the structure.

2.1. Headboard

The headboard of trucks and trailers with a Gross Vehicle Weight (GVW) exceeding 3.5 tonnes should at least be designed in accordance with standard EN12642 or equivalent if used for cargo securing (see illustration below). This is a safety design requirement, meaning that the headboard must be able to withstand a force equivalent to 40% of the maximum cargo weight, but not more than 5.000 daN, directed forward, and evenly distributed over the headboard, without excessive residual deformation. When the cargo is blocked against the headboard, the capacity of the headboard should be taken into account when calculating the number of lashings.

As mentioned above, these rules do not imply that any vehicle is able to bear these, lower or even higher loads. The actual properties of the vehicle in this issue and all the others shown below have to be investigated before starting to secure the cargo or even before loading the vehicle.

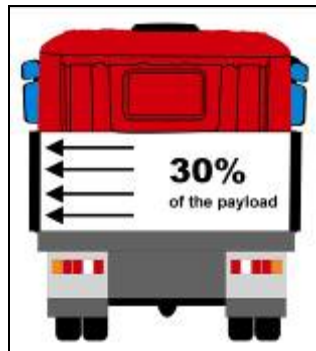


Picture 7: Strength requirements for headboard

2.2. Sideboards

Sideboards of trucks and trailers with a GVW exceeding 3.5 tonnes should at least be designed in accordance with standard EN12642 or equivalent if used for cargo securing. This is a safety requirement, meaning that the sideboard must be able to withstand a force equivalent to 30% of the maximum cargo weight, directed sideways and uniformly distributed over the sideboard, without excessive residual deformation. When the cargo is blocked against the sideboard, the capacity of the sideboard should be taken into account when calculating the number of lashings.

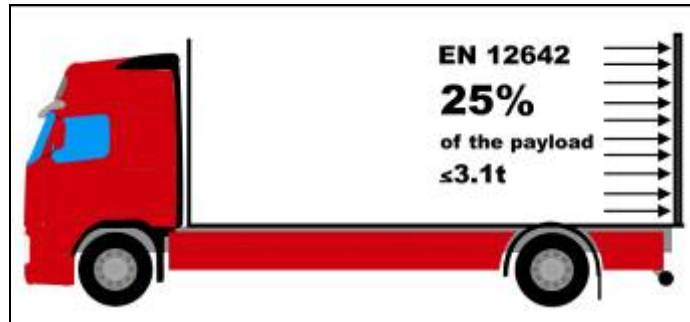
The same requirement is applicable to cover/stake body type with sideboards.



Picture 8: Strength requirements for sideboards

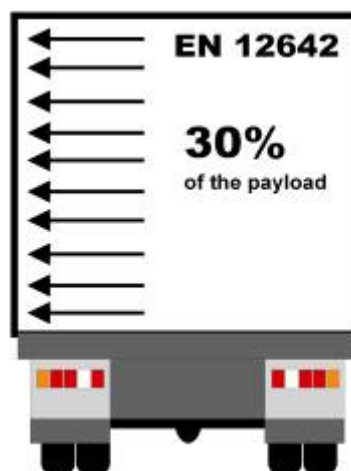
2.3. Endboards

The endboard should at least be designed in accordance with standard EN12642 standard or equivalent if used for cargo securing. This is a safety requirement, meaning that the end board must be able to withstand a force equivalent to 25% of the maximum cargo weight, but not more than 3.100 daN, directed backward and uniformly distributed over the endboard, without excessive residual deformation. When the cargo is blocked against the endboard, the capacity of the endboard should be taken into account when calculating the number of lashings.



Picture 9: Strength requirements for endboards

2.4. Box type bodies



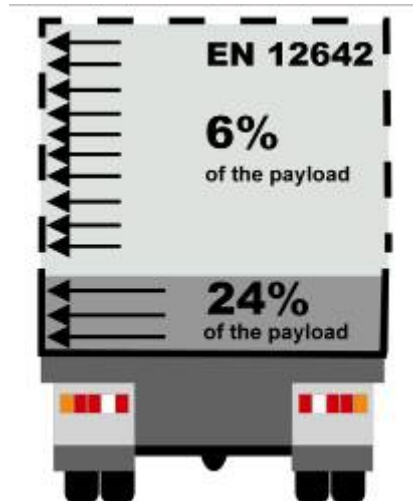
Picture 10: Strength requirements for sidewalls of box type bodies

The sidewalls of box type bodies should preferably be designed in accordance with standard EN12642. This is a safety requirement, meaning that the sidewall must be able to withstand a uniformly distributed force equivalent to 30% of the maximum cargo weight without excessive residual deformation. When the cargo is blocked against the sidewall, the capacity of the sidewall should be taken into account when calculating the number of lashings.

2.5. Open side type (cover/stake body or tilt trailer types)

Sidewalls on coverstake bodies or tilt trailer types can be used for cargo securing to some extent. The sidewalls on these body types should be able to withstand an internal horizontal force equivalent to 30% of the maximum cargo weight.

The force is evenly distributed horizontally with 24% of the maximum cargo weight on the rigid part of the sidewall and 6% of the maximum cargo weight on the lath work (standard EN12642). When the cargo is blocked against the sidewall, the capacity of the sidewall should be taken into account when calculating the number of lashings.



Picture 11: Strength requirements for sidewalls of cover stake bodies or tilt trailer types

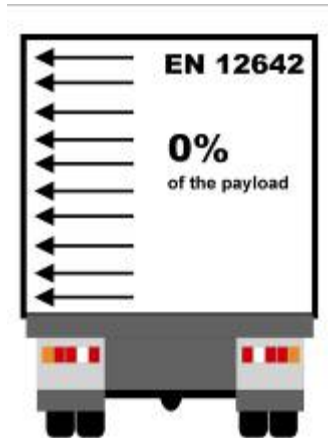
2.6. Curtainsiders

As a general rule, goods carried within curtain-sided vehicles should be secured as if they were being carried on a flat, open-bed vehicle. If the loading configuration, or its securing, would cause concern when used on an open vehicle, then it should be considered equally unacceptable with a curtain-sided vehicle.

Unless they are purposely designed according to EN12642-XL, the curtains of curtain-sided vehicles **MUST NOT** be considered as part of any load restraint system. If the curtains have been designed as a restraint system, the load capability should be clearly marked on the vehicle – if no mark can be seen, then it should be assumed that the curtain has **NO** load-bearing function. Similarly, where vertical inner curtains are fitted and they are not purposely designed for a specific load, they also **MUST NOT** be considered as part of the load restraining system. Curtains and vertical inner curtains should be considered purely as a means of containing within the vehicle any small, loose items that may have become dislodged during the journey.

European standard EN283 states that “Cargo securing devices are mandatory for swap bodies of curtainsider type”.

The advice here would be to not rely on a curtain to provide load restraint.

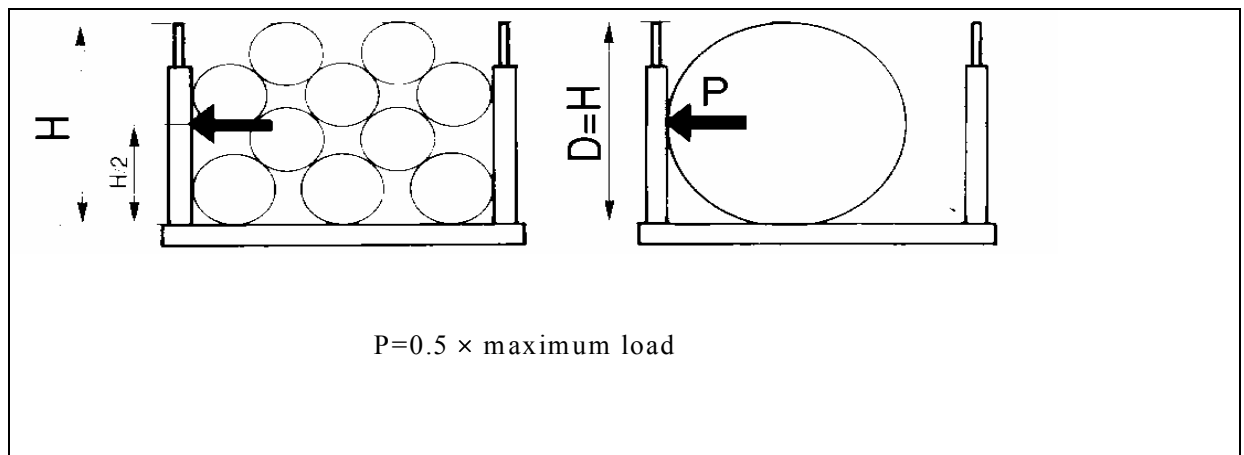


Picture 12: Strength requirements for sidewalls of curtainsiders

2.7. Stanchions

Stanchions for roll-type cargo should provide transverse blocking against roll forces emanating from cylindrical packages. They should be designed so that, together, they can withstand a lateral force equivalent to 50% of the maximum cargo weight at half the cargo height ($H/2$) above the platform bed in road transport.

Stanchions for other than roll-type cargo should be designed so that, together, they can withstand a lateral force equivalent to 30% of the maximum cargo weight at half the cargo height ($H/2$) above the platform bed in road transport.



Picture 13: Stanchions for roll type cargo

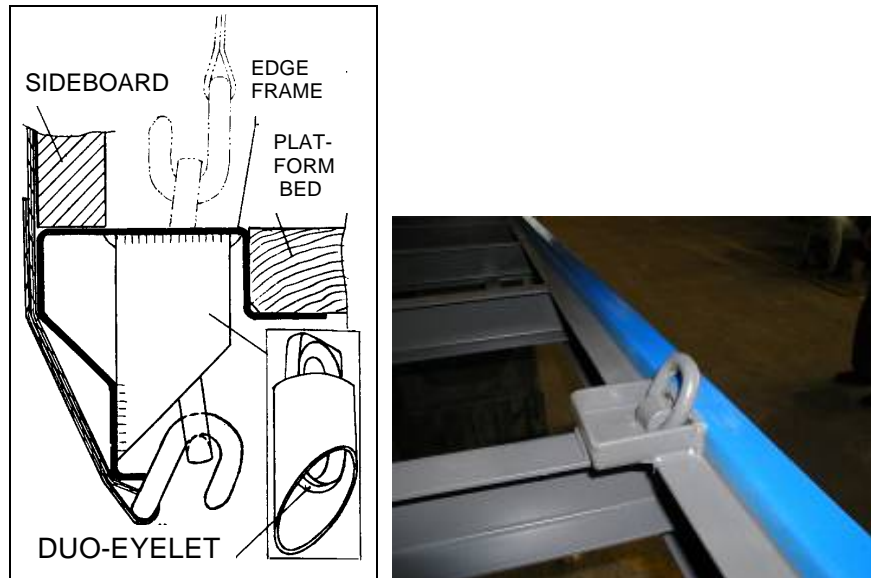
2.8. Lashing points

Lashing points in load carriers should be placed in pairs, opposite each other, along the long sides with a spacing of 0.7 – 1.2 m longitudinally and a maximum of 0.25 metres from the outer edge. Continuous lashing anchorage bars are preferable. Each lashing point should, in accordance with standard EN12640, at least withstand the following lashing forces:

Vehicle total weight in tonnes	Strength of lashing point in daN
3.5 to 7.5	800
7.5 to 20.0	1.000
over 20.0	2.000*

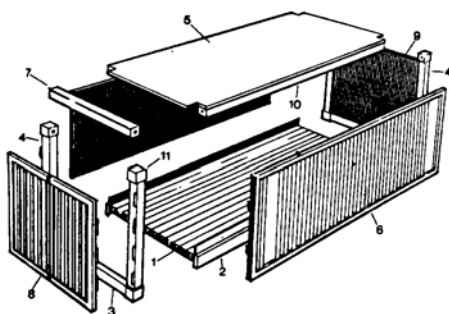
*(in general 4.000 daN is recommended)

Below, lashing attachments are shown in the form of fixed tensioner as well as hooks fitted to the load carrier.



Picture 14: Lashing eyelet

2.9. ISO-Containers (ISO 1496-1)



Picture 15 Exploded view of the design and construction of the container

- 1 Floor
- 2 Base member
- 3 Door sill
- 4 Corner pillar
- 5 Roof
- 6 Wall trim
- 7 Upper door frame
- 8 End door
- 9 End wall
- 10 Roof member
- 11 Gusset fitting

2.9.1. End walls

According to the ISO standard, both the front and rear walls (rear doors) must withstand an internal load (force) equivalent to 40% of the maximum cargo weight, evenly distributed over the entire end wall surface (door surface).

2.9.2. Sidewalls

Sidewalls must withstand an internal load (force) equivalent to 30% of the maximum cargo weight, evenly distributed over the entire wall.

2.9.3. Attachment- and lashing points

Each attachment point shall be designed and installed in accordance with standard EN12195-2, or ISO1496-1 which states that it shall provide a minimum rated load of 1.000 daN applied in any direction. Each lashing point shall be designed and installed to provide a minimum rated load of 500 daN applied in any direction.

2.10. Swap bodies



Picture 16: Swapbody standing on landing legs

The load force values for swap bodies are outlined in standard EN283. This almost corresponds with the body structure standard for carriers in standard EN12642 (see chapter 2.1 – 2.6 above)

3. Restraining Methods

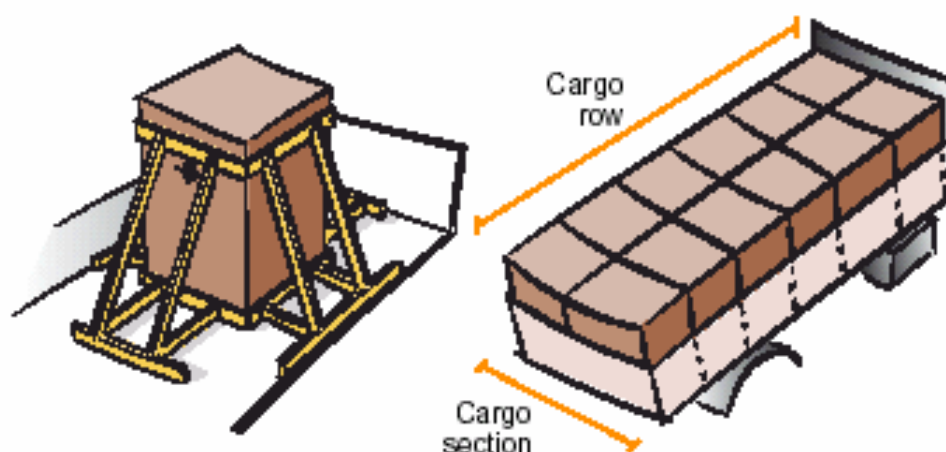
Restraining methods are principally the following:

- locking,
- blocking ,
- direct lashing,
- top-over lashing and
- combinations of these

in conjunction with friction.

The restraining method(s) used should be able to withstand the varying climatic conditions (temperature, humidity...) likely to be encountered during the journey.

3.1. Blocking



Picture 17:

Blocking or bracing means that the cargo is stowed to lie flush against fixed structures and fixtures on the load carrier. These may be in the form of headboards, sideboards, sidewalls or stanchions. The cargo can be stowed directly or indirectly by means of filling against the fixed blocking devices built into the load carrier, and these prevent any horizontal movement of the cargo. In practice it is difficult to achieve a tight fit against the blocking devices and a small clearance usually remains. Gaps must be kept to a minimum, especially those to the headboard. The cargo should be blocked against the head board either directly or by the use of filler material in between.

Be aware that the loaded packages also have to be secured to the vehicle. If the vehicle's superstructures comply with standard EN12642 and the load is uniformly distributed, total maximum sideways gaps must not exceed 80 mm for packages to be considered as properly blocked between sideboards. With heavy concentrated loads, any gaps should be avoided. Improperly blocked packages need supplementary securing measures to the vehicle.

3.1.1. Blocking with filler

Effective securing of cargo by blocking requires close stowage of the packages both against the load carrier's blocking fixtures and between the individual packages. When the cargo does not fill the space between the side and end boards, and is not otherwise secured the gaps must be filled with a filler material to create compressive forces that ensure a satisfactory blocking of the cargo. These compressive forces should be proportionate to the total cargo weight.



Picture 18: Filler between the rows of cargo

Some possible filler materials are shown hereafter.

- Goods pallets

Goods pallets are often a suitable form of filler material. If this clearance towards the blocking is larger than the height of a EURO pallet (about 15 cm) then the gap could be filled with, for example, such pallets standing on end, for the cargo to be properly blocked. If the clearance towards the sideboards on any side of the cargo section is smaller than the height of a EURO pallet then the gap to the sideboard must be filled with suitable filling, for example planks of wood.

- Air cushions

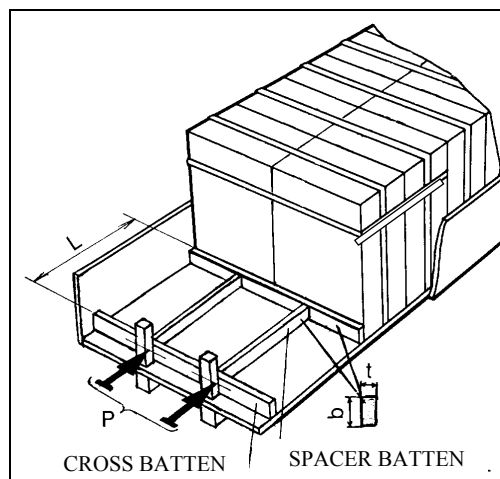
Inflatable air cushions are available both as disposable items and as recyclable products. The cushions are easy to install and are inflated by compressed air, often by means of an outlet in the truck's compressed air system. Suppliers of air cushions are expected to provide instructions and recommendations concerning load capacity and appropriate air pressure. For air cushions it is important to avoid damage as a result of wear and tear. Air cushions should never be used as filler against doors or any non rigid surfaces or partitions.



Picture 19: Air cushion in a semi trailer

- Blocking braces

When there are large gaps between the cargo and blocking fixtures, and high bracing forces, it is often appropriate to use blocking braces fitted with sufficiently strong wooden spacers. It is essential that blocking braces are fixed in such a way that the spacers are always at right angles to the cargo that is being braced. This will ensure that the blocking braces are more able to resist the forces exerted by the cargo.

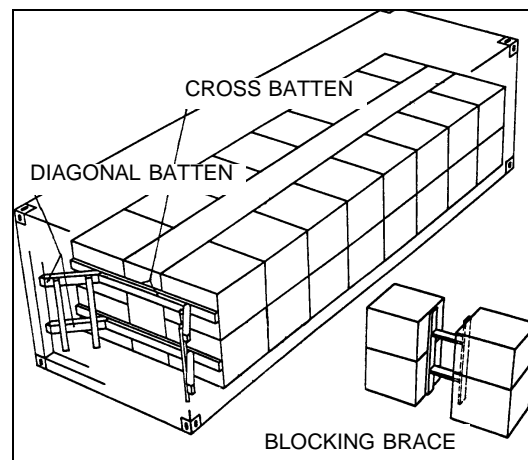


Picture 20: Blocking braces

- Diagonal and cross battens

Blocking in longitudinal direction by means of diagonal and cross battens is a direct blocking method particularly suited to containers, where the container's robust and vertical corner beams are used as counter holds for diagonal battens.

Blocking braces are used for longitudinal base blocking, but can also in certain cases be used as filler material.

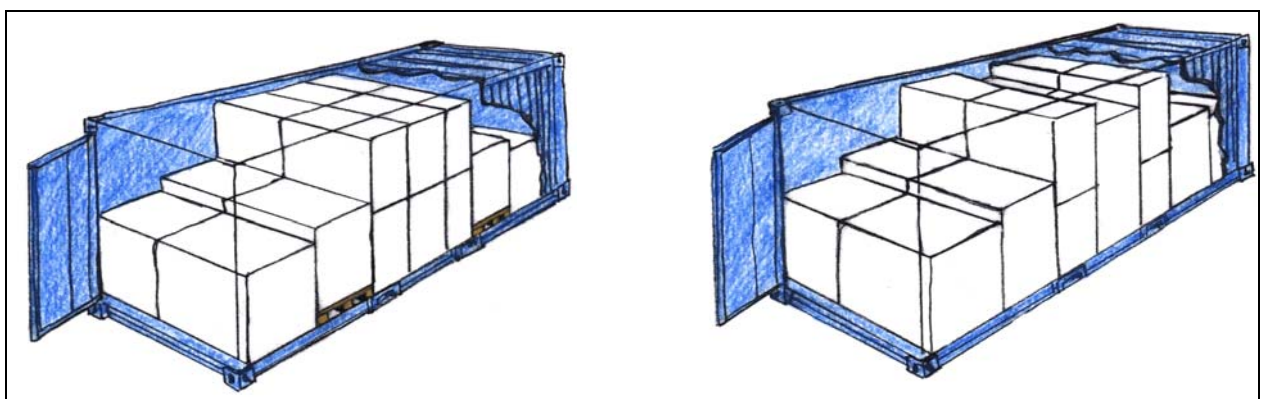


Picture 21: Diagonal and cross battens

3.1.2. Threshold blocking and panel blocking

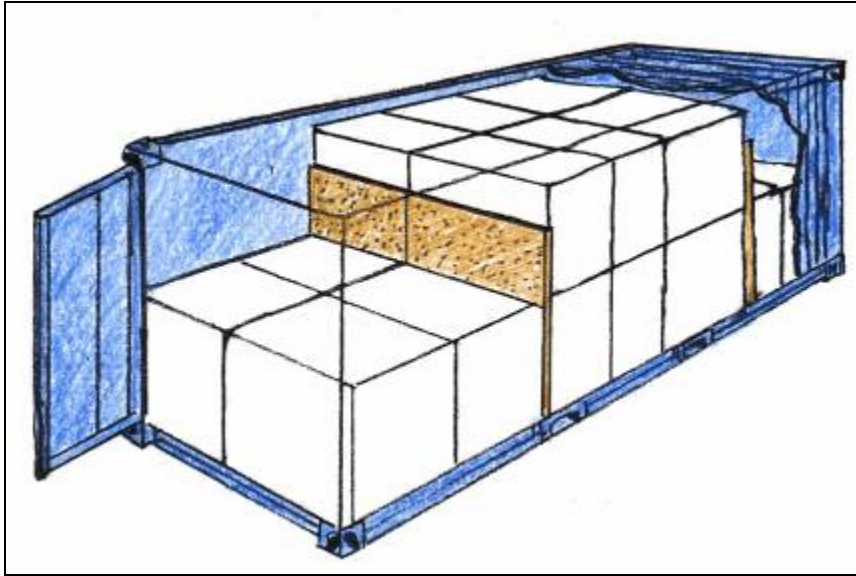
When there is a height difference between various layers, threshold blocking or panel blocking can be used for base blocking of the upper layer against the lower layer.

Using some form of base material, such as load pallets, the cargo section is raised so that a threshold is formed, and the upper cargo layer is base blocked longitudinally.



Picture 22: Threshold blocking

If the packages are not sufficiently rigid and stable for threshold blocking, a corresponding blocking effect can be achieved by using panels consisting of boards or load pallets as shown in the figures below. Depending on the rigidity of the cargo packages, a blocking structure can be created to provide a large or small blocking surface.



Picture 23: Panel blocking

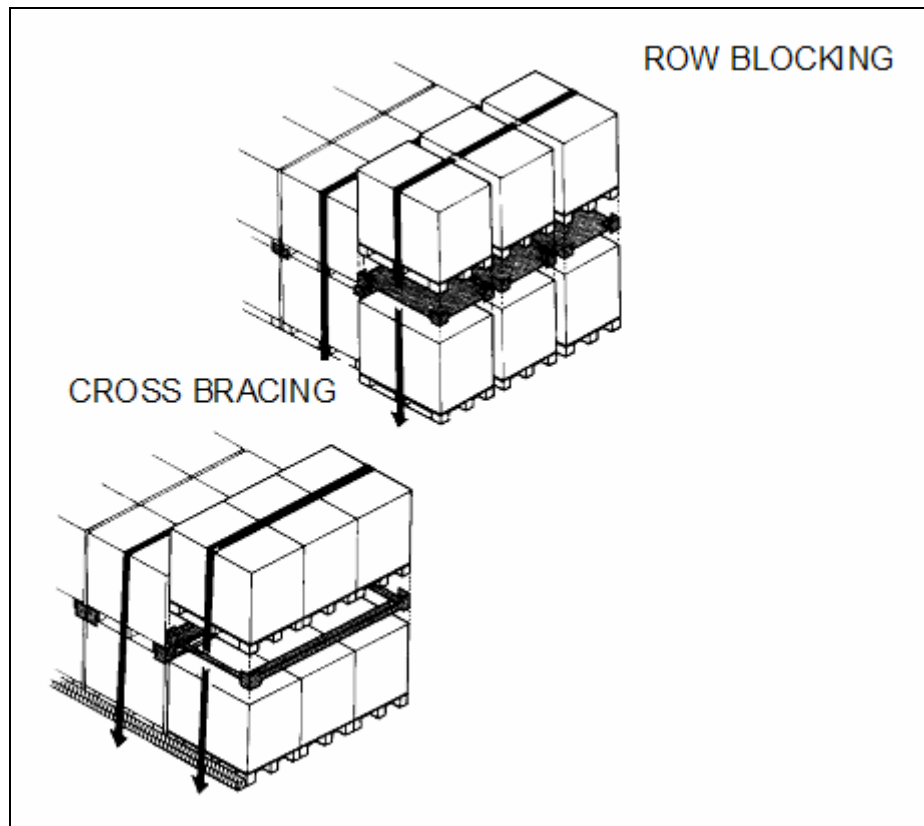
When threshold or panel blocking is used at the rear, at least two sections of the bottom layer must be behind the blocking section.

3.1.3. Blocking between rows within a cargo section

Cross bracing in the form of frames (the lower left picture) is used for blocking various layers laterally (known as layer blocking).

Threshold blocking sideways can also be achieved if the packages have different heights or if vertical planks or panels are placed between the rows.

Row blocking can be achieved by use of stacking cover as shown on the upper figure in the picture below.



Picture 24: Cross bracing and row blocking

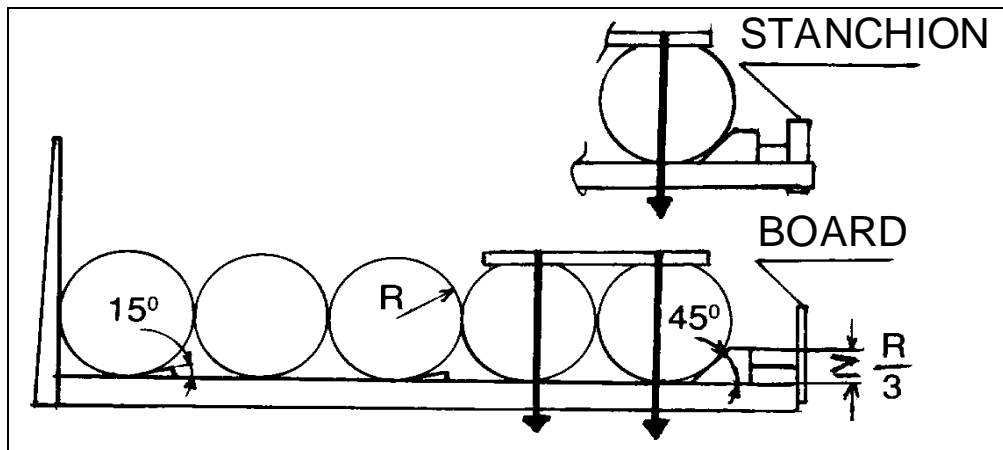
3.1.4. Wooden battens nailed to the load platform

On load carriers that have robust wooden platform beds of good quality, base blocking can be achieved by nailing wooden battens directly to the floor. The maximum closure force per nail can be found in Annex 8.3.

3.1.5. Wedges and wedge beds

Pointed wedges and block wedges can be used to prevent cylindrical objects moving along the loading platform (see picture below).

Block wedges should have a minimum height of $R/3$ (third of the roll radius) if there is no top-over lashing. If used in conjunction with top-over lashing, no more than 200 mm is required. The angle of the wedge should be approximately 45° , as shown below.



Picture 25: Pointed wedges and blocked wedges

If wood wedges are nailed to the floor, caution should be taken to ensure their strength is not reduced.

Pointed wedges, normally with a 15° wedge angle, have no cargo securing capacity, and their chief function is to keep round shaped goods in position during loading and unloading. The small angle means that the wedge normally self locks to prevent sliding.

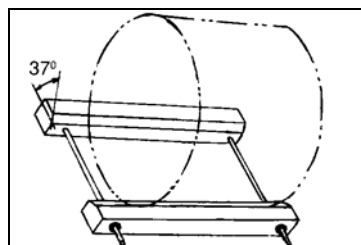
Block wedges (approximately 45°) are used as blocks to prevent rows of round shaped goods from shifting, and must therefore be blocked against suitable blocking devices on the load carrier. The rolls must also be lashed against the platform bed, with an edge beam and top-over lashing being required over both the rear rolls.

Wedge bed

The two long wedges are kept in position by adjustable cross bracing such as bolts or chains. The cross bracing should be arranged so that a minimum clearance of 20 mm is achieved between the roll and the platform bed in order to ensure the wedge bed is prevented from moving sideways

The height of the wedges should be:

- minimum $R/3$ (third of the roll radius) if there is no top-over lashing or,
- maximum 200mm in combination with top-over lashing.



Picture 26: Cylindrical goods on wedge bed
(the angle of approximately 37° comes from the Egyptian rectangular triangle, whose sides are in the proportion of 3, 4 and 5).

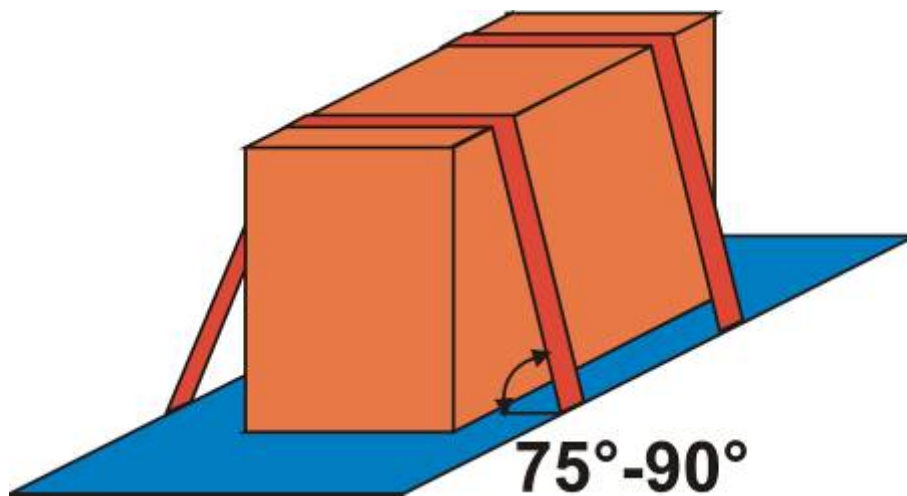
3.2. Lashing

A lashing is a restraint device such as webbing, chain or wire rope that either ties cargo together or keeps cargo in contact with the load platform or any blocking device. Lashings should be positioned so that they are in contact only with the cargo to be secured and/or the securing points. They should not be bent over flexible items, side gates etc.

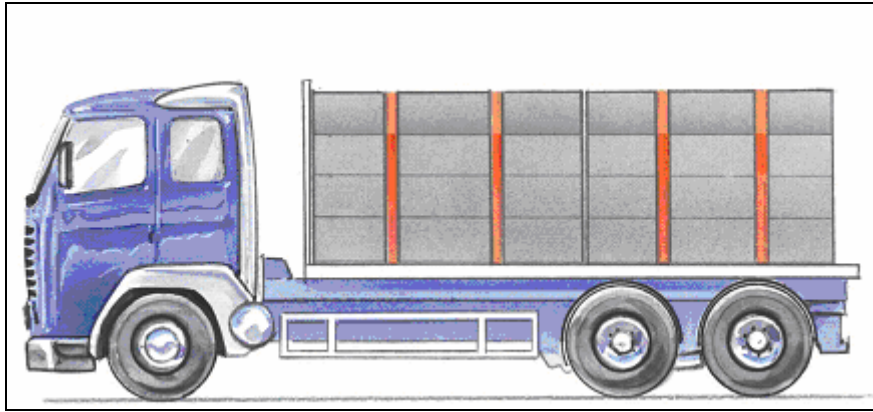
3.2.1. Top-over lashing

Top-over lashing is a method of securing where lashings are positioned over the top of the goods in order to prevent the cargo section from tipping or sliding. If there is no side blocking at the bottom, for example top-over lashing can be used to press the cargo section towards the platform bed. Contrary to blocking, top-over lashing forces the cargo against the load platform.

Even if friction prevents the cargo from sliding, vibrations and shocks during transportation can make the cargo wander. This makes top-over lashing necessary even if the friction is high.



Picture 27: Top-over lashing

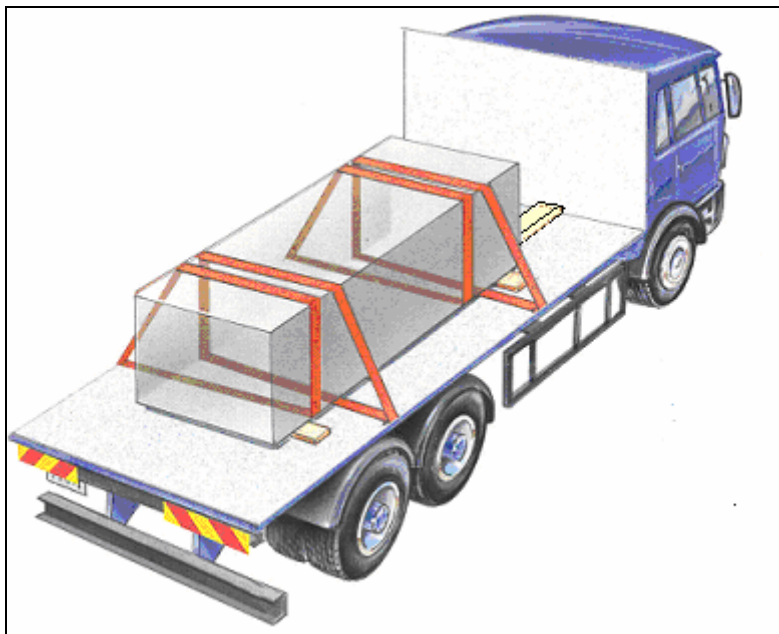


Picture 28: Top-over lashing

3.2.2. Loop lashing

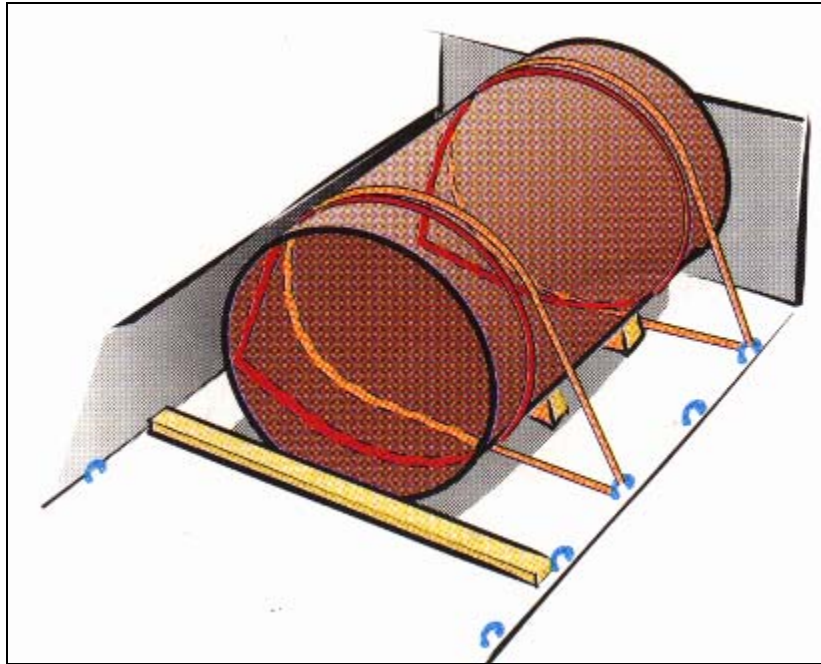
Loop lashing is a form of sling lashing cargo to one side of the vehicle body, thereby preventing the cargo from sliding towards the opposite side. To achieve double-action lashing, loop lashings must be used in pairs, which will also prevent the cargo from tipping over. Two pairs of loop lashings will be required to prevent the cargo from twisting longitudinally.

The loop lashing ability to sustain the required traction force depends upon the strength of the lashing points among other things.



Picture 29: Loop lashing

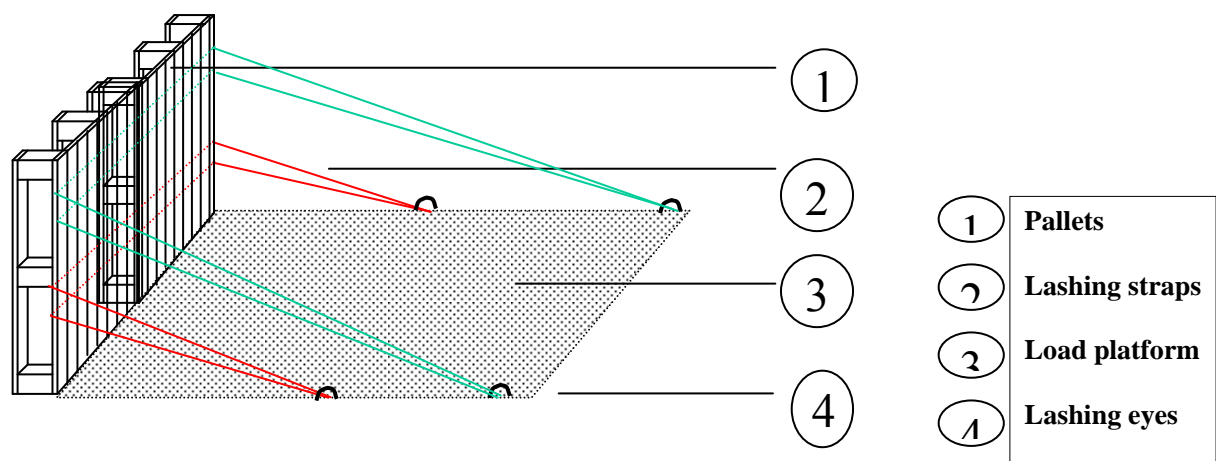
To prevent the cargo from moving in a longitudinal direction, loop lashing must be combined with base blocking. The loop is only providing lateral restraint, i.e. in a sideways direction.



Picture 30: Loop lashing combined with base blocking

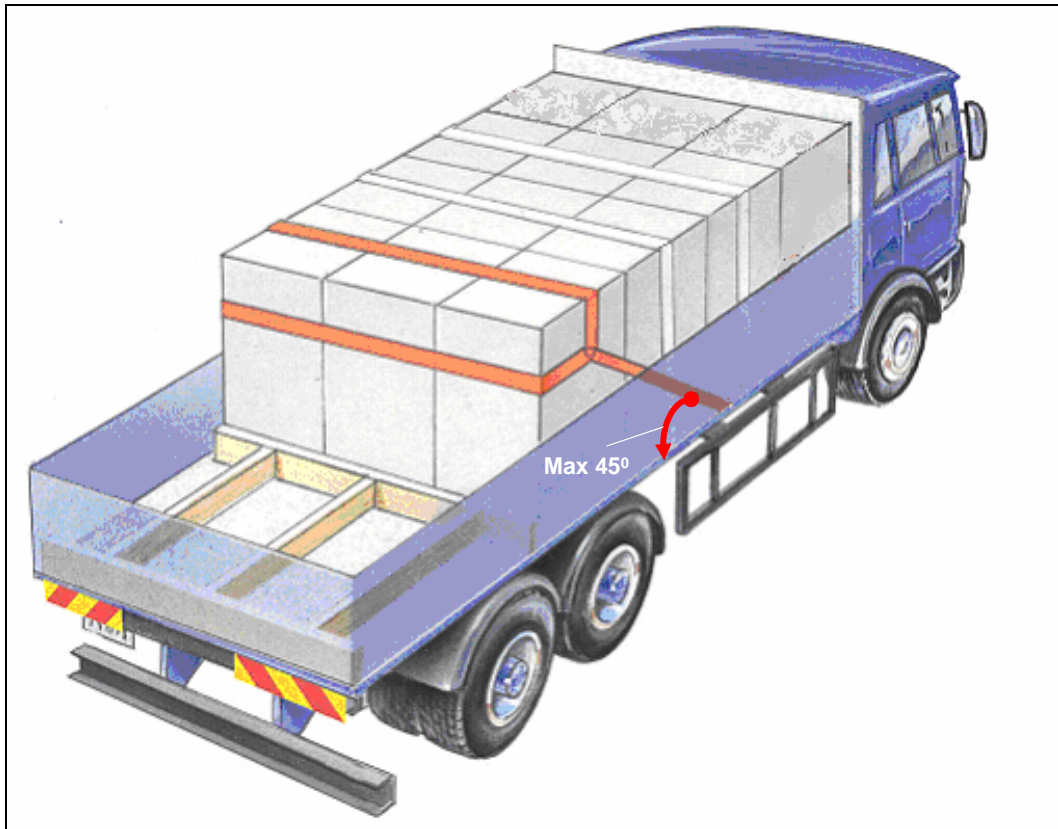
3.2.3. Spring lashing

Spring lashing can be used to prevent tipping and/or sliding forwards or backwards. Spring lashing in combination with base blocking forwards or backwards is a restraining method consisting of a sling (bridle) across the corner of the cargo layer and two diagonal lashings, the purpose of which is to prevent a cargo layer from tipping or sliding. Spring lashing may also be in the form of a single, closed round-sling, placed across the edge of the cargo layer and lashed by means of a diagonal lashing on each side. The angle to the cargo surface is measured in the longitudinal direction, and it is recommended that the angle is not more than 45° .



Picture 31: Example of rear-end lashing

A diagonal lashing with corner strap must be calculated taking into account the angle, the friction and the lashing capacity (LC) given on the label of the lashing as required by standard EN12195. Two opposite pairs of diagonal lashings with corner straps may also be used as an alternative to round-turn lashing.

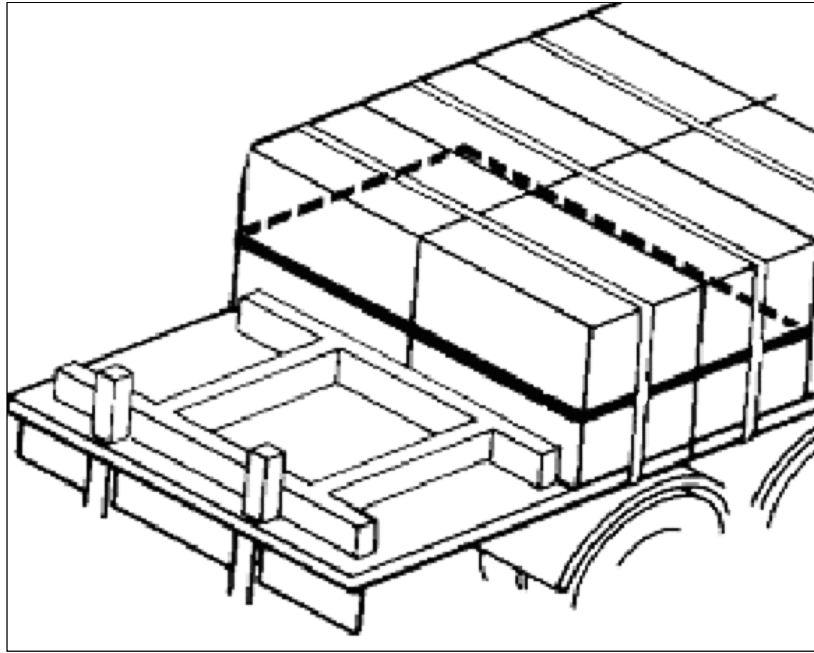


Picture 32: Spring lashing preventing the goods section from tipping over

3.2.4. Round turn lashing

Round turn lashing is, in combination with other forms of securing, a method to bind a number of packages together

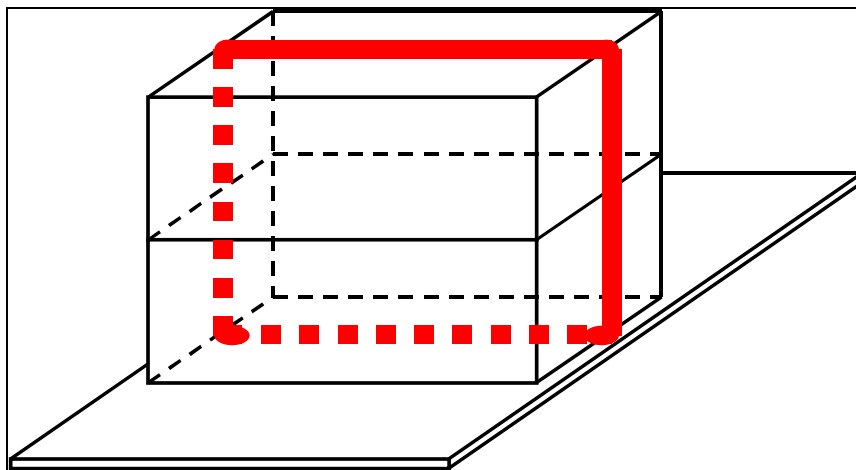
Horizontal round turn cargo lashing is applied by binding a number of packages together in cargo sections and therefore reduces to some extent the risk of the cargo tipping over.



Picture 33: Horizontal round turn lashing of the two last sections of cargo.

Vertical round turn cargo lashing is used to bind a number of cargo items together to stabilise the cargo section and to increase vertical pressure between the layers. Risks of internal sliding are thus reduced.

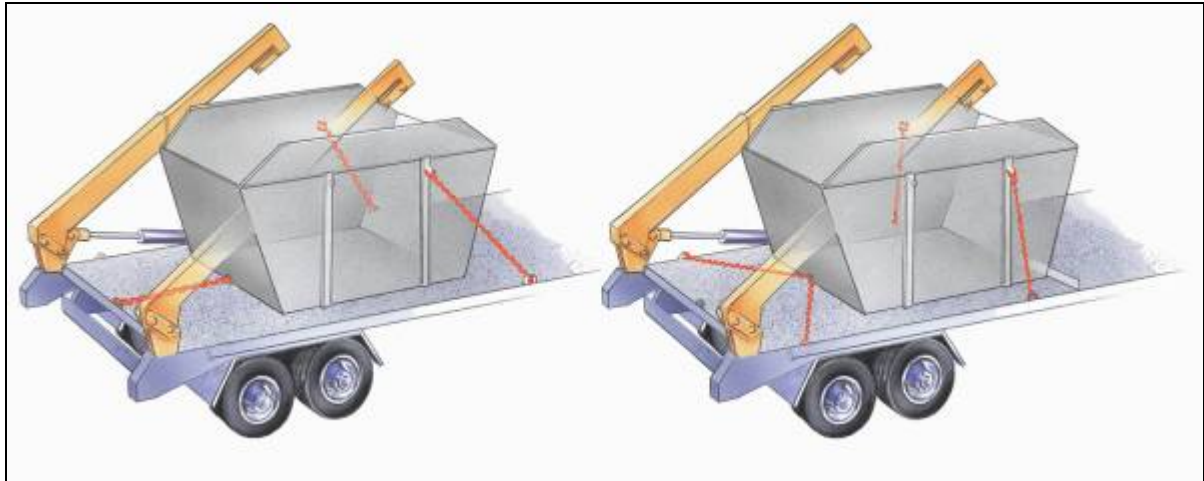
Plastic or steel straps (see 1.3.4.5) are commonly used for round turn lashing.



Picture 34: Vertical round turn lashing of cargo.

3.2.5. Direct lashing

If the cargo is equipped with lashing eyes compatible with the strength of the lashing, it is possible to lash directly between the lashing eyes and the lashing points on the vehicle.



Picture 35:

3.2.6. Lashing equipment

The choice of the best means of securing a load to a vehicle will depend on the type and composition of the load to be carried. Operators should equip the vehicle with the securing equipment appropriate for the types of load usually carried. If general cargoes are carried various types of securing equipment should be available.

Web lashings are often used for top-over (frictional) lashing, but may also be used for direct lashing (especially when the larger sizes of lashing are used).

For goods with sharp edges and heavy goods such as machinery, steel, concrete, military hardware etc., lashing chains should be used. Chains should normally be used for direct lashing.

Wire rope lashings are suitable for cargo such as wire mesh that is used for concrete reinforcing and certain types of timber loads, such as round logs stacked longitudinally.

When securing cargo, various types of lashings are used for various purposes. Web lashings made of man-made fibres (usually polyester) (see standard EN12195 Part 2), Lashing chains (see standard EN12195-3) or Wire lashing ropes (see standard EN12195-4) are mainly used as lashing materials. They have a tag or label specifying the Lashing Capacity (LC) in deca-Newtons (daN: the official force unit instead of kg) and the standard tension force for which the equipment is designed. The maximum hand force that should be applied to lashings is 50 daN.

NOTE: Do not use mechanical aids such as levers, bars etc, unless the tensioning device is specially designed to be used with them.

Only legibly marked and labelled lashing equipment shall be used.

Lashings can be linked together, but combinations used in parallel should be of the same marking. They can be linked as round combinations or be fitted with end fittings for attachment to fixed devices such as rings, hooks, recesses etc. in the load carrier. For top-over lashing with web lashings the tensioning device - a ratchet - shall achieve a pre-tension force of at least 10% of the lashing capacity (LC), at a hand force of 50 daN. The maximum authorised pre-tension force at 50 daN hand force is 50% of lashing capacity (LC) for all lashing equipment.



Picture 36: Severely damaged webbing? Throw it in the waste basket!

All equipment used for securing loads should be regularly inspected for wear or damage. Inspection and maintenance arrangements should be in accordance with the manufacturers' instructions. Special attention should be paid to webbing and rope to ensure that there are no visible defects, such as fraying of the strands. They should also be inspected to ensure that they have not been otherwise cut or damaged through misuse. Consult the lashing manufacturer or suppliers if there is any doubt as to whether repairs are required.

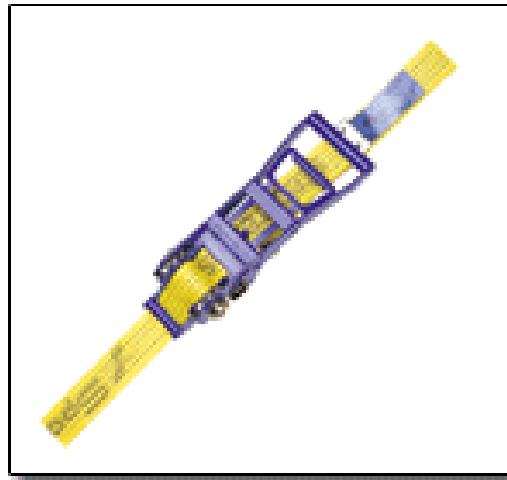
3.2.7. Webbing assemblies

Webbing assemblies are suitable for securing many types of load. They usually consist of a webbing strap with some form of end fittings and incorporate a tensioning device.

It is strongly recommended to use assemblies made according to standard EN12195-2 or equivalent.

One way lashings are not covered by any standard so it is important to verify that they are of similar characteristics as standardised webbings

The tension force, which can be achieved by a hand force of 50 daN is given on the label as the standard tension force for the webbing assembly (Lashing Capacity LC, Standard Hand Force S_{HF} , Standard Tension Force S_{TF})



Picture 37: Ratchet



Picture 38: Label in accordance with standard EN12195-2

Webbing made from polyester, polyamide or polypropylene is available. Polyester loses a little strength when wet, is highly resistant to moderate strength acid but can be damaged by alkalis. Polyamide may lose up to 15% in strength when wet, is highly resistant to alkalis but can be damaged by moderate strength acids. Polypropylene is useful where chemical resistance is a requirement. Polyester straps are available in various sizes and their properties should be clearly marked according to standard EN12195-2.

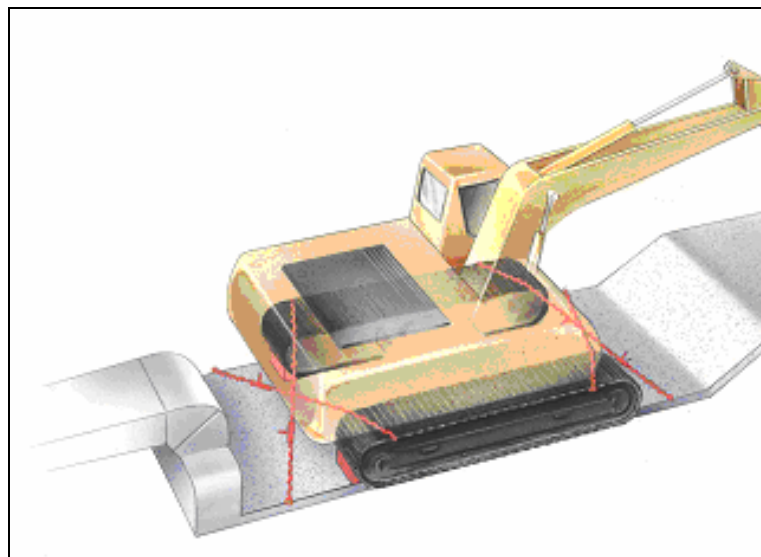
Before use, it should be verified that the metal parts of the harness are not corroded or damaged, the webbing is not cut or frayed and all stitching is

sound. If any damage is found, advice should be sought from the manufacturer or suppliers.

50-mm wide reusable polyester straps with 2.000 daN LC are normally used on heavy trucks. The maximum elongation is 7% at LC. Lashings with LC up to 20.000 daN are being used in connection with heavy machine transports.

3.2.8. Chain lashing

Two properties determine the strength of a chain: the thickness of the links and the quality of the metal used. Standard EN12195-3 - Load restraint assemblies on road vehicles – Safety; Part 3: Lashing chains - gives the requirements for lashing chains (see Annex 8.4 for details). The chain used should be compatible with the requirements of the load carried. Where necessary strong packing or bevelled sections should be used on corners or sharp edges, which prevent damage to the chains and also increase the radius around which they bend thus increasing their effective strength.



Picture 39: Excavator diagonally lashed with chains

Lashing chains shall never be used when knotted or connected with a pin or screws. Lashing chains and the edges of the loads shall be protected against abrasion and damage by using protective sleeves and/or corner protectors. Lashing chains showing any signs of damage must be replaced or returned to the manufacturer for repair.

The following are considered to be signs of damage requiring the replacement of the faulty components:

- for chains: superficial fissures, elongation exceeding 3%, wear exceeding 10% of the nominal diameter, visible deformations.
- for connecting components and tensioning devices: deformations, splits, pronounced signs of wear, signs of corrosion.

Repairs should only be carried out by the manufacturer or their agent. Following repair, the manufacturer shall guarantee that the original performance of the lashing chains has been restored.

Any joining links in chains should always be inspected before use. Chains should only be used in conjunction with suitable tensioners and turnbuckles with a safe working load compatible with that of the chain.

3.2.9. Wire rope lashing

Steel wire ropes are suitable for lashing load when used in a similar manner to chains. Single part wires should never be used for lashing as they cannot easily be assessed for serviceability and any failure will result in complete failure of the restraint.

If bent over edges, ropes strength decreases depending on the bending diameter. For a rope to retain its full mechanical resistance, the diameter of the bend needs to be at least 6 times the diameter of the rope. As a rule of thumb, for smaller bending diameter, the strength is reduced by 10% for each unit under 6 (e.g. if the bending diameter equals 4 times the diameter of the rope, the rope strength is reduced by 20%; so the residual strength represents 80% of its nominal value).

In any case, it must be considered that ropes laid over **sharp** edges only keep 25% of their normal strength.

In addition, rope eyes should be squeezed with at least 4 clamps. With less clamps, the strength is reduced proportionally. The open end of an eye always should be opposite the screws. As a rule of thumb, the rope should be squeezed to half of its diameter.

Wire and flat wire lashing ropes in addition to all connecting components shall be examined at regular intervals by a qualified person. The following are considered to be signs of damage:

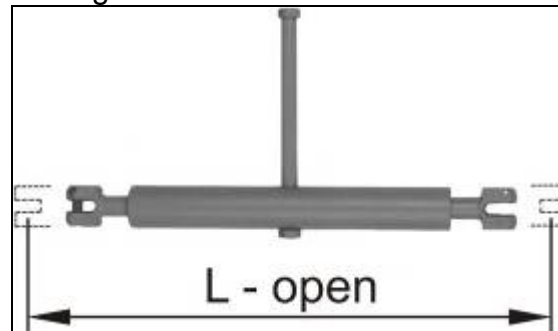
- localised breaks; reduction by abrasion of the ferrule diameter by more than 5%;
- damage of a ferrule or a splice;
- visible wire breaks of more than 4 threads on a length of 3d, more than 6 threads on a length of 6d or more than 16 threads on a length of 30d;(d=diameter of the wire);
- heavy wear or abrasion of the rope by more than 10% of the nominal diameter (mean value of two measurements at right angles);
- crushing of the rope by more than 15%, flaws and kinks;
- for connecting components and tensioning devices: deformations, splits, pronounced signs of wear, signs of corrosion;
- visible defects on the jaws of the rope pulley.

Wire lashing ropes with broken strands shall not be used. Wire lashing ropes shall only be used in a temperature range from -40°C to +100°C. At

temperatures below 0°C, look for and eliminate icing on brake and traction rope of tensioning elements (winches, hoists). Care shall be taken that wire lashing ropes are not damaged by possible sharp edges of the cargo.

3.2.10. Turnbuckle

Turnbuckles are commonly used for both chains and lashing wire ropes (See standard EN12195-4) provided with a thimble at each eye and a minimum of three or four separate U-bolt wire rope grips compliant to standard EN13411-5 on each side. They must be secured against working loose and must be positioned so that bending is avoided.



Picture 40: Turnbuckle with short handle to avoid overloading by 50 daN hand force (achieved tension should not be more than 50% LC).

3.2.11. Nets or covers with lashings

Nets used for securing or retaining certain types of cargo may be constructed from webbing straps or ropes of either natural or man-made fibres or steel wire. Webbing nets are generally used as barriers to divide the load space into compartments. Rope or cord nets may be used to secure loads either to pallets or directly to the vehicle as the primary restraint system.

Lighter nets can be used to cover open vehicles and skips when the type of load does not require a cover sheet. Care should be taken to ensure that the metal parts of nets are not corroded or damaged, that the webbing is not cut and that all stitching is sound. Rope and cord nets should be checked for cuts or other damages to the fibres. If necessary, repairs must be carried out by a competent person before the net is used. The mesh size of the net must be smaller than the smallest part of the cargo.



Picture 41: Cargo securing net

A cover with lashings can be used instead of a net.



Picture 42: Cover with lashings

3.2.12. Ropes

The use of ropes as a means for securing cargo is very questionable. If ropes are used for securing a cargo they should preferably be made from polypropylene or polyester.

Polyamide (nylon) ropes are not suitable as they tend to stretch under load. Sisal or manila ropes are also unsuitable as their strength is reduced by water saturation.

Ropes should be made of 3 strands and must have a minimum nominal diameter of at least 10 mm. The ends of the rope should be spliced or otherwise treated to prevent fraying. Rope should be selected in relation to the

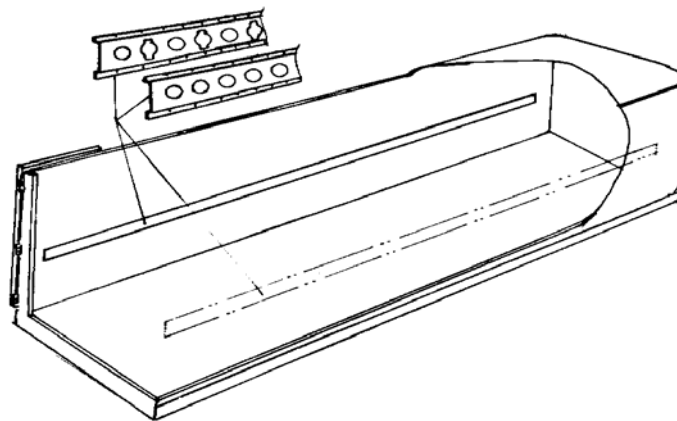
maximum force to be imposed in each lashing. The manufacturer must indicate the maximum authorised load for these ropes on an attached label or sleeve. Knots and sharp bends will reduce the strength of a rope. Wet ropes should always be allowed to dry naturally.

3.2.13. Steel straps

Steel straps should never be used for securing cargo on open load platforms.

3.2.14. Attaching rails for booms and lashings in sidewalls

Sidewalls may have longitudinal rails with anchorage points, with each point usually designed to withstand a 2-tonne load in longitudinal direction. Lashings and booms with suitable end fittings can be secured quickly and give effective blocking. This is an extremely effective method for rear blocking of remaining packages after partial unloading, but load concentration adjacent to fixing points should be avoided.



Picture 43:

3.2.15. Intermediate Blocking Boards

Intermediate blocking boards are frequently used for cargo securing to the rear, particularly to secure cargo on partly loaded vehicles. Intermediate blocking boards are mounted onto the normal longitudinal laths or onto drop boards of curtainsiders or cover stake bodies. The maximum load bearing capacity needs to be checked on the manufacturer's information. Generally, intermediate blocking boards can withstand loads up to a maximum of about 350 daN if mounted on wooden laths and 220 daN on aluminium laths.

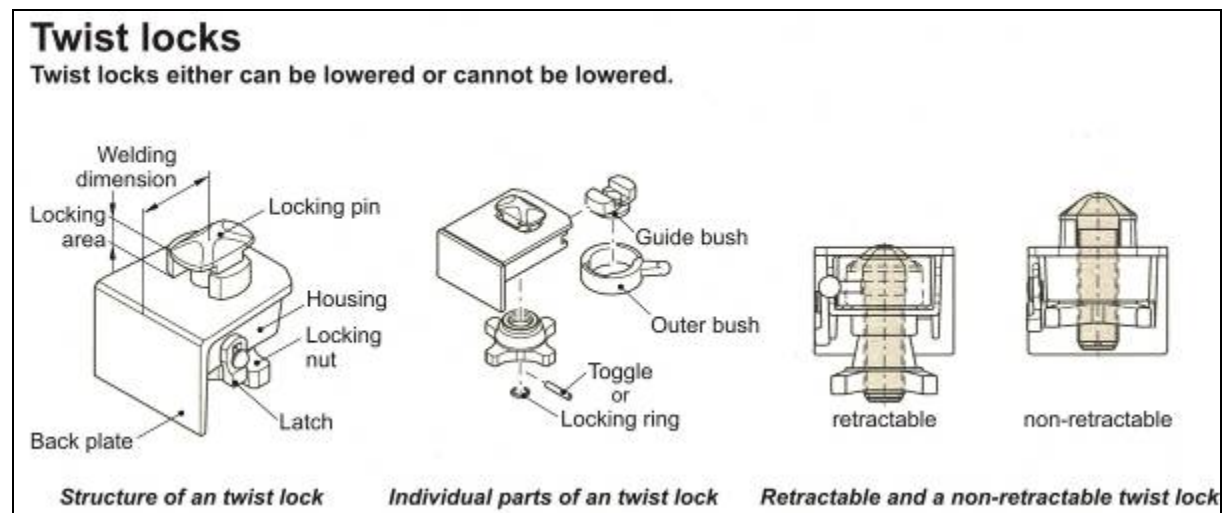


Picture 44:

3.3. Locking

Freight containers like ISO containers, swap bodies etc. with a mass of more than 5.5 tonnes should only be carried on vehicles fitted with twist locks. Provided the twist locks are fully engaged and locked in position, the container will be adequately secured and no further restraint will be necessary. The twist locks must be maintained in a serviceable condition and a minimum of four should be used for each container carried. (ISO 1161 covers the specification for corner fittings for series 1 ISO freight containers).

In most cases twist locks are fitted to the vehicle during manufacture but if fitted at a later stage, modifications to the chassis/structure must be carried out in accordance with the recommendations of the vehicle manufacturer. Twist locks should be regularly inspected for wear, damage and operation defects. Locking devices intended to prevent operating levers from moving during the journey should be given special attention.



Picture 45: Twist locks



Picture 46: Twist locks

3.4. Combination of restraining methods

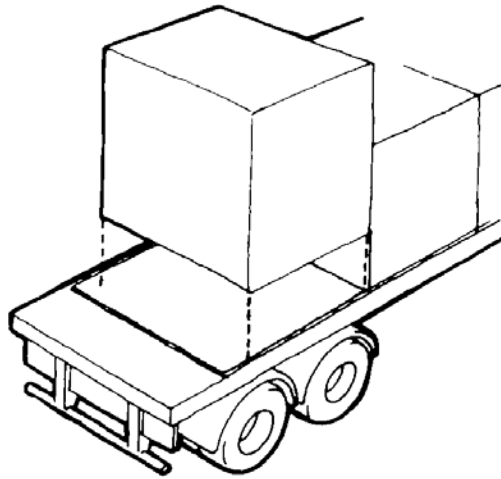
Combining two or more restraining methods is usually the most practical and cost efficient way for effectively securing cargo. For instance top-over lashing can be combined with base blocking.

Care must be taken that the restraining forces from the combined restraining methods all apply concurrently and not one after the other. Each restraining method may be insufficient for safely securing the cargo if acting independently from the other(s).

3.5. Supporting equipment

3.5.1. Friction mats

Base material and spacers made of high friction material can be used to increase friction between the platform bed and the cargo, and also between cargo layers when required. There are different types of high friction material, for example carpets, rubber mats and sheets of paper (slip-sheets) covered with friction material. They are used in conjunction with other securing methods. The mats should have friction, strength and thickness commensurate with the load (weight, surface...). The mats should have suitable properties (such as friction, strength, thickness, granularity ...) commensurate with the load (weight, surface...) and environmental conditions (temperature, humidity...) likely to be encountered during the journey. This should be verified with the manufacturer.



Picture 47:

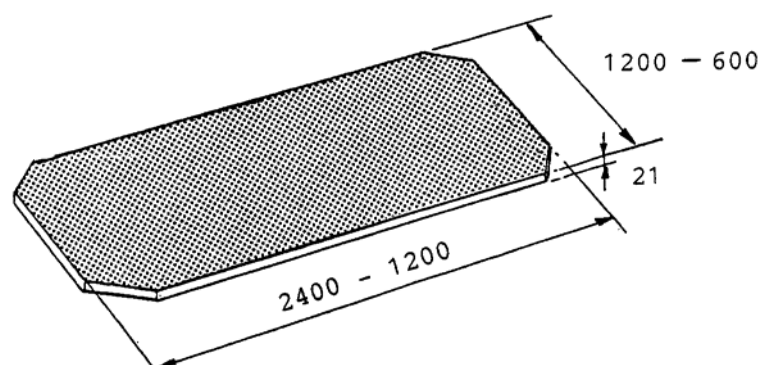
The use of slip inhibiting material allows for the reduction in the number of lashings required (see Annexes 8.6 and 8.7). Very often the material is used as square pieces, cut off in strips of 5 to 20 m length and 150, 200 or 250 mm width. The thickness ranges from 3 to 10 mm. If used carefully, such pieces may be reused up to ten times, but they cannot fulfil their function if they become greasy. Cargo has to be lowered into place upon these materials since it is not possible to slide the cargo into position.

3.5.2. Walking boards

Spacer boards, so called walking boards, are used as stabilisers for cargo layers. They are usually plywood panels approximately 20 mm thick, although discarded sawn timber is often adequate. The boards are placed between the various cargo layers. Spacer boards are particularly useful when upright rows are loaded in several layers.

Common sizes and weights

- 21 x 600 x 2400 mm, approximately 20 daN
- 21 x 1200 x 1200 mm, approximately 20 daN
- 21 x 1200 x 2400 mm, approximately 40 daN

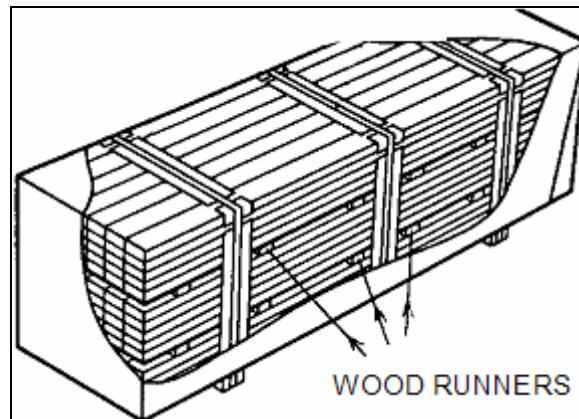


Picture 48:

3.5.3. Wood runners

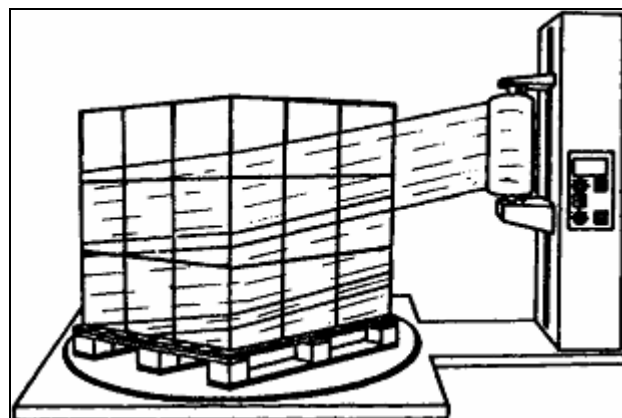
Cargo sections with many rows and layers, such as sawn timber, must often be stabilised by means of cross bracing. Wood runners with square cross

section are not suitable, because they may rotate in service. The width/height ratio of the cross section should be at least 2:1.



Picture 49: Sawn timber stabilised with wood runners

3.5.4. Shrink film and Stretch film



Picture 50: Packaging with stretch film.

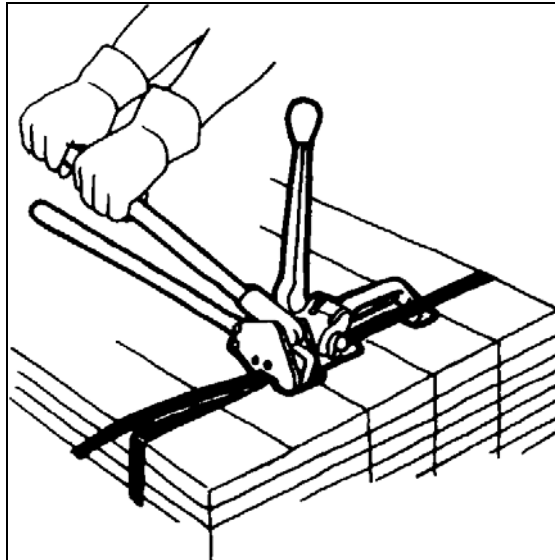
Small packages may easily and effectively be secured to the load pallets by means of a stretch film. A stretch film is easy to apply and the desired rigidity of form is achieved for the entire pallet load by using an appropriate number of “wraps”.

With shrink film a plastic hood is placed over the wrapped pallet load, which is then heated to make plastic shrink and therefore make the load more rigid. The pallet can be considered as a stable load unit if the loaded pallet is able to withstand a tilt angle of at least 26° without any significant deformation. Shrink and Stretch film wrapping is not usually suitable for heavy pallet loads, or loads with sharp corners that may damage the film.

3.5.5. Steel or plastic band straps

Steel or plastic band straps are suitable for bounding heavy and rigid goods such as iron and steel products to a pallet. They require special tensioners and cannot be re-tightened. Disposable (suitable for single use, due to their one way operation) steel straps may be used for securing loads onto pallets. The pallets and cargo must additionally be secured to the vehicle, either by blocking or lashing.

These one-way straps are not suitable to secure loads directly to the vehicle as internal tensions can built into the fixing to the vehicle and into the seals during the journey, making the removal of the steel straps hazardous. One-way steel straps that have been cut open and lie on the ground represent a tripping and cutting danger. When webbing straps are used to secure goods bound with steel straps, care must be taken to ensure that the steel straps can not cut into the webbing straps.

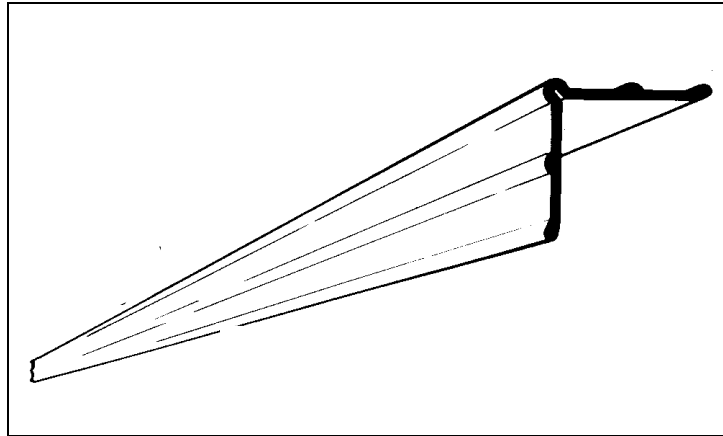


Picture 51:

In open load carriers the use of steel straps is a common cause of injuries as loose ends of the straps may protrude from the sides of the carrier during transport.

3.5.6. Edge beams

Supporting edge beams are designed to be structurally rigid (stiffened against bending) and have a right angle profile. They are used for distributing the forces from top-over lashings to the cargo sections and can be made of wood, aluminium or similar material of sufficient strength.



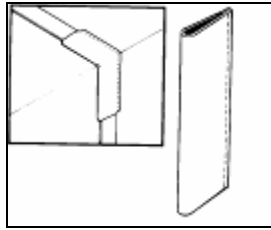
Picture 52: Edge beam made of aluminium



Picture 53: Edge beam made of wooden boards.

3.5.7. Wear protectors for synthetic webbing straps

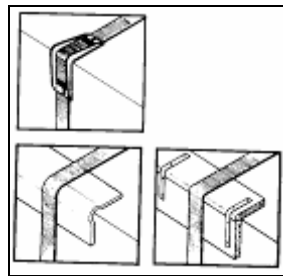
Wear protectors for synthetic webbing straps are applied between the cargo and lashing straps when there is a risk that of the webbing strap being damaged. The wear protectors can be made from different materials, for example polyester and polyurethane, both as stocking or clamp case.



Picture 54: Wear protector

3.5.8. Edge protectors to prevent damage to cargo and lashing equipment

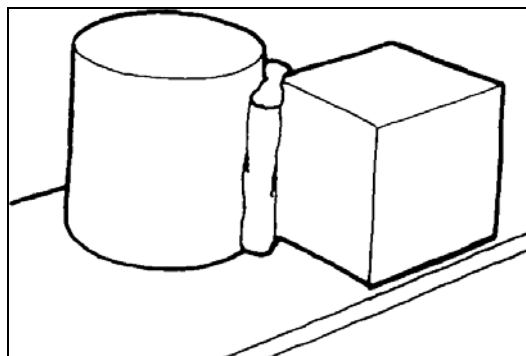
Edge protectors made of wood, plastic, light alloy metal or other suitable material are used for distributing the lashing force to prevent the lashings from cutting into the cargo, and also for binding short ends. Edge beams provide the same or even better edge protection, but are rigid in design and therefore distribute the force from the lashings. For that purpose it is essential that edge protectors have low friction properties on the webbing face so the straps can easily slide and distribute the lashing force. On the other hand, it is in some cases advisable to use high friction edge protectors to reduce the risk of tipping.



Picture 55: Edge protectors

3.5.9. Protective spacers

If sharp edges can damage the cargo, use some form of protective material (see also Section 3.1.1: Blocking with filler).



Picture 56: Protective spacers

3.5.10. Tag washers

Double-sided tag washers are suitable for holding various layers together in a cargo row. Row blocking can often be achieved by means of tag washers instead of a stacking cover. Tag washers are available in different sizes. Tag washers can only be used with soft materials (wood etc) and should completely enter the material.

NOTE: As tag washers are not visible once the load covers them their function is not controllable. Be also aware that the tag washers may damage the platform's surface and the cargo. The use of friction mats instead of tag washers is preferable.

Tag washers should never be used in connection with dangerous goods.

Tag washers usually have a round form with a 48, 62 or 75 mm diameter (95 mm diameter is seldom used) (see picture below).



Picture 57: Round tag washer

There is no standard for tag washers, but some experience guide values are shown in Annex 8.3. A minimum of two tag washers has to be used. To enter into wood, a minimum of 180 daN on each tag washer is needed. Do not use too many tag washers!

Friction mats (see Chapter 3.5.1) can be an alternative to tag washers.

4. Calculating the number of lashings

If lashings are used to prevent both sliding and tipping over, proceed as follows:

Calculate separately the number of lashings required to prevent sliding and the number of lashings required to prevent tipping over. The highest figure is the minimum number of lashings required. In case the load is placed against the headboard, the weight of the load can be reduced by the compensation of the headboard when calculating the number of lashings to prevent sliding.

More detailed Information can be found in IMO/ILO/UNECE, Guidelines for packing of cargo transport units and IMO Model course 3.18, as well as in standard EN12195 "Load restraint assemblies on road vehicles", part 1: Calculation of lashing forces", part 2" "Web lashing made from manmade fibres, part 3: "Lashing chains" and part 4: "Lashing steel wire ropes". The information to these lashings is an integrated part of these guidelines (see Sections 1, 2 and 3.).

The majority opinion of the Expert Group is that either the IMO/ILO/UNECE or CEN methods should be accepted as giving a safe level for cargo securing in cross border operations; both methods should be recognised by the controlling authorities for International Transport, leaving to the haulier or the loader the choice of which method to apply. Some Member States could however impose one of the two methods or specific rules for transport on their roads.

Annexes 8.6 and 8.7 provide quick guides for calculating the number of lashings based on the IMO/ILO/UNECE guidance and on standard EN12195-1 respectively.

5. Inspection during drive / Multidrop operations

Wherever possible it is advisable to check the cargo securing regularly during the journey. The first check should preferably be done after a few kilometres drive at a safe place to stop.

In addition the cargo securing should also be checked after heavy braking or another abnormal situation during driving. It should also be verified after additional loading or unloading during the journey.

When loading or unloading general cargo, as is frequent in distribution transports, it is necessary to restore the blocking of the remaining goods. Restorable blocking can be provided by lashing or with removable blocking bars. Be aware that the number of blocking bars should correspond to the load to be secured.

6. Standardised or semi-standardised cargo (geometrical forms)

The following sections describe examples of possible ways of securing various types of packages and loads. The variety of loads, vehicles and operating conditions make it impossible to cover every possible situation likely to be encountered and these guidelines must therefore not be regarded as exhaustive or exclusive. Satisfactory alternative securing methods do exist, providing equivalent safety levels of cargo securing and others will be developed. However, the basic principles described in these guidelines will continue to apply irrespective of the method used to secure the load.

6.1. Rolls, Drums or Cylindrical Loads

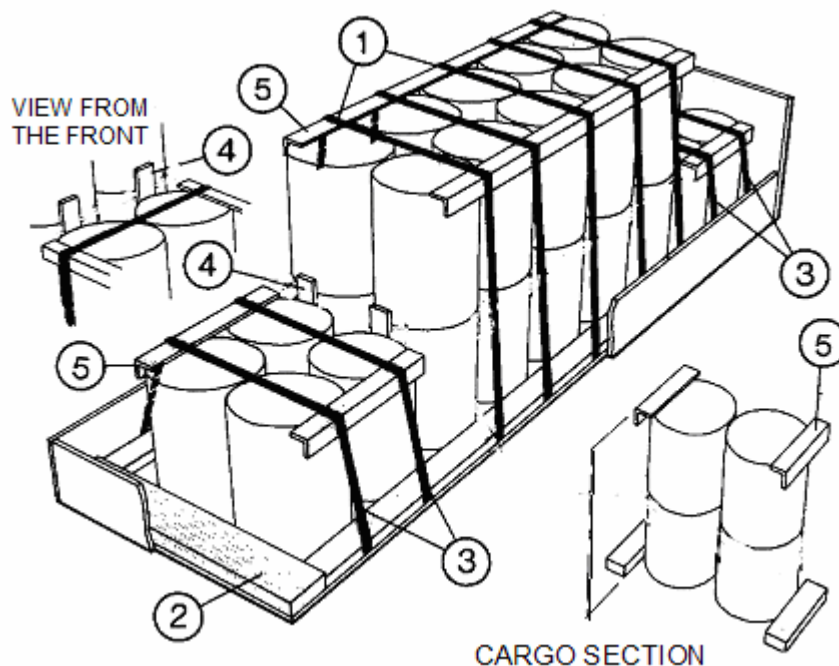
Rigid rolls, drums or cylindrical loads, rigid in form, can either be stowed with bore vertical or horizontal. Bore vertical position is generally used when the mantle surface and the cylindrical form has to be protected and preserved (for example paper rolls).

Rolls or cylindrical items in bore horizontal position should ideally be placed with their axis across the vehicle so that the rolling tendency, usually prevented by block wedges or wedge beds, will be to the front or rear.

When securing cylindrical items consideration should be given to how the cargo can be unloaded in a safe and controlled manner. The use of pointed wedges will help to ensure that safe and controlled loading and unloading is achieved.

6.2. Paper rolls

Example of paper rolls in two layers and two rows, upper layer incomplete, stowed on a flat platform fitted with sideboards:



Picture 58: Paper rolls

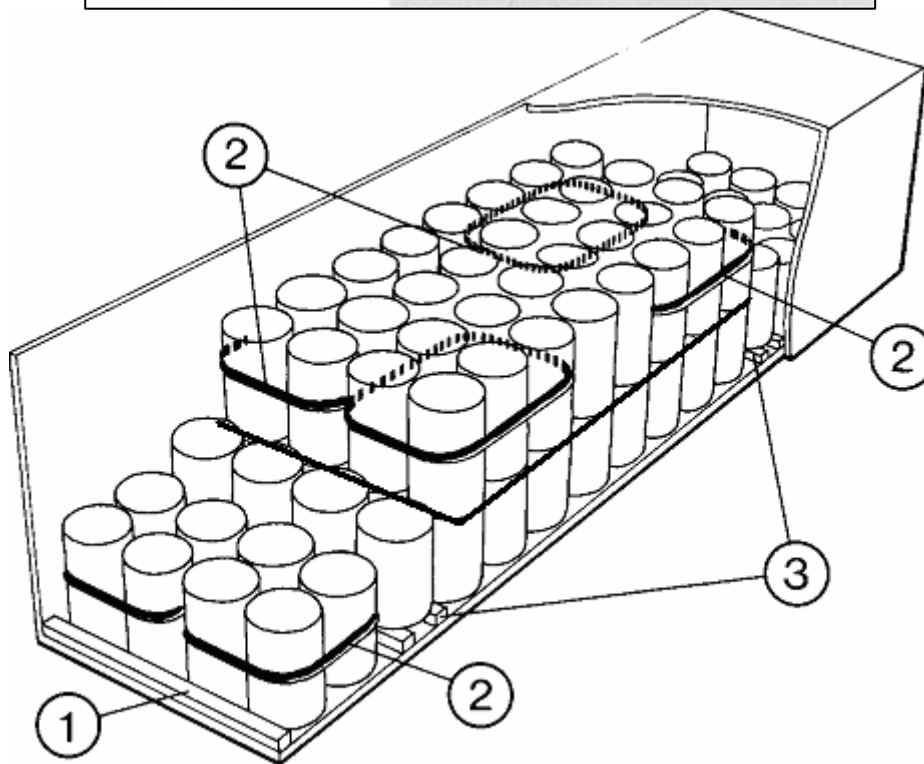
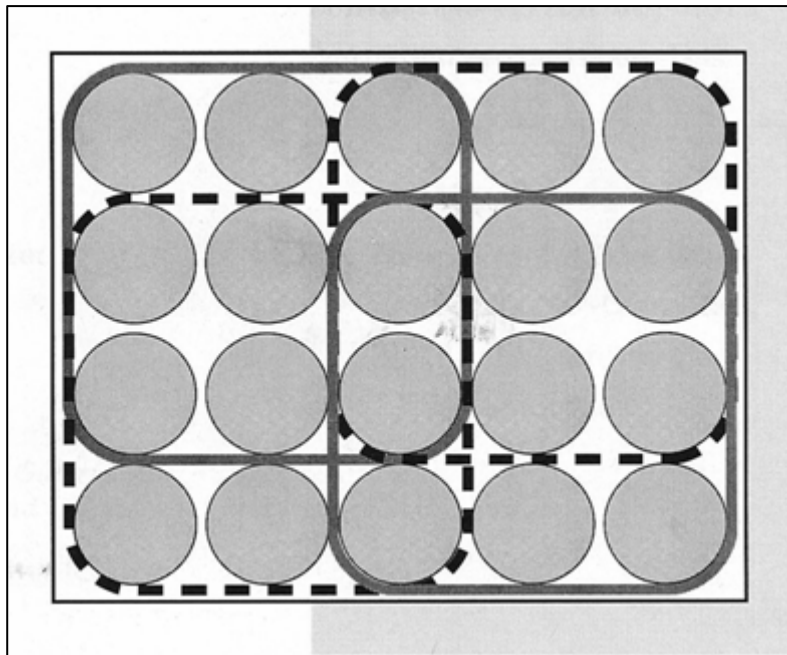
**Guidance for calculating the required number
of lashings is found in Annex 8.6 or 8.7**

The upper layer is friction secured laterally and panel blocked to the front and rear ④. Alternative threshold blocking is applicable.

- The cargo does not fill out the entire platform's width.
- The angle between the top-over lashing's side part and the platform bed is larger than 60°.
- The rearward blocking is, when required, made of filler material ②.
- For effective distribution of the lashing forces, supporting edge profiles ⑤ are being used between the cargo sections.

①③ Top-over lashing
② Filler material
④ Panel blocking
⑤ Supporting edge profiles

6.3. Drums



Picture 59: Example of full size drums, arranged in two layers and four longitudinal rows. The upper layer is incomplete and the cargo is stowed in a container or box type vehicle.

- The cargo fills out the entire container's width.
- Filling ① or block bracing provides rearward blocking.
- Horizontal round turn lashing ② is used to reduce the risk of the cargo tipping.
- Base material ③ provides panel-blocking forwards and backwards in

- | |
|-------------------|
| ① Filler material |
| ② Round turn |
| ③ Base material |

the upper layer.

In recent years there has been a significant increase in the use of drums and kegs of assorted shapes and sizes that are made from plastics instead of metal. Plastic surfaces, particularly when wet, are very slippery and care must be taken when loading, securing and sheeting. It is particularly important to be aware that plastic can deform when pressure is applied.

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

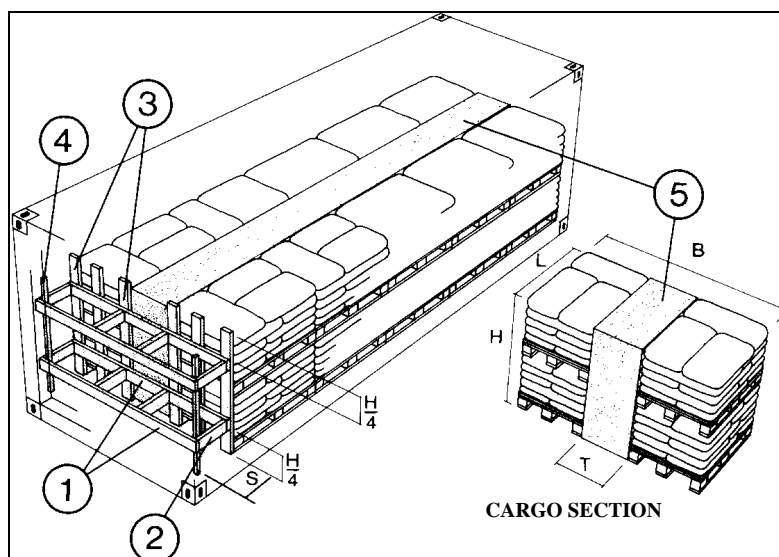
6.4. Boxes

Boxes, as with other goods, must be loaded so that they are prevented from moving in any direction. Where possible they should interlock and be loaded at a uniform height within each row across the vehicle (load section). To calculate the amount of load securing to prevent sliding and tipping, the size and weight of each section must be accounted for in the calculation. If the load height exceeds the height of the sideboards and edge beams are not used, there must be at least one lashing for each section.

6.5. Bags, bales and sacks

Sacks and bags.

Sacks do not usually have a rigid form and therefore need to be supported. This is particularly true in cases when the head, end and sideboards cannot be used for blocking. Filler material, boards, walking boards and supporting edge profiles, can be used to achieve the blocking effect.



Picture 60: Example, sacks on pallets in a container

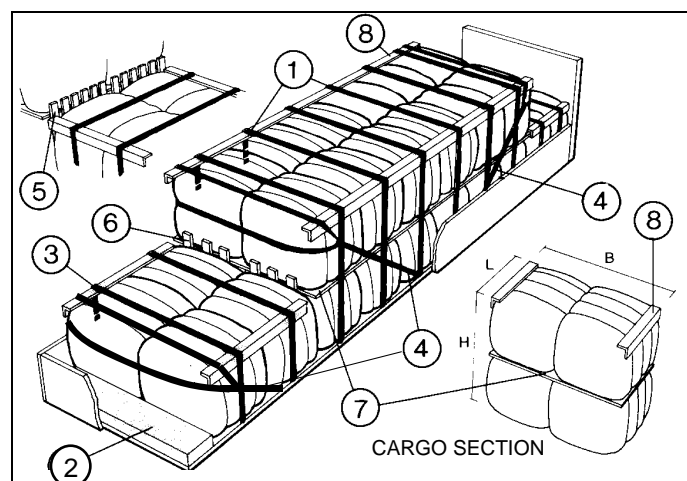
Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

- The cargo contains sacks on pallets with fillings ⑤ in the centre. The load fills out the entire container width.
- The cargo is enclosed backwards by filling with double beams ①

- ① Double beams
- ② Stanchions
- ③ Boards
- ④ Support struts
- ⑤ Filler material

Bales and big sacks.

The securing of bales is similar to securing sacks. The difference is that usually the material that is to be transported within bales (waste paper, hay, cloth etc.) may not be as well secured in its packaging. Therefore if there is a possibility of any part of the cargo breaking free, the whole cargo should be covered with a sheet after having been secured.



Picture 61: Bales in two layers and at the most three rows, upper layer INCOMPLETE, stowed on open load platform fitted with sideboards

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

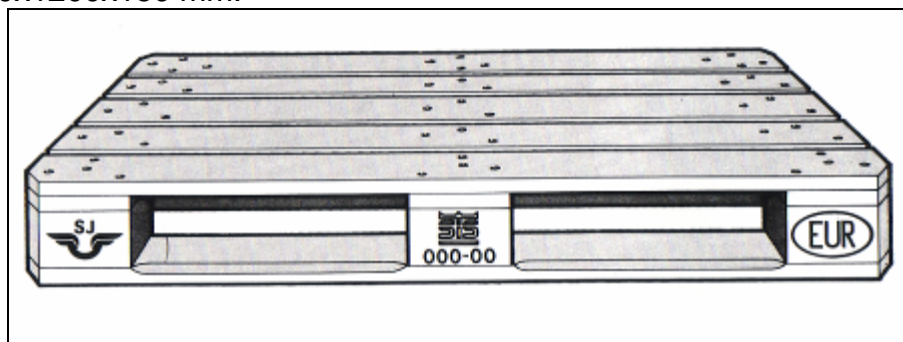
- The cargo fills the entire platform width.
- If the cargo's upper layer is not close to the head board, some cases require blocking forwards with corner strap ④ and timber ⑤.
- In certain cases blocking through filling ② and/or corner strap ④ and/or timber ⑥ is required.
- If the stability of the cargo is such that there is a risk of loose lashings, there is a need for supporting edge profiles ⑧. Alternatively for stabilising, there is a need for walking boards ⑦.

- ① ③ Top-over lashing
- ② Filler
- ④ Corner
- ⑤ ⑥ Boards
- ⑦ Walking boards
- ⑧ Supporting edge

6.6. Pallets and Wheel Pallets

6.6.1. Euro-pallet

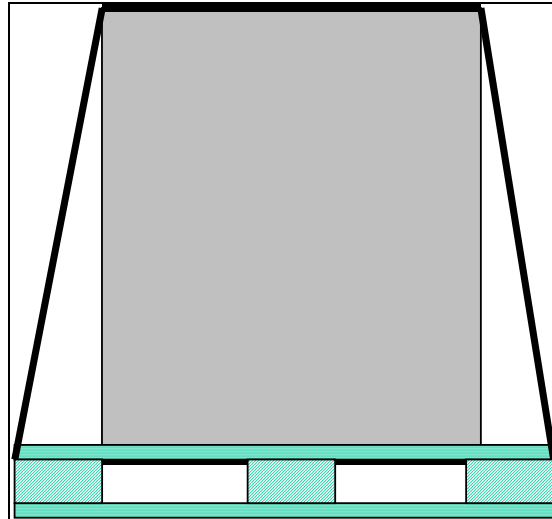
The most common pallet used for goods transportation is the EURO pallet (ISO 445-1984). It is made primarily of wood, and the standard dimensions are 800x1200x150 mm.



Picture 62: Euro-pallet

When cargo boxes of a size equal to or smaller than the pallet are loaded on a pallet, the pallet constitutes a load carrier similar to a load platform without sideboards. Measures to prevent the cargo from sliding or tipping in relation to the pallet should be taken by lashing means similar to the methods described above. The friction between the surfaces of the cargo and pallet are therefore important for calculating the cargo securing. The ratio of the loaded pallet height/width and weight also has to be taken into account (here the loaded pallet's weight corresponds to the weight of a cargo section (see Section 1.3.5: Tilting and tipping).

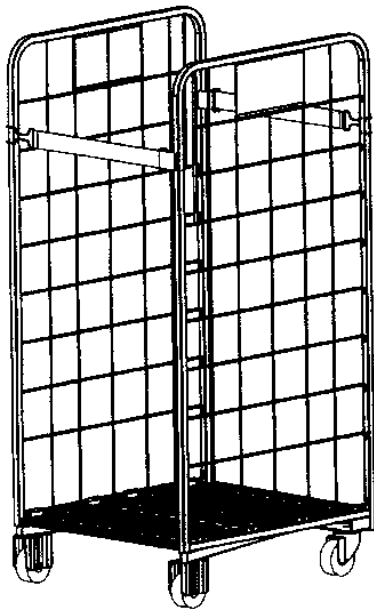
Any means of securing the load to the pallet, e.g. lashing, shrink wrapping, etc... can be used as long as the load pallet is able to withstand a sideways tilt angle of at least 26° without any significant sign of distortion (see Section 3.5.5).



Picture 63: Cargo unit lashed to a Euro-pallet

6.6.2. Wheel-pallet

Framed pallets are commonly used for food transportation. Securing the wheeled pallets by blocking is particularly effective; however, alternative methods may be used.



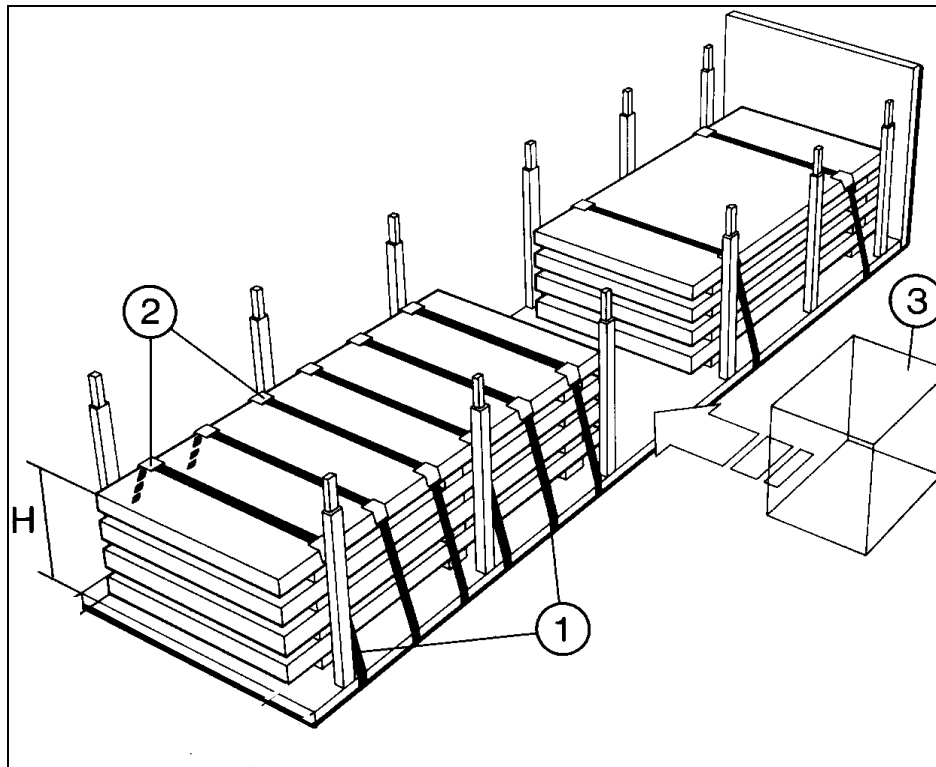
Picture 64: Wheel pallet with side supports and clipping bars

6.7. Flat metal sheets

When sheets or plates of mixed sizes are transported, the smallest should normally be loaded on top and at the front of the vehicle against the headboard or other blocking so that they cannot slide forward.

Oiled flat sheets should be bundled together. For cargo securing, these bundles should be treated as boxes in general. Flat sheets may sometimes be loaded onto pallets and secured to the pallet accordingly.

Below is an example of sheets or panels on a flat platform equipped with side stanchions. For high density loads like these, it is especially important to consider the load distribution.



Picture 65: Front section blocked against the headboard wall

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

- If the cargo is not stowed against the headboard blocking forwards with filler material or base blocking is required.
- In certain cases rear blocking by filler material or brace blocking is required.
- The panels are positioned on the platform in one or more cargo sections and centred along the centre line.
- The space between the cargo sections is blocked by suitable filler material ③.
- Wear protectors ② are placed between the straps and the cargo.
- If the cargo does not fill up the space to the side stanchions this is blocked with suitable filler material.

- ① Top-over lashing
- ② Wear protectors
- ③ Filler material

If the rear section is not blocked in the forward direction, additional lashings will be required.

It is not recommended to transport flat sheets on loading platforms without stanchions or sideboards.

6.8. Long Sections

Long sections will generally be carried along the length of the vehicle and can pose particular problems as a section could easily penetrate a headboard or driver's cab if it is allowed to move. It is essential therefore that the vehicle is loaded and secured in such a way that the complete load forms one unit and no single item can move independently. A long rear overhang can also cause considerable problems with weight distribution and may result in a lack of stability, steering and braking due to a low front axle load.



Picture 66: Long poles

The load will always need to be restrained by lashings, preferably chains or webbing which should be attached to the vehicle by means of adequate lashing points. It is essential to be aware that top over or loop lashings will be able to provide adequate sideways restraint, but if used in isolation the forward restraint will be solely provided by friction. An adequate amount of friction to prevent longitudinal movement may be achieved by using sufficient number of lashings to produce the required pull down force however, an additional means of longitudinal restraint such as blocking or spring lashing should be used.

Wherever possible, in order to provide longitudinal restraint, the cargo should be in contact with the head or rear board or be properly secured by blocking. The height of the cargo should never exceed the height of the headboard and it is recommended that stanchions or side pins at least as high as the cargo are used to provide additional lateral restraint and to facilitate the safe unloading of the cargo.

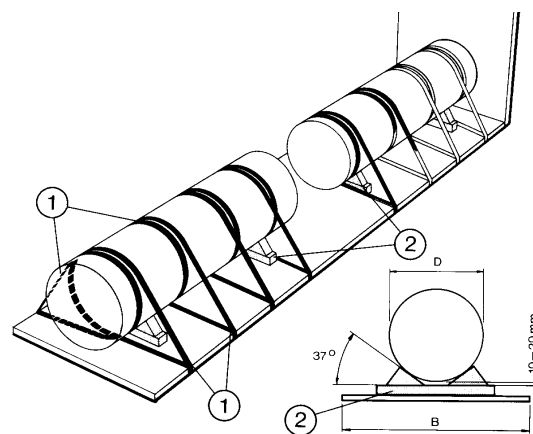
If the packages are stacked, the heavier items should be placed at the bottom and the lighter ones on top. No layer should be larger than the one underneath it.

6.9. Beams

Beams or profiles should usually be stowed on wedge beds and secured with loop web lashings. The example below shows beams or profiles on a flat platform without side stanchions. The longitudinal securing has not received any consideration in the example below.

- If the cargo is not stowed against the headboard blocking in the form of filler material or block bracing is required.
- In certain cases blocking backwards through filling or block bracing is required.
- Loop lashings are placed around the cargo ①.
- Cylinders are placed on wedge beds ②.

① Loop lashing
② Wedge bed



Picture 67:

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

6.10. Coils

To avoid confusion over terminology, in the following paragraphs a coil with its hollow centre or bore horizontal is referred to as 'bore horizontal' and a coil with its hollow centre or bore vertical as 'bore vertical'. A coil may be either a single coil or a number of coils bound together with the bores in line so as to form one cylindrical unit.

Before loading, the coil banding and packaging should be examined to ensure that it is intact and not likely to break apart while in transit. When banding is used to strap coils and pallets together it is important to note that banding is only strong enough to keep the coil and pallet together during loading and unloading, not during transit. Therefore it is necessary to secure the entire unit to the vehicle. Securing the pallet alone is not sufficient.

Heavy sheet metal coils are usually stowed on wedge beds and secured with loop web lashings.

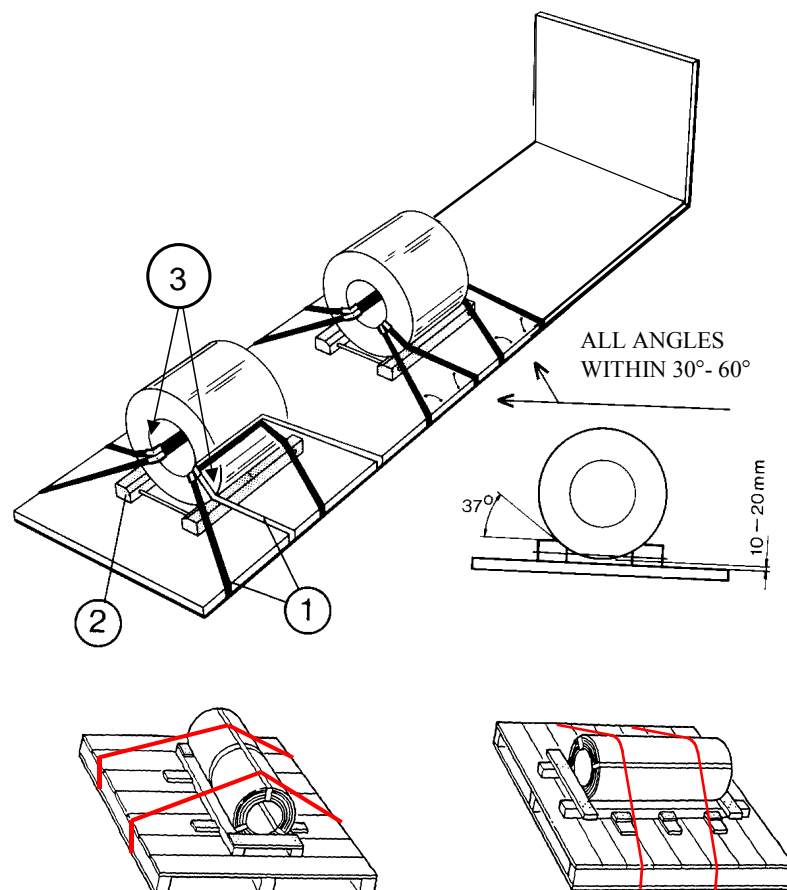
Coils of wide sheet - Bore Horizontal.

These coils, when loaded bore horizontal will preferably be carried on vehicles having a coil well (wedge bed) in the load platform. Without additional securing, it is likely that the coils will move in the well so a sufficient number of lashings must be used to provide the necessary load restraint. Alternatively, for instance when specialised vehicles are not available, coils may be carried packed on pallets with wedge beds as shown below.

Below are examples of heavy sheet coils on a flat platform without sideboards. For high density cargo items like these, it is particularly important to consider the load distribution.

- Sheet metal coils on wedge bed ② blocked in all directions through loop lashings ①.
- Edge protection ③ is placed by all edges.

① Loop lashing
② Wedge bed
③ Edge protection



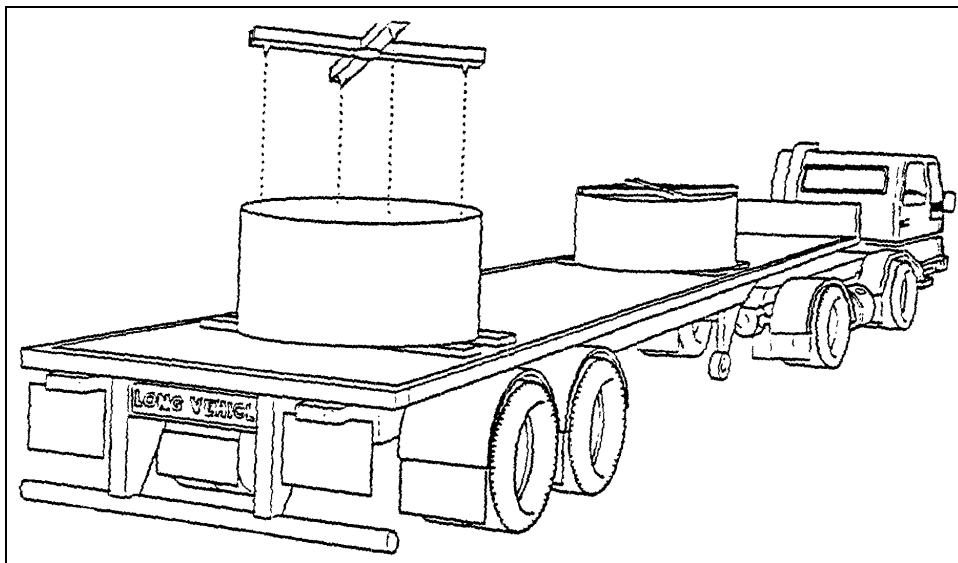
Picture 68:

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

Coils must be securely attached to the cradle by at least two web lashings or by an approved steel strapping. The lashings must be in contact with the surface of the coil and the softwood wedges.

If a coil well is not used, coils or coil and cradle units should be secured to the vehicle by chain or webbing lashings that incorporate tensioning devices. For securing purposes each line of coils across the vehicle load section must be considered separately and each one must be lashed.

Coils of wide sheet - Bore Vertical



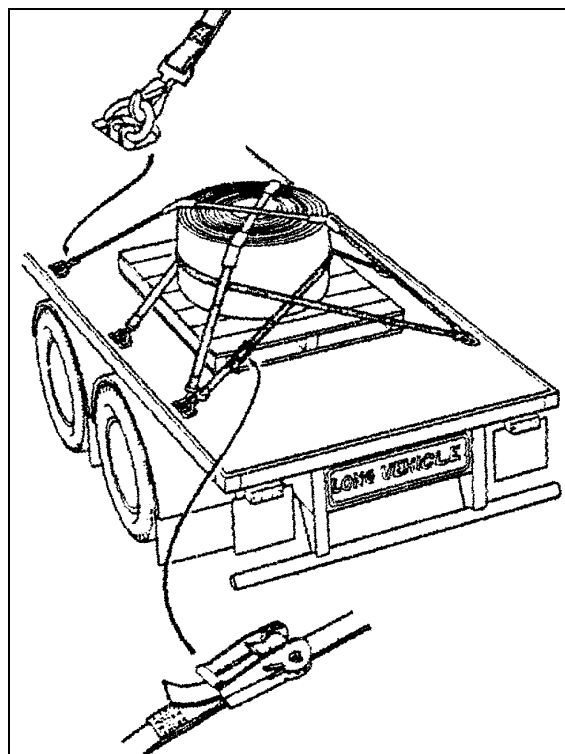
Picture 69: Coils of wide sheet - Bore Vertical

Coils carried bore vertical are usually loaded onto platform vehicles and are one of the most difficult cargos to secure. The figure below shows a suitable restraint system employing a cruciform that can be used with chains or webbing to secure large diameter bore vertical coils. The placed on the centreline of the vehicle and the cruciform placed on top of the coil with the spigots located inside the bore. The cruciform should be positioned with the open through channel across the line of the vehicle to accommodate a conventional securing chain lashing. Lashings should be attached to the vehicle anchorage points and tensioned in the usual way.

It is possible to secure such coils without using the clamp described, but the webbing or chains must be positioned with great care to ensure they fully prevent any movement. Dense loads of relatively small volume, such as coils, may require a concentration of heavy-duty anchorage points to ensure adequate provision for the location of tensioning devices.

For high density coils it is particularly important to consider the load distribution.

Lighter coils are sometimes packed onto pallets. Such units should be treated according to the guidelines given for securing bore horizontal coils packed on pallets.



Picture 70: Example of lashed coil

More details about securing of steel products can be found in Annex 8.9.

6.11. Coiled Wire, Rods or Bars

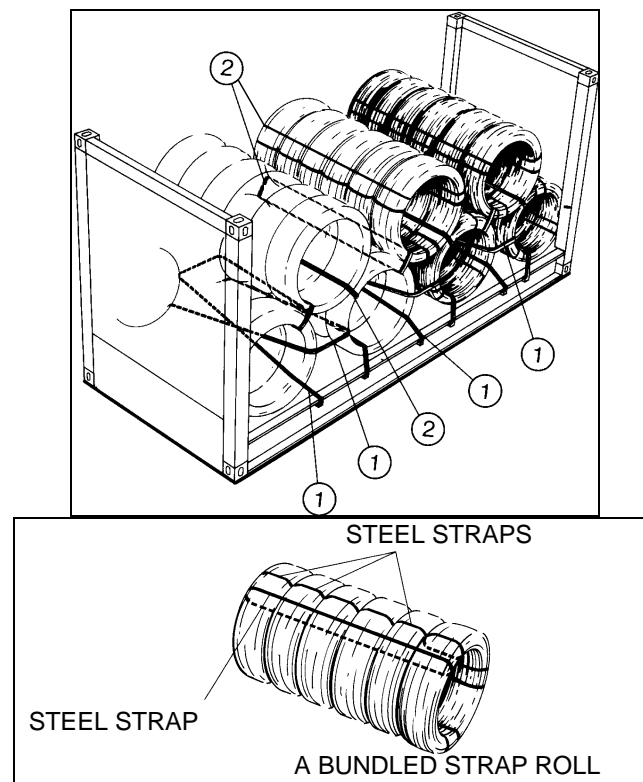
Coiled wire, rods or bars are preferably bundled to form continuous and firm rolls and should be stowed across the platform as shown in the figure below. The bundling should be arranged so that a gap of approximately 10 cm is obtained between the cargo and the side edge of the platform.

The front and rear rolls of the base layer should be stowed tight against the front wall and end blocking. The other rolls of the base layer are evenly distributed between the front and rear rolls, parallel to them. Gaps between the rolls should not be greater than half the roll radius.

Stop boards measuring about 50 x 50 mm are placed across and under the rolls so that these are kept in position when the upper layer rolls are loaded and placed in the “pits” formed by the lower layer.

According to the following picture, round-turn lashings (2) are tightened between the layers so there is a firm layer blocking of the upper layer by the lower layer.

Loop lashings (1) with straps are tightened through the rolls of the base layer in such a way as to realise “suspended” blocking on both sides of all the rolls of the base layer.



Picture 71: Coils in two layers, stowed on a container platform with end walls.

- The upper layer is layer blocked with round-turn ②.
- Loop lashings of steel wire block the cargo laterally ①.

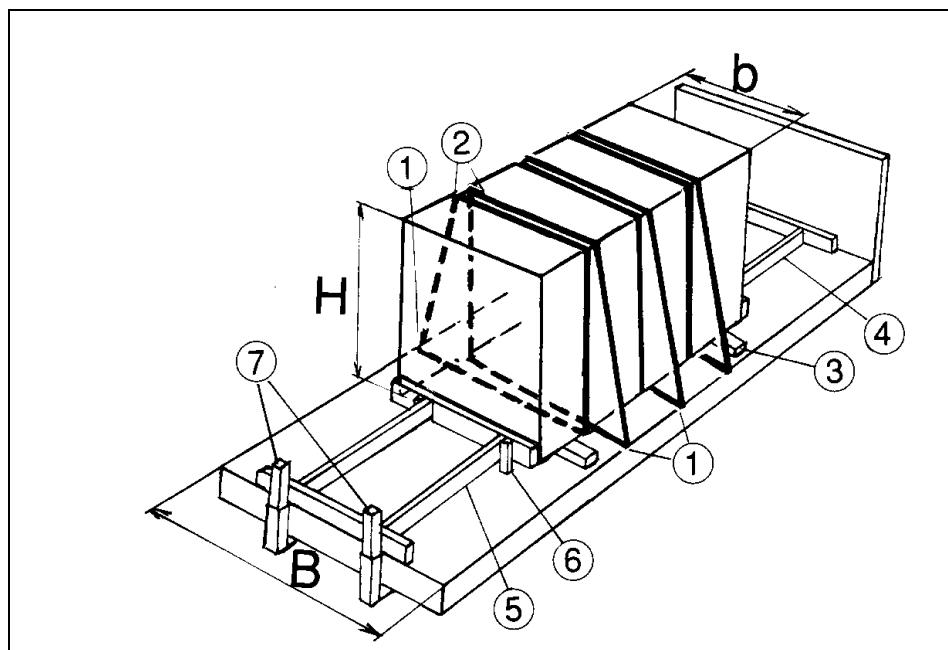
① Loop lashing
② Round-turn

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

NOTE: Steel straps for other securing purposes are not recommended.

6.12. Large Units and Castings

Large units and castings will usually need to be secured by the use of both chain lashing and adequate blocking devices.



Picture 72: Large unit with loop lashing and blocking on a platform without sideboards

- | | |
|--|--|
| <ul style="list-style-type: none"> • The package is placed on a wooden base on the platform having no sideboards. • The package is secured laterally by means of loop lashings ②. • The package is secured longitudinally by means of brace blocking ④ and ⑤, wooden lugs ⑥ as well as rear struts ⑦. | <ul style="list-style-type: none"> ① Lashing attachments ② Loop lashings ③ Wooden base ④ Brace blocking forwards ⑤ Brace blocking backwards ⑥ Wooden lugs ⑦ Rear struts |
|--|--|

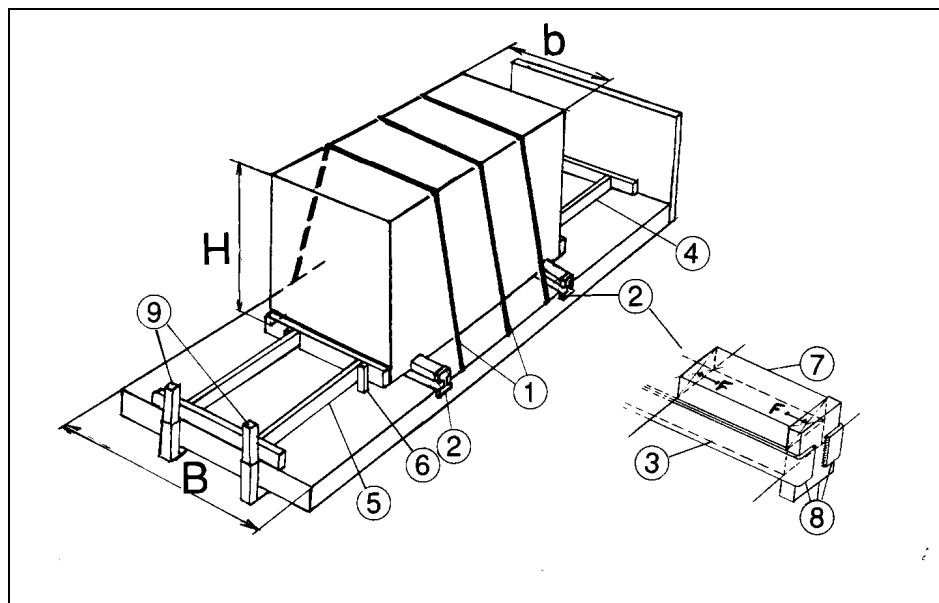
Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

The package is placed on a wooden base (3) and secured laterally by means of loop chains lashings (2).

The package is secured longitudinally by means of blocking braces both to the front (4) and to the rear (5). To achieve effective blocking in this case, the blocking brace must be raised by means of wooden lugs (6) and the spacer battens are then chamfered.

A double blocking brace, as shown in the figure above, is used when two load-bearing rear and/or front beams of a conventional flat platform body are used to absorb the forces applied to the head or tail board. If the headboard or rear end (tailboard, rear wall, or rear door) is designed to absorb longitudinal forces evenly distributed along the entire load platform width, a triple blocking brace (with three spacer battens) must be used. Note that blocking braces must be fixed laterally unless the platform has sideboards and the cross battens cover the entire platform width.

For high density loads it is particularly important to consider the load distribution



Picture 73: Securing by straddles blocking, top-over lashings and blocking braces on flat platforms without sideboards

- The package is placed on two side-blocking straddles ② that together with top-over lashing ① secures the package laterally.
- Longitudinally the cargo is secured by brace blocking (④ and ⑤), wooden lugs ⑥ and rear struts ⑨.

- | |
|----------------------------|
| ① Top-over lashing |
| ② Side-blocking straddles |
| ③ Base material |
| ④ Brace blocking forwards |
| ⑤ Brace blocking backwards |
| ⑥ Wooden lugs |
| ⑦ Wedges made of wood |
| ⑧ Cross batten |
| ⑨ Rear struts |

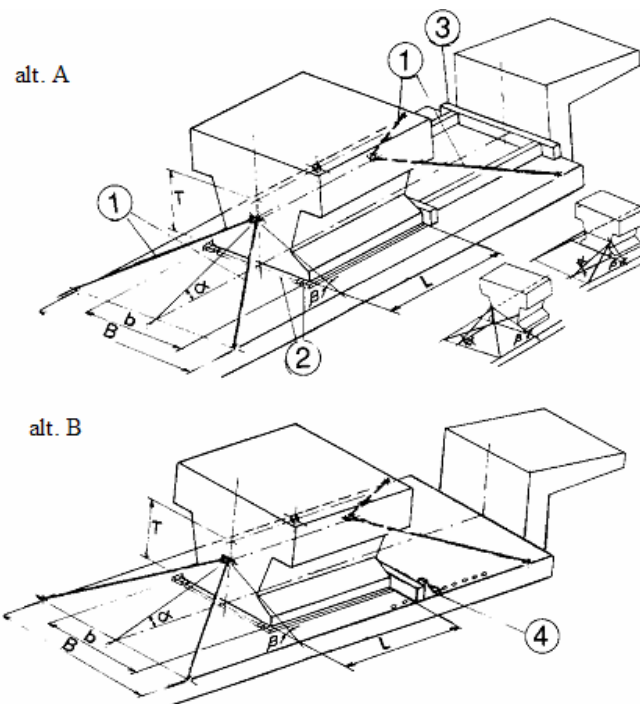
Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

The package is placed on two side blocking straddles (2) with a base (3) and end wedges (7) made of wood and also cross battens (8) that transmit the lateral force to the edge of the platform. The base should be about 5 mm higher than the cross batten (made of steel) to avoid steel to steel contact. Each straddle must have adequate strength, preferably with an acceptable safety margin.

It is assumed that both the package and the platform edge can withstand high spot loadings. If this is not the case, the number of straddles must be increased, which would give a correspondingly lower force. When more than 2 straddles are used, all base layers must be fixed longitudinally because of the undetermined static load situation with 3 straddles or more (the cargo could rest on some of the installed straddles only).

The package is secured longitudinally by means of blocking braces both to the front (4) and to the rear (5), that are designed for the calculated pressure force.

Rear struts (9) with attachments to the platform, must have adequate strength.



Picture 74: 4-part cross lashing on a machine trailer

- The package is secured and blocked with lashings ①.
- The cargo may possibly be secured forwards with brace blocking ③ (alt A) alternatively with vehicle wedge ④ (alt B) to reduce the strain in the lashings.

① Lashing
② Base material
③ Brace blocking forwards
④ Vehicle wedge

The large cargo section above may only be placed directly onto the flat platform if one of the contact surfaces is made of wood or a material with equivalent friction properties. If there is any possibility of metal to metal contact, a walking board should be placed between the cargo and the load platform to increase the friction.

Four lashings (1) made of chain or another appropriate lashing, are applied symmetrically, laterally and longitudinally, between the attachments on the package and the edges of the platform.

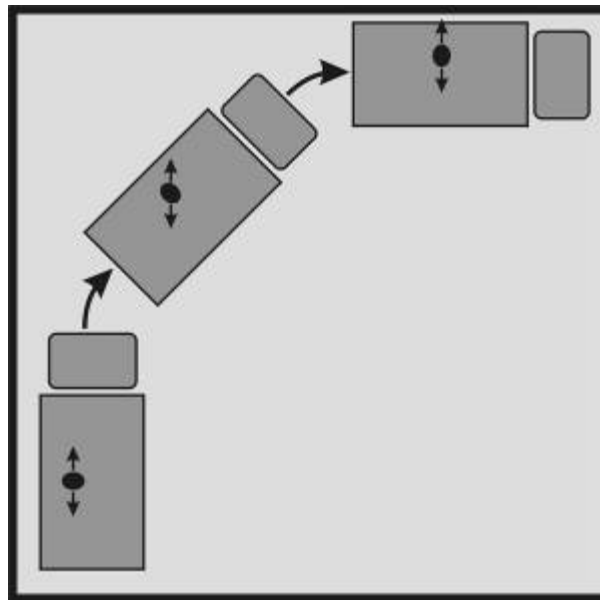
In the case of heavier packages, the front should be blocked by use of a blocking brace (picture 74, alt. A, item 3) or a vehicle wedge (picture 74, alt. B, item 4).

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

6.13. Hanging Loads

Hanging load, carcasses for example, have to be properly secured to prevent them from swinging or any other unacceptable movement inside the vehicle. If this movement should occur, the load and vehicles centre of gravity will move and it is likely to affect the driving dynamics of the vehicle such that it is unstable to the point of being uncontrollable and lead to an incident such as vehicle rollover.

If inadequately secured, hanging loads will start to swing longitudinally as a result of the vehicle accelerating or decelerating and even though the vehicle may change direction, the hanging loads will continue to swing in the same direction (as shown in Picture 75 below). This means that after the vehicle has negotiated a 90° turn, the hanging load will be swinging transversally and this is obviously undesirable since this could cause the vehicle to be uncontrollable or even roll-over.



Picture 75: Swinging of hanging load during turn

Vehicles used for the carriage of carcass meat should be equipped with rails and sliding hooks. The rails should be fitted with fixed hinge 'stops' at 1 to 1.5m intervals to prevent the surging or sliding of carcasses due to the motion of the vehicle or brake application. When loading the vehicle, the carcasses should be distributed evenly on all rails and the stops applied. If part unloading occurs, the remaining load should be re-distributed evenly and the 'stops' re-applied. At all times the floor of the vehicle should be kept clear of slip hazards such as blood and other slippery matter.

6.14. Bulk Liquid Load

Liquid loads or loads which behave in the same way as liquids (grain or flour for example which are also frequently carried within tanks), the same

movement problems that apply to hanging loads are likely to be encountered (see section 6.13). If tanks or similar transportation units are partly filled, the load will start moving if the vehicle accelerates, decelerates or turns through a corner. This will change the Centre of Gravity (CoG) of the load and the whole vehicle and/or launch a swinging process (i.e. a continuous shift of the CoG) of the load. The dynamic behaviour of the vehicle will be affected and may be unstable to the point of being uncontrollable and lead to an incident such as vehicle rollover.

Where possible, tanks shall be nearly completely filled with liquid or empty (ADR requirements: more than 80% or less than 20% for tanks larger than 7500 litres) to avoid the effects mentioned above. Where necessary, additional measures shall be taken to avoid load movements encountered with partly filled tanks, such as the use of tanks equipped with baffles.

Be aware that all bulk and liquid securing issues are not fully covered in these Guidelines.

7. Requirements for some specific loads

7.1. General cargo

When various types of cargo are stowed on load carriers, difficulties arise mainly because of the differences in weight and shape of the cargo units. Differences in package strength and properties of the goods, which means that, individually or in combination with others, they constitute hazards are further reasons why consideration is required. Also, dangerous goods may be part of the cargo and these will require special care.

This particular load securing domain is very wide, with numerous combinations, and is therefore difficult to deal with in terms of quantifiable data. However, some general guidelines are given hereafter.

DISTRIBUTION OF WEIGHT

When stowing the cargo units on the load carrier, the centre of gravity must be as low as possible to achieve the best possible stability when the vehicle brakes, accelerates or changes direction. Heavy goods in particular should be placed as low and as close to the centre carrier's platform as possible. Axle loads must also be taken into consideration (see Annex 8.1).

PACKAGE STRENGTH

Cargo that has weak packaging is usually light in weight. For this reason, cargo with more fragile packaging may generally be placed in the upper layers without creating problems of weight distribution. If this is not possible, the cargo should be separated into different load sections.

BLOCKING

By using a suitable combination of various sizes of rectangular block-type packages, you can easily achieve satisfactory blocking against head, end and sideboards.

FILLER MATERIAL

Empty spaces that may arise resulting from the cargo units being of different shapes and sizes must generally be filled to provide sufficient support and stability for the cargo.

PALLETISING

Pallets enable individual cargo parts and goods of a similar size and nature to be made up into cargo units. Palletised cargo can be more easily handled mechanically which reduces the effort required to handle and transport them. Palletised goods should be carefully secured to the pallet (see section 6.6).

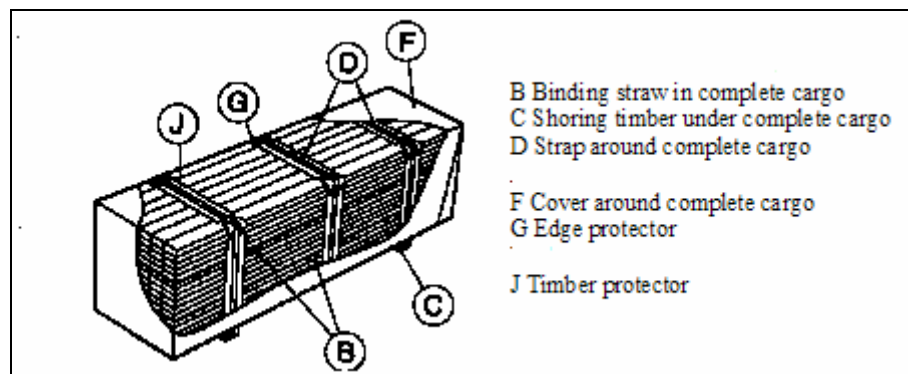
7.2. Timber Loads

This section is intended to provide general guidance on the measures necessary for the safe carriage of timber, both bulk and sawn. Timber is a 'live' commodity, which can lead to independent movement of parts of the load if the restraint is inadequate. It is essential that timber is not loaded to a height, or in such a way, as to result in the likelihood of either the vehicle or load becoming unstable.

As with any other cargo, it is important to ensure that, wherever practicable, the cargo is placed against the headboard or similar fixed restraint. If this is not possible then all the restraint will have to be provided by the lashings.

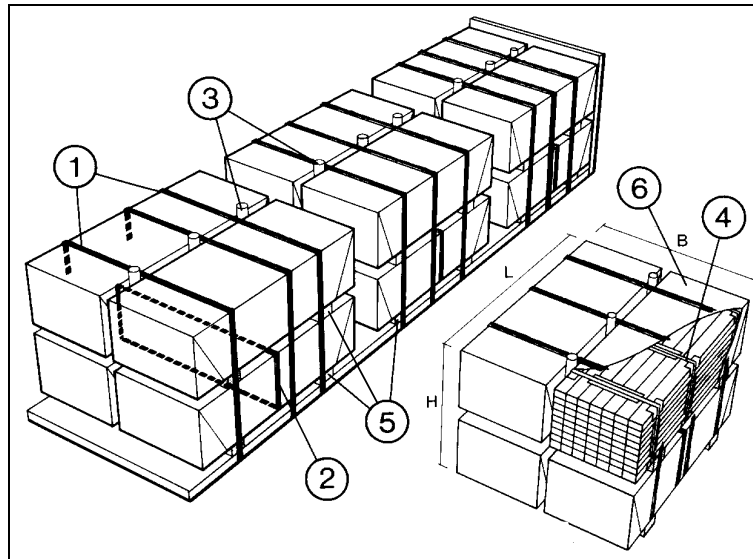
7.2.1. Sawn Timber

Sawn timber is usually transported in standard packages complying with ISO4472 and related standards. Be aware that any plastic covering the timber will lower the coefficient of friction and more lashings may be required. These packages are generally strapped or wired at each end and before loading the straps should be checked for safety. If the straps are damaged or insecure extra care must be taken to ensure that the complete load is adequately secured to the vehicle.



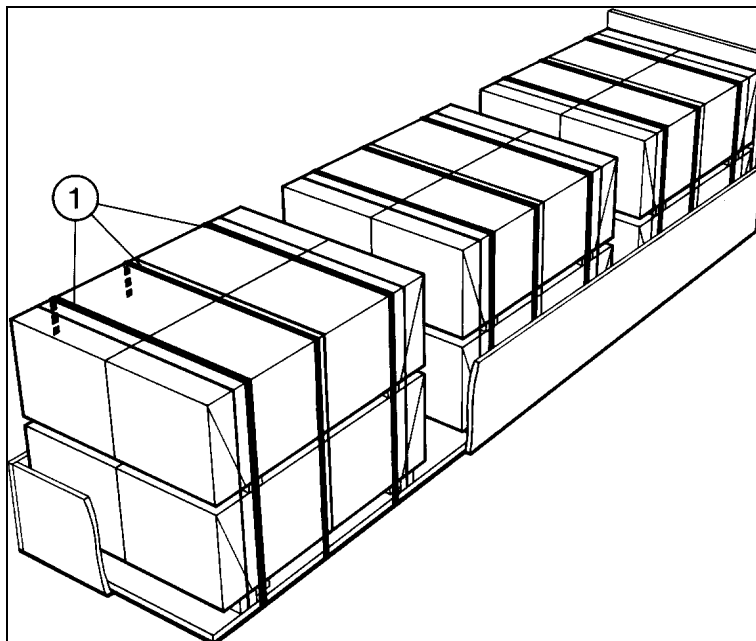
Picture 76: Standardised package in accordance with ISO 4472

Standardised packages of this kind should preferably be stowed on flat platforms equipped with either centre stanchions or sideboards and secured with top-over web lashings.



Picture 77: Sawn timber in bundles on flat platform with centre stanchions

- The bundles of wood, with a rough quadratic cut section, are kept together by package straps ④ of steel.
 - The bundles are stowed against centre stanchions ③.
 - The front cargo section is stowed against the head-board.
 - In certain cases a round-turn ② is used, that holds the lower package pairs tight together.
 - The cargo case is only valid for road transport
- | |
|---|
| ① Top-over lashing |
| ② Round-turn |
| ③ Centre stanchions |
| ④ Package straps (usually steel straps) |
| ⑤ Base material |
| ⑥ Cover |



Picture 78: Sawn timber in bundles on flat platform with sideboards

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

7.2.2. Round Timber

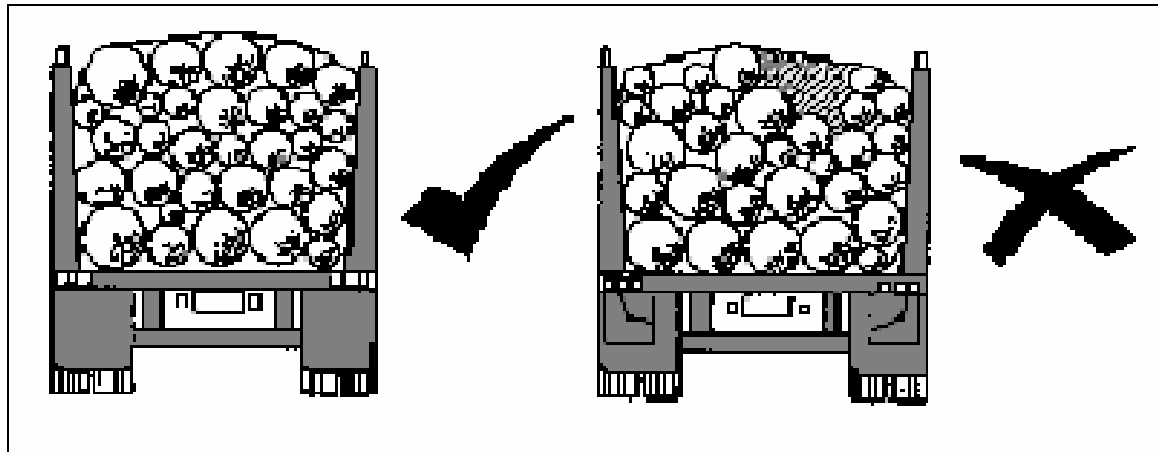
The general principles of load distribution should be adhered to and it is important to ensure that, whenever possible, the load is placed against the headboard or similar restraint. The use of chain or webbing lashings is recommended and all lashings should be capable of being tightened by a toggle or load binder. The load and lashings must be checked before passing from a forest road to public highway and should be regularly rechecked during the journey and all lashings retightened if necessary.

The transporting of timber stacked transversely (lying across the vehicle) supported by the front headboard and the rear support (bolster) is not recommended, it is safer to transport it longitudinally (lying along the length of the vehicle) in several stacks, each individually supported by upright supports (stanchions).

Stacked Longitudinally

Each outer log or piece of timber shall be restrained by at least two upright supports (stanchions) that should be either of sufficient strength or fitted with top chains to prevent the load spreading them apart. Any timber that is shorter than the distance between two upright supports should be placed in the centre of the load and all logs should preferably be laid top to tail alternately to ensure an evenly balanced load. Where timber is supported by two uprights, the ends of the timber should extend at least 300mm beyond the uprights.

The centre of either top outside timber must be no higher than the stanchion. The top middle timber must be higher than the side timbers to 'crown' the load and enable it to be properly tensioned by the lashings, as illustrated below:



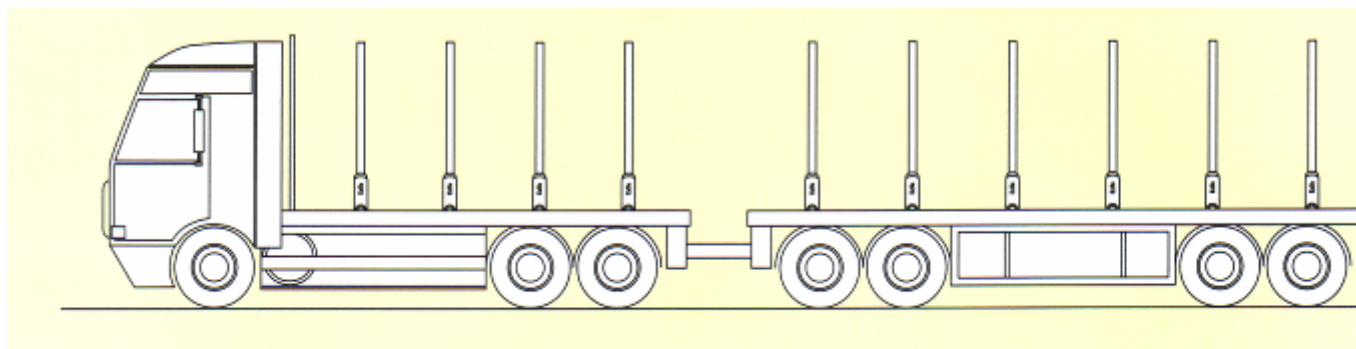
Picture 79: Correct and incorrect loading of round timber

The vehicle should be fitted with a headboard in accordance with standard EN12642 and the load should be no higher than the headboard.

Top-over lashings (1) should be tightened over each cargo section (timber pile) in the following numbers:

- a) At least one if the cargo section consists of timber with bark still present, up to a maximum length of 3.3 m;
- b) At least two if the cargo section is longer than 3.3 m or irrespective of the length if the bark has been removed.

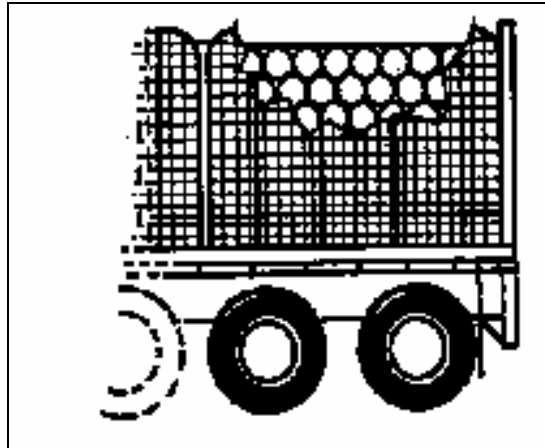
The top-over lashings should be placed transversely between each cargo section's front and rear pairs of side stanchions. The use of a single chain stretched between the upright supports, even if well secured, is not a sufficient method of restraint.



*Picture 80: Example of a round timber vehicle equipped with stanchions
(This is a special purpose vehicle not complying with Directive 96/53/EC)*

Stacked transversely

Timber stacked transversely across a flat bed vehicle cannot be adequately secured by conventional restraining methods. Passing straps or chains from the front of the vehicle across the top of the timber to the rear with cross straps is not considered to be an acceptable load securing method. If timber is carried transversely then suitable side gates must be used and the load should not be higher than the side gates.



Picture 81: Timber stacked transversely with side gate

7.2.3. Whole Trees

The carriage of whole trees is a very specialised field of timber haulage that is generally accomplished using pole vehicles or vehicles where the timbers are secured to a trailing dolly at one end. Vehicles should be fitted with bolsters and stanchions of sufficient strength to restrain the load. Chains or web lashings are necessary for securing the load and generally a minimum of three chains or web lashings should be used, one of which should bind together any overhanging tails or the middle of an awkwardly shaped load. It should be possible to tighten the lashings using a toggle or load binder.



*Picture 82: Transport of whole trees
(This is a special purpose vehicle not complying with Directive 96/53/EC)*

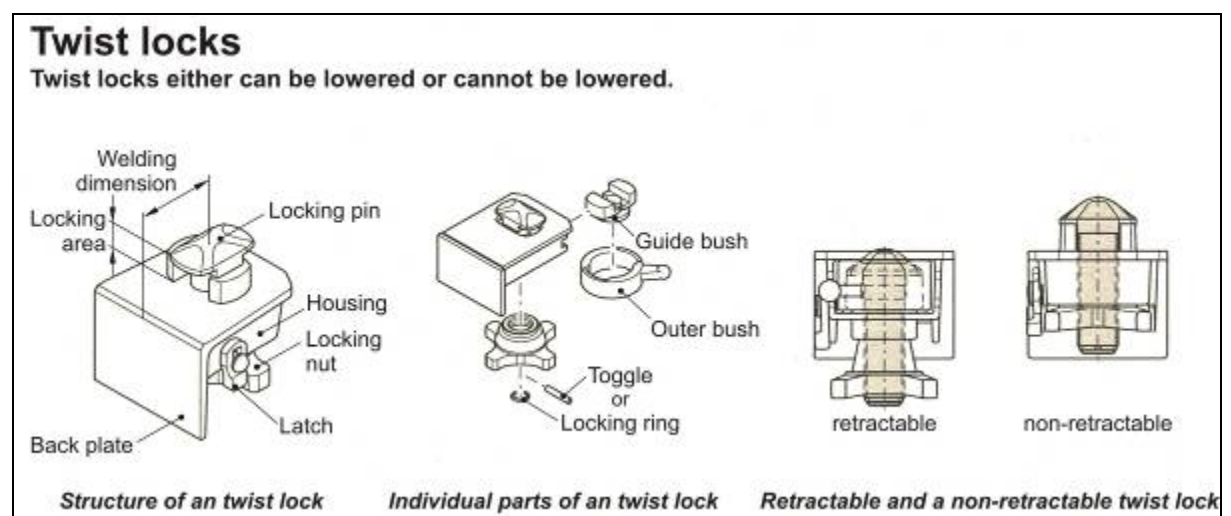
7.3. Large containers or large and heavy packages

ISO-containers and similar load carriers with anchorage points for twist locks or similar locking mechanisms should preferably always be transported on loading platforms with container locks. However large containers for road transport, with or without cargo, having a total mass of less than 5.5 tonnes, can alternatively be secured as recommended for one single box but with additional wooden battens in combination with top-over lashings at each end of the container (see instructions below). If shorter than the whole container's length, the wooden batten's length should be at least 0.25 m per tonne of the container mass. Unlike normal box type loads that spread their mass over a large area, containers are designed to stand on the twist lock sockets or feet protruding down at each corner. With heavy containers this produces high loading points that could over-stress a normal platform floor.

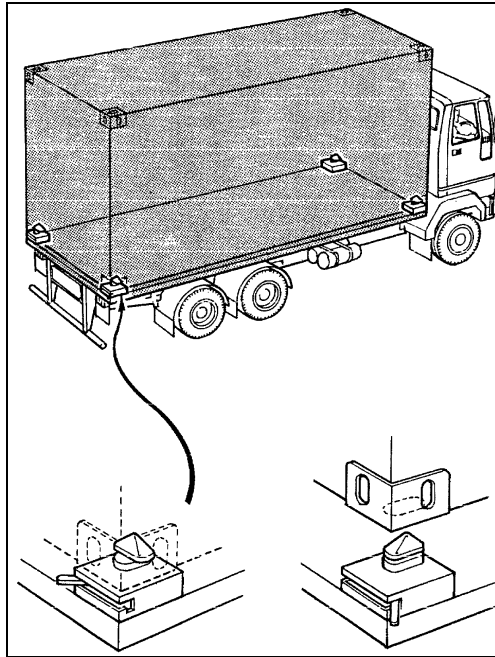
Large and heavy packages can be secured as recommended for boxes with top-over lashings. In order to maintain the carrier stability, the package must be placed in the specified position along the platform. The gaps between the package and the front and end boards can be filled with adequate blocking material to achieve adequate securing.

The majority of containers in use are constructed to International standards (ISO 1496). These containers are generally fitted with special corner castings, which when used in conjunction with correspondent twist locks fitted on the vehicle provide a simple and effective restraining method.

Loaded ISO containers weighing more than 5.5 tonnes should only be carried on vehicles fitted with twist locks. Provided that all twist locks are fully engaged and locked in position, the container will be adequately secured and no further restraint is necessary. The twist locks must be maintained in a serviceable condition and a minimum of four should be used for each container carried.



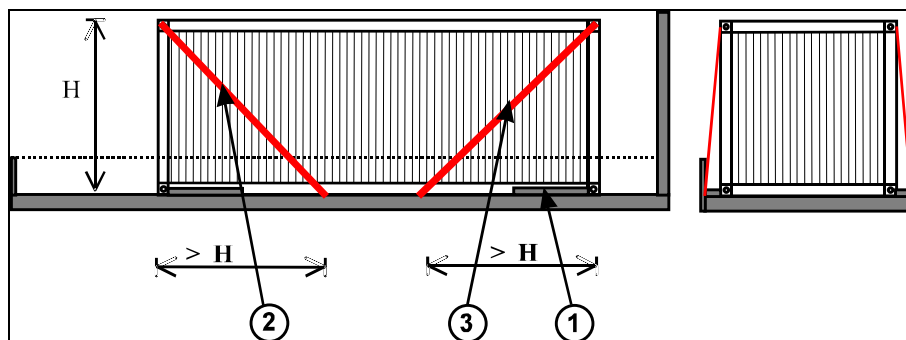
Picture 83: Twist lock



Picture 84: Container on platform with twist locks

- Container of ISO-type is loaded on a flat platform with sideboards

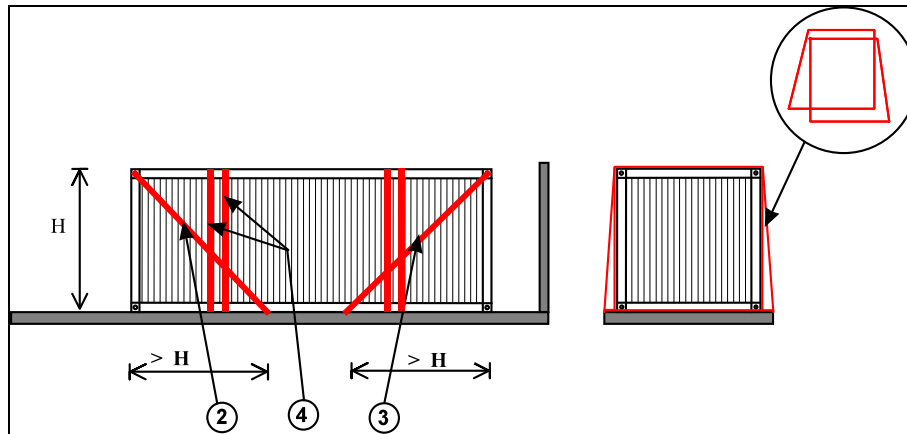
①	Wooden batten
②	Supply lashing backwards
③	Supply lashing forwards
- The load is base blocked laterally by wooden battens ① that fill the space between the sideboards and the load.
- This method is only suitable for road transport.



Picture 85: Empty container on flat platform without twistlocks but equipped with sideboards

- Container of ISO-type is loaded on a flat platform without sideboards

①	Supply lashing backwards
②	Supply lashing forwards
③	Loop lashing
- The cargo is secured laterally with loop lashings ③.
- This method is only suitable for road transport.



Picture 86: Empty container on platform without twistlocks or sideboards

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

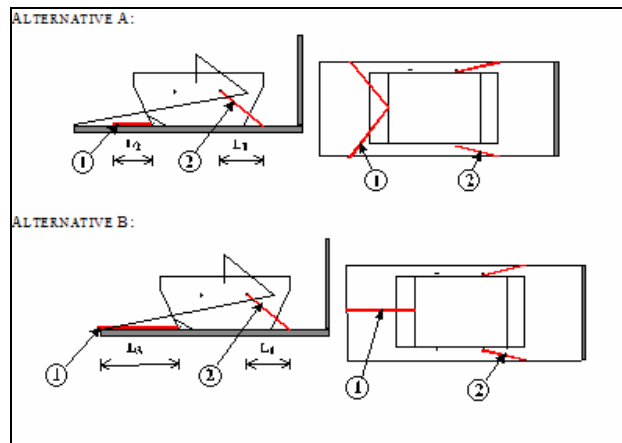
7.4. Swap bodies without container locks

Swap bodies which do not have ISO type corner castings may be fitted with special attachment brackets or lashing rings. Safe methods for securing these containers will therefore vary according to the type being transported but the restraint system used must fulfil the cargo securing requirements.

Lashings or other securing devices should only be attached to points on the container intended for this purpose or for mechanical handling when laden, such as lashing rings or special brackets. Attachment points on the container should be checked to ensure they are in sound condition and all the attachment points should be used to secure the container to the vehicle platform.

7.5. Skip Containers

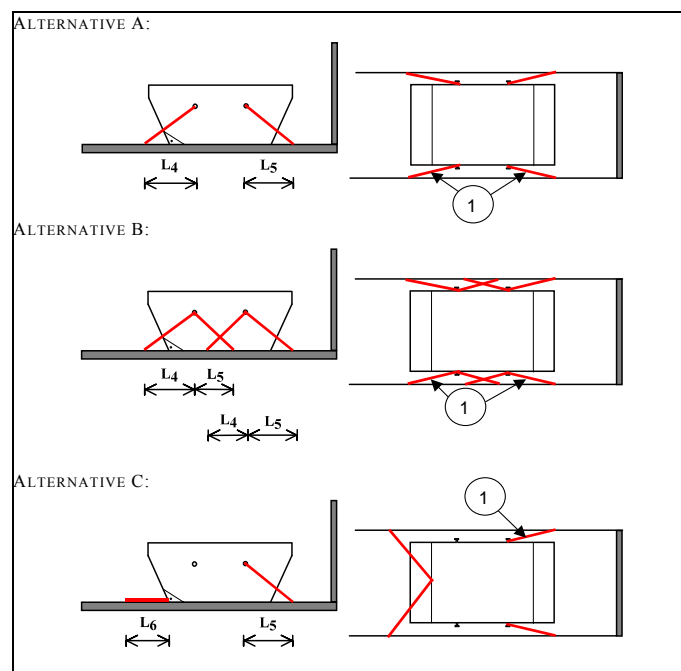
Skip containers, when loaded onto the carrying vehicle, must be adequately secured against movement when they are subjected to the forces encountered when the vehicle is driven. The lifting arms should be correctly positioned in their designated travelling position and the loading chains must be properly stowed before moving the vehicle. Skips may alternatively be carried on vehicles providing they are safely secured with adequate web or chain lashings. Problems may be encountered with skip containers due to the driver not having any control over how the skip is filled or its contents. However, when the skip is accepted for loading the driver must assume responsibility for the safe carriage of the skip and its contents. A sheet or net will usually be needed if there is any risk of the contents falling or being blown from the top of the load compartment by air turbulence.



Picture 87: Skip container on flat platform with lift arm

- Skip container secured laterally by the lift arm.
 - This cargo case is only valid for road transports
- ① Lashing backwards
② Lashing forwards

Skip containers can be carried on regular platform vehicles if they are safely secured with adequate web or chain lashings.



Picture 88: Example of skip container on flat platform without lifting arms

7.6. Stowage of Goods in Containers

Standard ISO-containers and similar containers usually provide sufficient support for securing the cargo in many directions. Usually only fillings with wood or air cushions are needed on the sides and against the front. Appropriate steps should be taken to ensure that the cargo or any blocking device will not fall out when the doors are opened.

Incorrect loading of a container may result in dangerous situations when the container is handled or transported and could adversely affect the stability of the vehicle. In addition it may result in serious damages to the cargo.

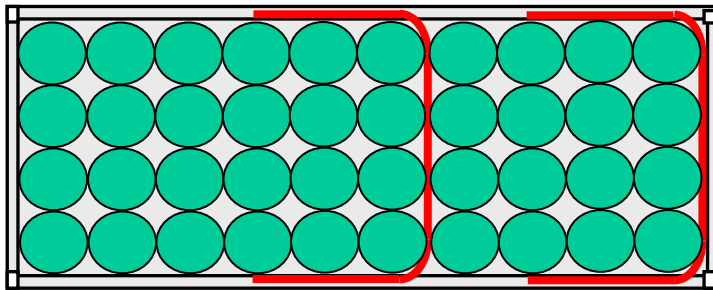
In many instances the driver has no control over the packing of a container nor is he able to inspect its contents when accepting it for carriage. However, if it appears that the container has not been safely loaded then it should not be accepted.

The following general stowage rules that are important to road safety should always be observed:

- a) The cargo should not exceed the permitted payload of the container;
- b) The load should be evenly distributed across the container floor area. There should never be more than 60% of the total cargo mass located in one half of the length of the container. If this is the case, it could lead to an axle being overloaded;
- c) Heavier goods should not be stowed on top of lighter goods and, wherever possible, the centre of gravity of the loaded container should be below the mid point of its height;
- d) The cargo should be secured in the container against any forces that might reasonably be expected to occur during the journey. A tightly packed cargo is less likely to move than one that has spaces between parts of the load.

After the packing of the container is completed, steps should if necessary be taken to ensure that the load and dunnage will not fall out when the doors are opened. Web lashings or nets are often suitable for this purpose; alternatively a timber or metal gate can be constructed.

Always verify that the doors are locked and that the locking mechanisms are in working order.



Top view



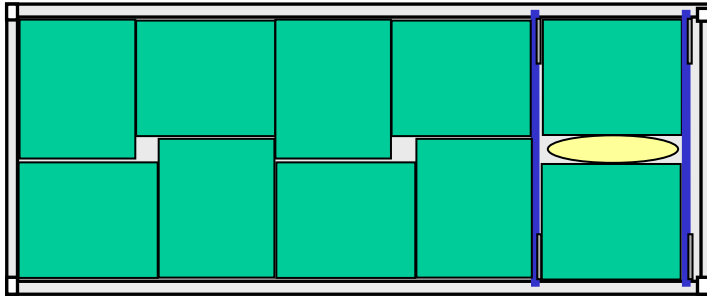
Steel drums, double-stacked in a block stow, and secured

20'-Container:

80 loose steel drums secured by tensionable straps which are fixed to the framework of the container

Picture 89: Loose drums double-stacked in a container, two layers of four rows

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7



Combination IBCs in an ISO freight container, double-stacked and secured



20'-Container:

18 combination IBCs, blocked by horizontally inserted timber planks, and void spaces filled with air bags or equivalent packing material

Picture 90: [Intermediate bulk containers \(IBCs\) double stacked in a container](#)

Guidance for calculating the required number of lashings is found in Annex 8.6 or 8.7

7.7. Loose Bulk Loads

Loose bulk loads can be described generally as those which do not readily lend themselves to any form of packaging, e.g. sand, ballast, aggregate etc. For ease of loading they are usually carried in open bodied vehicles. Removable open top containers (skips), normally used for transporting waste materials, also come into this load category.

Shedding of loose bulk loads is more likely to take the form of small quantities of material falling through gaps in the bodywork or being lifted by air turbulences from the top of the load compartment.

The load compartment should be kept in good condition to minimise the risk of leakage. Special attention should be given to drop sides and tailboards where damage or deformation can easily lead to loss of part of the load through small gaps, which are created. All tailgates and drop sides must fit correctly and shut tightly enough to prevent the spillage of any sand, shingle or other loose load being carried.

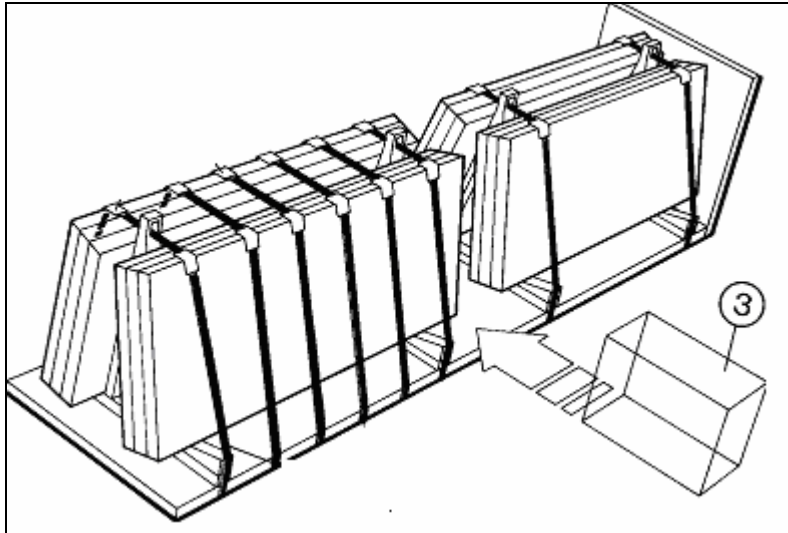
All the body to chassis attachment points and body fittings such as hinge pins and brackets, tailboard locking mechanisms, drop side fasteners, etc. should be in serviceable condition.

The body sides should be of sufficient height not only to completely contain the cargo when it is loaded but also to reduce the risk of parts of the load, which might have moved during the journey, from falling or being blown over the edge.

The load compartment should be covered if there is a risk of part of the load falling or being blown from the top of the vehicle. The type of cover used will depend on the nature of the load being carried. Materials such as dry sand, ash, and metal turning swarf are particularly susceptible to being blown off and should always be covered by a suitable sheet. Covering with a net can sometimes adequately retain loads that consist of large items, such as scrap metal and building waste. If a net is used the mesh size should be smaller than the smallest items being carried and the net should be strong enough to prevent any carried article from escaping.

7.8. Panels stowed on flat platform with A-trestles

Panels of concrete, glass or wood etc. may be stowed on a flat platform using "A"-trestles. The trestles will additionally need to be secured on the loading platform.



Picture 91: Panels stowed on a flat platform using “A”-trestles. The front section is blocked against the front wall and the space between the cargo sections is blocked by suitable filler material (3).

Guidance for *calculating the required number of lashings* is found in Annex 8.6 or 8.7

- If the cargo is not stowed against the headboard blocking forwards in the form of filler material^③ or corner straps is required.
- In certain cases blocking backwards is required through filling, brace blocking or corner straps.
- The panels are leaning against A-trestles and are lashed down with topover lashings^①.
- If necessary, the space between the cargo sections is blocked by suitable filler material^③.
- Wear protectors^② are placed between the straps and the cargo.

- ① Top-over lashing
- ② Wear protectors
- ③ Filler material

7.9. Engineering Plant / Construction equipment / mobile machinery

The following section provides guidance on the measures necessary for the safe carriage of tracked and wheeled engineering plant by vehicles complying with Directive 96/53/EC (vehicles allowed unrestricted circulation within the EU). It does not deal with the carriage of large machines etc. on special purpose vehicles whose use on the roads is restricted by permits. However, the general advice contained in this section will apply in many cases.

It is recommended that manufacturers of plant equipment either fit lashing points or provide a recommended lashing scheme for each of their vehicles.

For engineering plant equipped with lashing points dedicated for transport use, these points should be used and the vehicle secured according to the manufacturer's instructions. In the event of the manufacturers recommendations being unavailable, lashings or securing devices should only be attached to those parts of the engineering plant which are of sufficient strength to withstand the stresses likely to be imposed on them.

Heavy engineering plant is normally transported on purpose built vehicles which are specifically designed to provide easy loading and unloading facilities and are usually provided with adequate anchorage points for attaching the lashings. Lighter engineering plant may in some circumstances be carried on general-purpose vehicles. However, in these cases the method used to secure the load should provide equal safety level to that obtained by using purpose built vehicles.

High loads may damage bridges etc. over roads, so when these are carried it is essential that the driver knows the exact height of the load, and the width of the load at that height. Additionally, loads with a high centre of gravity can seriously affect the vehicle's stability and such items of engineering plant should only be transported on vehicles with a low platform height.

A wheeled or tracked vehicle must be lashed down in position on the carrying vehicle, with the parking brake applied. The effectiveness of the parking brake on its own will be limited by the frictional resistance between the vehicle and the deck of the carrying vehicle, and even in normal driving conditions this will be inadequate and the vehicle will therefore require additional restraint. This additional restraint should take the form of a lashing system and some arrangement whereby the load is prevented from moving either forward or to the rear by a blocking device securely fixed to the vehicle. These should butt against the wheels or tracks or some other part of the equipment carried.

All moveable assemblies such as jibs, brackets, booms and cabs etc. must be left in the position recommended for transportation by the manufacturer and must be secured to prevent movement relative to the main body of the machine.

Before the machine is moved onto the trailer all loose dirt that may otherwise come off and obstruct the highway or damage other vehicles must be removed. The ramp, the tyres of the machine and the bed of the trailer itself should all be free from oil, grease, ice etc. so that the machinery cannot slip.

When the machine has been stowed and the engine stopped, the pressure in the hydraulic system should be relieved by moving all of the control levers through all their positions. This operation should be done at least twice. Controls should be set so as to prevent movement of ancillary items during transit. Bags, tool kits, or other heavy objects should not be left loose in the operator's cab of the plant being carried and all items removed from the machine such as buckets, grabs, blades, shovels and lifting appliances should be lashed to the deck of the vehicle.

The machine should preferably be positioned on the carrying vehicle's platform so that forward movement is blocked by part of the main body of the vehicle, e.g. swan neck, step or headboard, or by an attached transverse member securely attached through the platform to the vehicle's chassis frame. Additionally, the engineering plant and any of its detached assemblies should be arranged so that the legal axle weight limits are not exceeded and the safe handling of the vehicle is not impaired. The clearance between the undersides of low loading vehicles and the road surface should be checked before moving off to establish whether sufficient clearance exists to prevent the vehicle grounding.

Wheeled and light tracked machines should be restrained so that the effect of bouncing caused by road shocks transmitted from the carrying vehicle and amplified by the machine's tyres or suspension units is minimised. Where possible the suspension unit of the machine should be locked and vertical movement limited by lashings or other means of restraint. Otherwise the machine's frame or chassis should be supported on blocks. Unless the machine is supported, the full contact area of its tracks or drums, and minimum half the tyre width should rest on the deck of the carrying vehicle. If the tracks extend outside the frame of the carrying vehicle then the machine's frame or chassis should be supported.

The machine should be restrained against forward, backward and sideways movement by chain or webbing lashings attached to anchorage points on the vehicle. All lashings should incorporate some form of tensioning device.

In deciding the number of anchorage points to be used when arranging a restraint system, the following factors should be considered:

- a. The need to position the machine to achieve the correct load distribution to meet the legal axle load requirements and to ensure that the vehicle's handling is not impaired.
- b. The extent to which other load restraint features is incorporated in the design of the vehicle.
- c. Whether the machine has wheels, tracks or rollers.
- d. The weight of the machine to be carried.
- e. A minimum of four separate anchorage points should be used.

The following guidelines apply to mobile engineering plant - vehicles fitted with hoists, working platforms, support legs and so on.

- a. High loads may endanger bridges and it is essential that the driver knows the height of the vehicle and has it displayed inside the vehicle cab.
- b. All moveable assemblies must be placed in the position and locked, where possible, as recommended for transportation by their manufacturer.

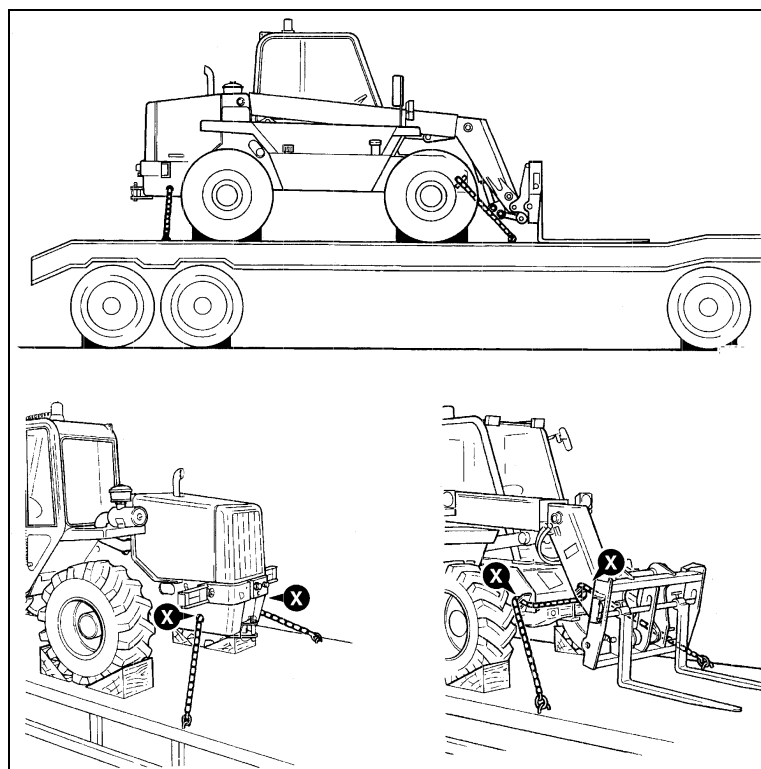
Restraining Devices

Apart from specialised fixing devices, the selection of materials for use in tie down schemes for engineering plant will be limited to chains, steel wire rope, webbing and their associated tensioning and coupling devices.

Where a transverse (side to side) beam is used as a baulk it should be securely fixed so that all loads imposed on it are transmitted to the carrying vehicle's chassis frame. Where individual wheels or drums are chocked with blocks or scotches these must be robust enough to resist crushing and be securely attached to the vehicle's platform where possible.

The lashings or securing devices should only be attached to those parts of the engineering plant, which are of sufficient strength to withstand the stresses likely to be imposed on them. Where engineering plant comes equipped with dedicated lashing points for use when being transported, these points should be used and the vehicle secured as per manufacturer instructions. Care should be taken before lashing to lifting points as these may not be suitable for restraint purposes.

The loaded machine should be inspected after the vehicle has been driven for a short distance in order to check that no movement has taken place and that restraining devices are fully secure. Periodic inspections should be made during the course of the journey.



Picture 92: Wheeled vehicle, cross-lashed to machine trailer from x-marked attachment points

7.10. Vehicles

Vehicles and trailers should only be carried on vehicles suitable for that purpose. This will include having appropriate lashing points in terms of number, position and strength. In general the securing arrangements should follow the same basic principles as suggested for the carriage of engineering plant, but the following additional points should also be addressed:

- The vehicle or trailer should be carried with the parking brake engaged;
- Steering wheel lock must be active and preferably with the wheels chocked;
- Where applicable the transmission should be engaged in lowest possible gear;
- If possible the chocks should be securely attached to the carrying vehicle's deck.

The vehicle or trailer being carried should be positioned so that its weight is fully supported by the carrying vehicle. If necessary, spreader plates should be used to avoid high localised loadings that may be caused by the landing legs of a semi-trailer for example.

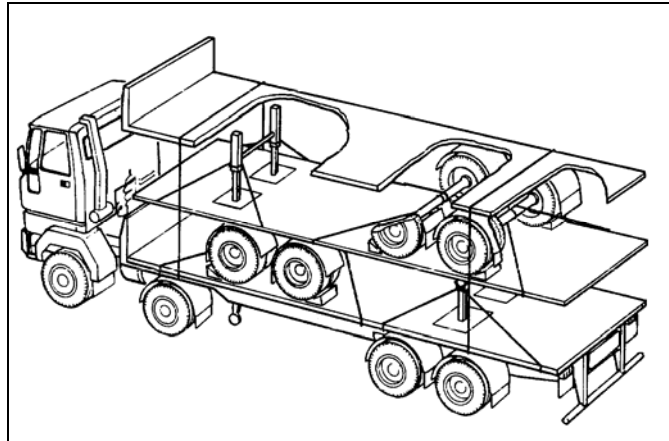
The restraint provided by the friction between the tyres and the deck with the parking brake on will not be sufficient to prevent movement. The vehicle or trailer being carried should be lashed to the carrying vehicle using appropriate lashing equipment. A tensioning device should be used in each lashing and the lashings used to restrain the fore and aft movement should be set at an angle of less than 60° from the horizontal to obtain the maximum effect. The lashings should be tested for adequate tension after the vehicle has travelled a few miles and again at intervals during the journey and be re-tensioned if necessary.

Lashing should be made onto parts of the vehicles or trailer's axles or chassis that are adequate for the purpose. Care should be taken to avoid straining or damaging the other vehicle components such as brake pipes, hoses, electrical cables etc., through lashing over or near them.

The carriage of laden vehicles is not recommended but if this is necessary then extra attention should be paid to the resultant higher centre of gravity of the carried vehicle and the possible resulting loss of stability when cornering or braking. It may also be necessary to put extra lashings onto the chassis of the vehicle or trailer being carried to pull it down on its springs and hence help to avoid an unstable load.

All loose equipment on the vehicles or trailers being carried, and on the carrying vehicle, should be securely stowed.

If more than one trailer is carried in 'piggyback' fashion then each trailer should be lashed to the one on which it rests and then all those carried should be lashed to the carrying vehicle (see picture below).



Picture 93: Trailers loaded on a trailer

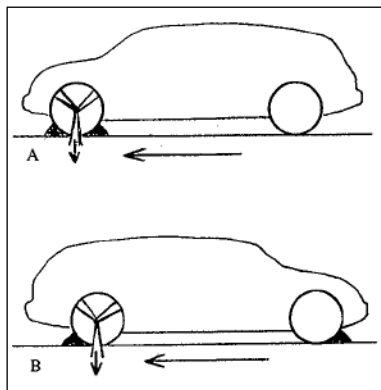
7.11. Transport of cars, vans and small trailers

7.11.1.

These vehicles should preferably be secured by using a combination of both lashing and blocking. However, these methods may not be required if the conditions specified in section 7.11.6 are completely fulfilled. Paragraphs 7.11.1.1 to 7.11.2.5 are examples of adequate lashing and blocking methods.

7.11.1.1.

If a vehicle is being transported on a platform that is either horizontal or inclined towards the front up to a maximum of 10° (i.e. $1/6$), blocks must be used. Two blocks should be placed in front of the front wheels, and two behind any pair of wheels. Lashings should be applied to the foremost pair of wheels. (Figs. A and B)



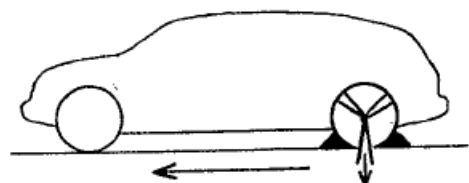
Lashings should be applied to the foremost pair of wheels. (Figs. A and B)

If the total weight of the vehicle exceeds 3.500 daN, lashings should be applied to both front and rear wheels. Blocks should also be positioned in front and behind all wheels. If trailers are being transported, the towbar should

be suitably secured either at the coupling device or as near to it as possible.

7.11.1.2.

If the vehicle is being transported as described in the first paragraph of 7.11.1.1 and the blocks cannot be positioned in front



of the front wheels, the blocks may alternatively be positioned in front of both rear wheels which must also be lashed.

7.11.1.3.

If the vehicle is to be transported on a platform that has an angle exceeding 10° towards the front of the transporting vehicle, two blocks should be positioned in front of the foremost pair of wheels and two behind the rear pair of wheels. Lashings should be applied to both front and rear wheels.

7.11.1.4.

If the vehicle is being transported as described in section 7.11.1.2 and blocks cannot be positioned in front of the foremost wheels, the blocks may alternatively be positioned in front of the rear wheels.

7.11.1.5.

If the vehicle is being transported on a platform that has an angle exceeding 10° to the rear, blocks must be used. The blocks should be positioned both in front and behind the foremost wheels of the vehicle being transported. Lashings should be applied to the wheels that have been blocked.

7.11.2.

Blocking against movement across the transporting vehicle must be done through well fixed flanges, blocks, bars or similar devices resting firmly against the wheel sides of the transported vehicle up to a height of at least 5 cm.

If the transporting vehicle is specially built for transport of cars, trailers, and if the cargo platform is fitted with grooves, limited by flanges being at least 5 cm high and permitting maximum 30 cm free movement across the transport vehicle, the requirements in respect of blocking of the movement across the transporting vehicle are regarded as having been met.

7.11.3.

Blocks or wedges used for preventing longitudinal movement should preferably be positioned against the transported vehicles tyre. The block wedges should preferably have a height corresponding to one third of the radius of the wheel being blocked and should be rigidly fixed to prevent movement along the bed of the transporting vehicle. The blocking should be carried out in accordance with the illustration on the right.

7.11.4.

Wherever possible the lashing should be positioned in such a way that the vehicle is pulled directly towards the platform floor (the lashing will be as close as possible to forming a right angle with the carrying vehicle floor). The total lashing for one pair of wheels should be strong enough to resist a force of 2 x Q daN directed upwards. As an alternative to applying the lashing to the wheel, the lashings may be attached to axle beam(s). If the lashing can be

positioned so that it cannot slide along the axle beam and has sufficient strength, it is acceptable to use one lashing per axle.

Q = mass of the vehicle in kg.

7.11.5.

The surface of the load carrying vehicles platform should preferably have a high resistance to help prevent slippage of the vehicle being carried.

7.11.6.

If the vehicle is enclosed on all sides (including above) by either the framework of the carrying vehicle or other vehicles, it may be transported without being lashed. Even though it is considered unnecessary to lash, it should still be subject to blocking.

In order to qualify as an enclosed cargo platform on the sides and above for this purpose, the cargo space must be limited by framework or similar that is so designed that the vehicle cannot reasonably leave this space in any direction.

7.12. Carriage of Multi Size Glass Plates up to Maximum Authorised Dimensions

Bulk deliveries of glass should normally be carried on a purpose built vehicle as described in the following section. However, when sheet or plate glass is carried in crates or on timber pallets, load restraint precautions as for general freight apply

Bodies for this type of transport normally have longitudinal nearside and offside A-frame sides integrated into the floor sub-structure providing two interior and two exterior frails. Frail faces should have an inclination of between 3° and 5°. Loading and unloading must take place with the vehicle placed on a firm level base. Care must be taken to ensure a balance of weights laterally and longitudinally so that the vehicle travels on an even keel and legal axle weights are not exceeded.

If carried on the outside of a vehicle, it is recommended that the plate glass is covered to prevent flying fragments should the glass break during transit.

Before removing restraints note must be taken of the road camber. If an unsafe condition is likely to occur steps must be taken to unload those frails that are safe, i.e. nearside internal and offside external frails when the vehicle is in the forward travel position. To unload the remaining two frails the vehicle must be turned around.

7.13. Carriage of Small Quantities of Plate Glass, Frames etc.

This transport is usually carried out using standard panel vans converted by specialist bodybuilders who add internal and external frails.

External fittings should be of metal rather than timber construction and fixing to the van should be as close as possible to sides and roof framework members. Any external carrying racks should be designed to provide protection to pedestrians in the event of a collision. All parts of the frail etc. coming into contact with glass should have rubber or similar material facings. The side overhang should never exceed 100 mm and the maximum authorised vehicle width must never be exceeded.

Although it is not a statutory requirement, the practice of fitting marker boards at the front and rear of external frails is a good safety feature. These boards are detachable and are marked with diagonal red/white stripes.

The manufacture of the frails, particularly those used on the exterior of the van, should include suitably designed vertical glass securing poles with a choice of anchorage points along the frails length to accommodate varying pieces of plate glass. It is not sufficient to rely upon lashings as the only means of securing the glass to a rack whilst it is in transit.

7.14. Dangerous Goods

In contrast to the transport of other cargoes, there are European legal provisions for the transport of dangerous goods. The transport of dangerous goods by road is covered by the UNECE European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)³, as amended.

The European Directive 94/55/EC⁴ (the so-called "ADR framework directive") makes the provisions of the ADR uniformly applicable to national and international road transport within the European Union.

The ADR oversee specific provisions for securing of dangerous goods because there can be extra risks for safety and the environment during the transport of such goods.

The provisions for the securing of dangerous goods can be found in Part 7, – section 7.5.7 of the ADR – Handling and stowage. The relevant paragraphs read as follows:

7.5.7.1 The various components of a load comprising dangerous goods shall be properly stowed on the vehicle or in the container and secured by appropriate means to prevent them from being significantly displaced in relation to each other and to the walls of the vehicle or container. The load may be protected, for example, by the use of side wall fastening straps, sliding slat boards and adjustable brackets, air bags and anti-slide locking devices.

³ In French: *Accord Européen relatif au transport international de marchandises Dangereuses par Route*

⁴ Council Directive 94/55/EC of 21 November 1994 on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road *Official Journal L 319 , 12/12/1994 P. 0007 - 0013*

The load is also sufficiently protected within the meaning of the first sentence if each layer of the whole loading space is completely filled with packages.

7.5.7.2 The provisions of 7.5.7.1 also apply to the loading, stowage and unloading of containers on to and from vehicles.

7.15. Vehicle Equipment

It should be remembered that any accessories or equipment, either permanently or temporarily carried by the vehicle, are also considered to be load and as such their securing is the responsibility of the driver. The damage that an unsecured landing leg can do if it extends whilst the vehicle is in motion is enormous as some fatal experiences have shown.

WARNING: Any landing legs, loader cranes, tailgates etc. should be stowed and locked according to the manufacturer's instructions prior to moving the vehicle. Any vehicle on which such a piece of equipment cannot be locked should not be used until such time as repairs have been undertaken to rectify the fault. Loose chains on unladen skip vehicles should also be restrained so as not to present a hazard to other road users.

WARNING: Vehicles should never be driven, no matter how short a distance, with any equipment extended or in an unlocked position.

Loose equipment, such as webbing, ropes, sheeting etc., should also be carried in a manner so as not to endanger other road users. Good practice is to have a separate locker in which to safely store these items when not being used. If, however they are kept in the driver's cab, they must be stowed in such a manner that they cannot interfere with any of the drivers controls.

8. Annexes

8.1. Load distribution guidance

8.1.1. Objectives and conditions

A load distribution plan is the basis for placing load on the vehicle so that individual axles are neither under or over loaded. For a single vehicle, the load distribution plan will only need to be drawn once and will depend on its maximum total weight and the minimum/maximum axle loads. Recalculation of the load distribution plan will need to be carried out if any characteristics of the vehicle are changed, such as a body change for example. Any machinery mounted on the vehicle (vehicle mounted cranes, forklifts) and vertical loads from trailers also need to be considered in a load distribution plan.

Trucks that are equipped with a trailer coupling device must be treated according to their usual operating conditions. Vertical coupling loads may be considered as load (in cases where a trailer is not usually drawn) or as part of the vehicle weight (if the truck is usually used with a trailer).

Necessary data for calculating the load distribution plan:

- maximum total weight;
- maximum payload;
- unladen weight;
- front axle load of unladen vehicle;
- rear axle load of unladen vehicle;
- maximum permitted front axle load;
- maximum permitted rear axle load;
- minimum front axle load;
- minimum rear axle load (% of total weight);
- wheelbase;
- distance front axle to foremost point of the headboard;
- load platform length.

Most of this data may be taken from plates fitted to the vehicle, registration documents, type approval document or determined by measuring the vehicle. However, some of the information may only be available from the vehicle manufacturer (minimum front axle load for example).

8.1.2. Using the load distribution plan

Before the vehicle is loaded and a loading plan is developed, the weight/dimensions and the horizontal location of the centre of gravity for each piece of load carried must be determined.

A virtual loading plan may then be drawn.

The horizontal location of the whole load has to be calculated, for example by calculating a torque balance around the foremost point of the load panel (or any other point of reference if more convenient).

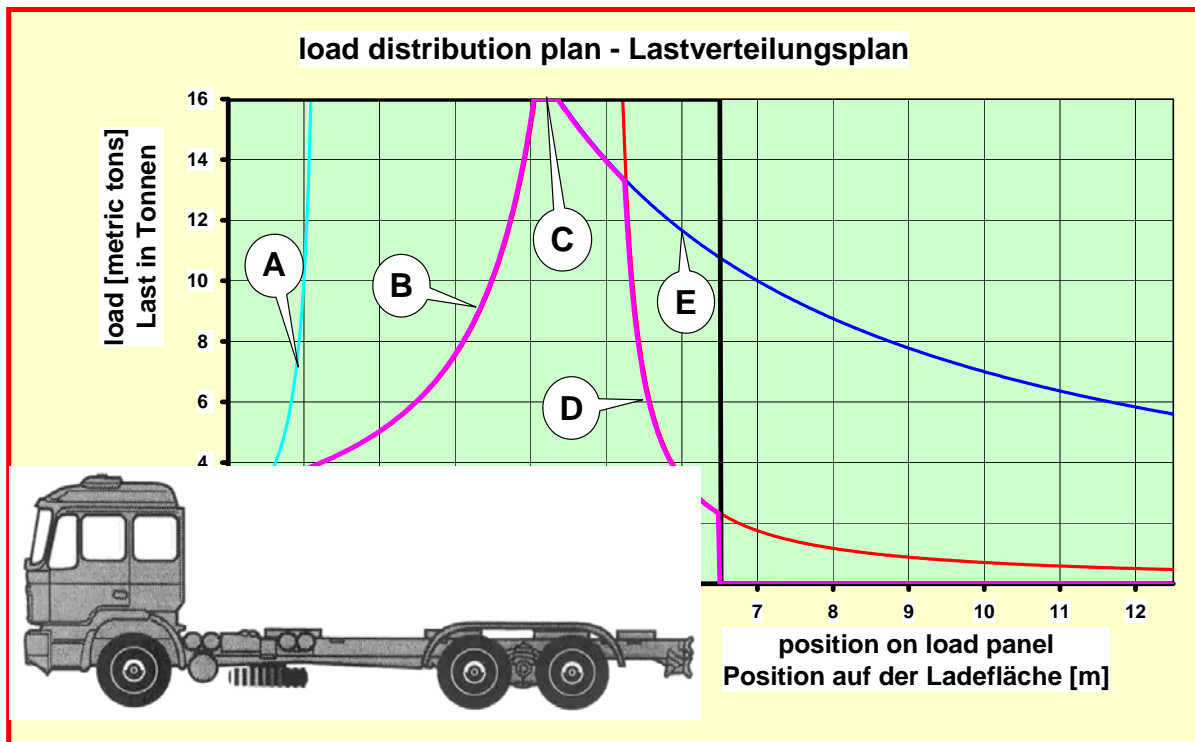
As described hereafter, the load distribution plan will determine whether the vehicle has sufficient capacity to carry the total weight of the load at the calculated centre of gravity.

Developing a load distribution plan.

To determine the maximum of cargo mass which may be loaded onto the vehicle taking into account the position of the centre of gravity for the entire load, the following items must be considered:

- The rear axle load must exceed a certain minimum, if required by the vehicle characteristics;
- The maximum load may be found for each point of the load panel by setting up a torque balance around the front axle regarding load mass, unladen and minimum rear axle load, distance from front axle to foremost point of load and wheelbase.
- Some Member States require that the driven axle load must represent a minimum of 15% - 25% of the total vehicle or road train weight. It is recommended that the driven axle load is a minimum of 25% of the total laden vehicle weight. (curve "A");
- The maximum front axle load must not be exceeded. Calculation is done by torque balance around rear wheel. (curve "B");
- The maximum payload must not be exceeded. Taken from vehicle data. (curve "C");
- The maximum rear axle load must not be exceeded. Calculation is done by torque balance around front wheel. (curve "D");
- The front axle load shall be at a recommended minimum (20% of total weight or another value recommended by manufacturer). Calculation is done by torque balance around front wheel. (curve "E").

The maximum authorised load is the minimum of all these results.

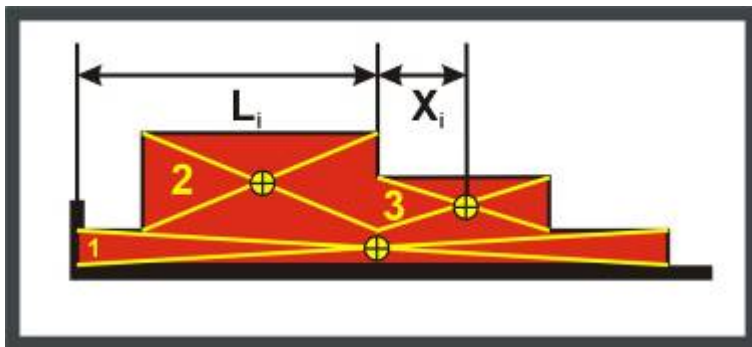


Please note that the truck in the graph is a schematic picture, the dimensions do not necessarily refer to the dimensions used in the calculation example here after. Although load panel length in the example is 6.5 m, the diagram is drawn up to a length of 12.5 m to show the curves as further information.

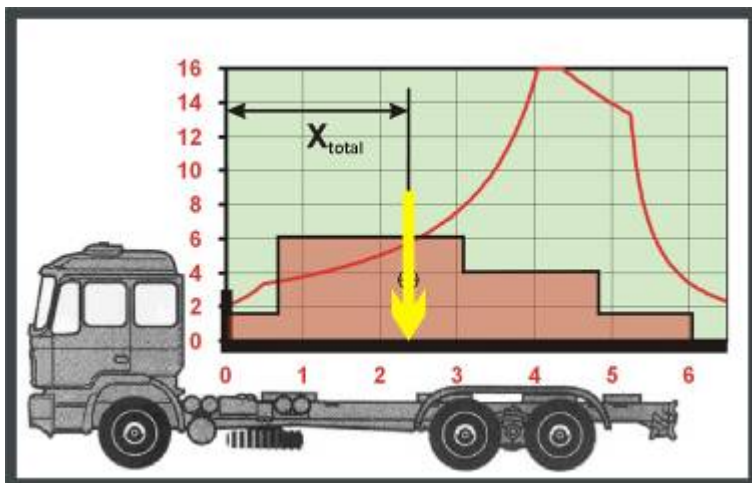
A detailed calculation guideline can be found in the German VDI guideline VDI2700 Part 4 ("Securing of loads on road vehicles, Cargo weight distribution").

Example:

A heavy cargo with a total mass of 10 t needs to be loaded on a truck with a total capacity of 16 t. The centre of gravity of the cargo is so far unknown and has to be calculated first. The mass and position of the three parts of the cargo, intended to be loaded on the truck, are known as well as the centre of gravity of all three parts.

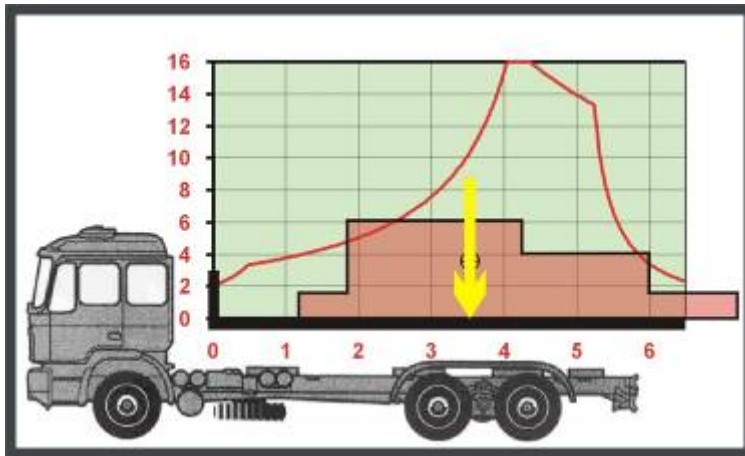


The distance from the headboard to the cargo's centre of gravity is shown as X_{total} and the yellow arrow represents the total mass of the cargo located at its centre of gravity. If the cargo is placed on the vehicle as shown, the graph of the load distribution plan shows that the vehicle is overloaded - although the mass of the load (10 t) is below the total capacity of the vehicle (16 t), the maximum front axle load is exceeded, since the yellow arrow crosses part B of the graph.

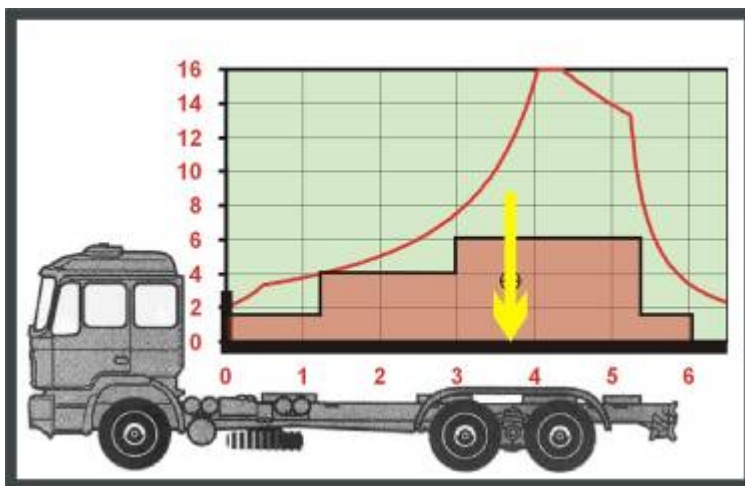


The cargo could be shifted to the rear of the vehicle, but two other problems will occur:

- The cargo overhangs the rear of the vehicle.
- The cargo can't be correctly secured because of the gap between the headboard and the load.



If the cargo is turned around 180° these problems disappear and the load distribution is correct.



8.2. Friction tables

The higher the friction coefficient, the better friction forces contribute to the securing. The IMO Guidelines is based static friction in the calculations for top-over lashing, and the standard EN12195-1 is based only on dynamic friction. The dynamic friction is considered as 70% of the static friction. The static and dynamic frictions between various materials are shown in the tables below.

The best option to determine the actual friction between vehicle and load is to measure it. The values in the following table may be considered as a rule of thumb if such measurement is not possible. These values will also be only applicable, if the load platform is in good condition, clean and dry.

8.2.1. Static friction table

MATERIAL COMBINATION IN THE CONTACT AREA	FRICTION COEFFICIENT μ_{Static}
SAWN TIMBER/WOODEN PALLET	
Sawn timber against plywood/plyfa/wood	0.5
Sawn timber against grooved aluminium	0.4
Sawn timber against steel	0.4
Sawn timber against shrink film	0.3
SHRINK FILM	
Shrink film against plyfa	0.3
Shrink film against grooved aluminium	0.3
Shrink film against steel	0.3
Shrink film against shrink film	0.3
CARDBOARD (untreated)	
Cardboard against cardboard	0.5
Cardboard against wooden pallet	0.5
BIG BAG	
Big bag against wooden pallet	0.4
STEEL AND SHEET METAL	
Flat steel against wooden bolt	0.5
Unpainted rough sheet metal against wooden bolt	0.5
Painted rough sheet metal against wooden bolt	0.5
Unpainted rough sheet metal against unpainted rough metal sheet	0.4
Painted rough metal sheet against painted rough metal sheet	0.3
Painted metal barrel against painted metal barrel	0.2

8.2.2.

Dynamic friction table

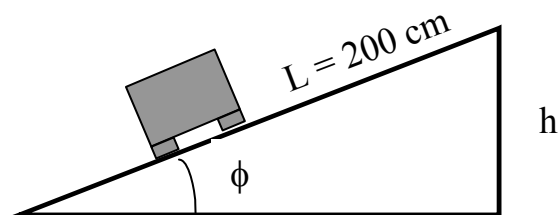
Dynamic friction factors of some usual goods μ_D

Combination of materials in the contact surface	Friction factor μ_D
Sawn wood	
Sawn wood against wood	0,35
Sawn wood against grooved aluminium	0,3
Sawn wood against steel sheets	0,3
Sawn wood against crimped foils	0,2
Crimped foils	
Crimped foils against fabric base laminate/plywood	0,3
Crimped foils against grooved aluminium	0,3
Crimped foils against steel sheets	0,3
Crimped foils against crimped foils	0,3
Cardboard boxes	
Cardboard box against cardboard box	0,35
Cardboard box against wood pallet	0,35
Large bags	
Large bags against wood pallet	0,3
Steel and metal sheets	
Oiled metal sheets against oiled metal sheets	0,1
Flat steel bars against sawn wood	0,35
Unpainted rough steel sheets against sawn wood	0,35
Painted rough steel sheets against sawn wood	0,35
Unpainted rough steel sheets against unpainted rough steel sheets	0,3
Painted rough steel sheets against painted rough steel sheets	0,2
Painted steel barrel against painted steel barrel	0,15
Concrete	
Wall on wall without intermediate layer (concrete/concrete)	0,5
Finished part with wooden intermediate layer on wood (concrete/wood/wood)	0,4

Combination of materials in the contact surface	Friction factor μ_0
Ceiling on ceiling without intermediate layer (concrete/lattice girder)	0,6
Steel frame with wooden intermediate layer (steel/wood)	0,4
Ceiling on steel frame with wooden intermediate layer (concrete/wood/steel)	0,45
Pallets	
Resin bonded plywood, smooth – Europallet (wood)	0,2
Resin bonded plywood, smooth – box pallet (steel)	0,25
Resin bonded plywood, smooth – plastic pallet (PP)	0,2
Resin bonded plywood, smooth – wooden pressboard pallets	0,15
Resin bonded plywood, sieve structure – Europallet (wood)	0,25
Resin bonded plywood, sieve structure – box pallet (steel)	0,25
Resin bonded plywood, sieve structure – plastic pallet (PP)	0,25
Resin bonded plywood, sieve structure – wooden pressboard pallets	0,2
Aluminium beams in the load-carrying platform (punched bars) – Europallet (wood)	0,25
Aluminium beams in the load-carrying platform (punched bars) – box pallet (steel)	0,35
Aluminium beams in the load-carrying platform (punched bars) – plastic pallet (PP)	0,25
Aluminium beams in the load-carrying platform (punched bars) – wooden pressboard pallets	0,2

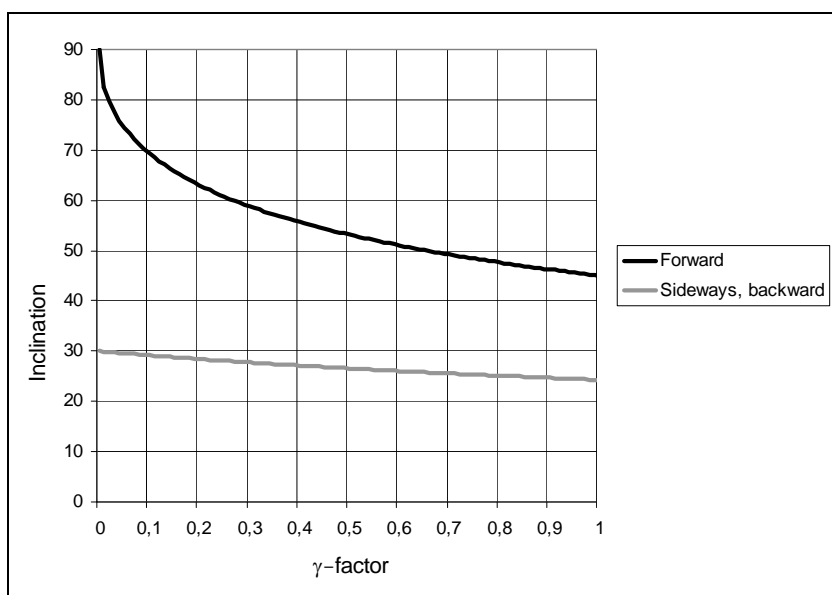
If the friction is unknown, a simple method to determine the value is to successively increase the inclination of the load platform until the object starts to slide.

Expressed in simple terms, the coefficient of friction states how easily a cargo unit will slide when the load platform is tilted. The friction is proportional to the weight of the goods. The figures below illustrate some of the more common connections between coefficient of friction and angle of inclination. A simple method to find which measure of friction applies is to incline a load platform with the cargo in question and measure the angle at which the cargo starts to slide. This gives the static rest friction.



when the friction coefficient μ is	the cargo starts to slide at an angle of ϕ °	equal to the heights h (cm) (if L = 200 cm)
0.2	11.3	39
0.3	16.7	57
0.4	21.8	74
0.5	26.6	89

If the friction is known it can in a similar way be checked if the cargo securing arrangement is sufficient. The load platform shall be tilted to a certain angle according to the diagram below. If the cargo stays in position, the securing arrangement is able to withstand the relevant acceleration.



γ -factor = base divided by height (B/H)

The γ -factor is the lowest value of the coefficient of friction (μ) and the ratio of breadth (B)

and height (H) and number of rows (n), $\frac{B}{n \times H}$, at accelerations sideways. At accelerations

forward or backward it is the lowest value of the ratio of length (L) and height (H), $\frac{L}{H}$, and the coefficient of friction (μ).

For securing arrangements not allowing sliding of the cargo the static coefficient of friction is used else the dynamic friction. If the dynamic friction is unknown it is to be taken as 70% of the static friction.

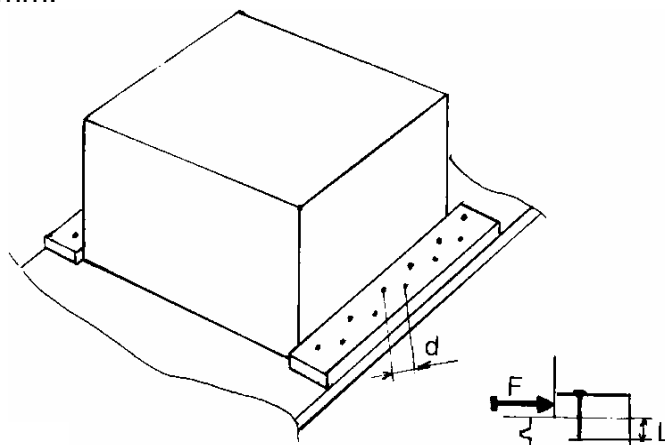


The efficiency of the securing arrangement of a heat exchanger is tested for accelerations forward and sideways.

8.3. Maximum closure force per nail and allowed charge for tag washers

8.3.1. Maximum closure force per nail

Maximum closure force per nail with a diameter of 5 mm (equal to a square nail that has the edge design of 0.85 x round nail diameter) is shown in the table on the next page. Minimum distance between the nails is 50 mm. Insertion length in the platform bed is at least 40 mm.



Blocking force table			
Round nail diameter (equivalent to square nail with edge design of 0.85 x round nail diameter)	ϕ mm	4	5
Minimum distance between nails	d, mm	50	50
Insertion length in platform bed	L, mm	32	40
Blocking force per nail	F, tonne	0.06	0.09

8.3.2. Allowed charge for tag washers

Tag washers for wood (mm)	ϕ 48	ϕ 62	ϕ 75	ϕ 95	30x57	48x65	130x130
Allowed charge daN/each	500	700	900	1.200	250	350	750

8.4. Lashing capacity of chains

The chain shall at least conform to EN818-2:1996 or, in multi-purpose lever hoists, to EN818-7, type T.

Only lashing chains of 6, 9 and 11 mm for timber transport (long timber or round timber) may have a greater maximum pitch of $6x d_n$.

The connecting components shall conform to EN1677-1, Components for slings, grade 8.

Connecting and shortening components shall have a securing device against coming undone.

On tensioning devices operated by hand, the recoil travel of the end of the tensioning device shall not exceed 150 mm; which means that lever-type tensioners are not to be used.

Unintended releasing of tensioning devices when under tension may not occur.

Turnbuckles and short loadbinders shall have a securing device against coming undone. Tensioning devices with hook-shaped ends shall have a securing device against unintended loosening;

Lashing capacity of chains, EN12195-3:

Complete lashing chain with chain of nominal size in mm or Code N° of components	Lashing capacity (LC) daN
6	2.200
7	3.000
8	4.000
9	5.000
10	6.300
11	7.500
13	10.000
16	16.000
18	20.000
20	25.000
22	30.000

8.5. *Lashing capacity (LC) of wire ropes*

The minimum breaking force of the new, unfinished steel wire rope or flat steel wire rope shall at least be 3 times LC, so that because of wear and tear the used lashing withstands the forces during service. The metal parts will withstand, like web-lashing and lashing chains, twice the lashing capacity.

The stranded rope shall be of 6-strand ordinary lay with fibre or steel core with a minimum of 114 wires or of 8-strand ordinary lay with steel core with a minimum of 152 wires, as given in EN12385-4. Only stranded steel wire ropes of the grade 1770 shall be used, the minimum diameter should be 8 mm.

There shall be no sharp edges, which may come into contact with the lashing steel wire ropes and flat lashing steel wire ropes and the operator's hands.

The recoil travel of the end of the handle of the tensioning device (for winches the crank) under tension shall not exceed 150 mm when the tensioning device is opened. Winches, turn buckles and short load binders shall be designed such, that there are no crushing or shearing points which might lead to the hands of the operator being injured during intended use.

A residual tension of at least 0,25 LC shall be generated in the lashing steel wire rope or flat lashing steel wire rope at a maximum force of 50 daN applied to the handle of the winch or the tensioning device.

The winch or tensioning element shall be designed such, that it can be released at a force of less than 50 daN.

The lashing capacity of the connecting components shall be at least equivalent to that of the lashing steel wire rope.

Ferrule secured eyes shall conform to prEN13411-3. Spliced eyes shall conform to EN13411-2. The minimum length of plain rope between the tails of splices shall be 15 times the nominal rope diameter.

The length of a soft eye shall be approximately 15 times the rope diameter. The width of the eye shall be approximately half of its length.

Thimbles shall conform to EN13411-1.

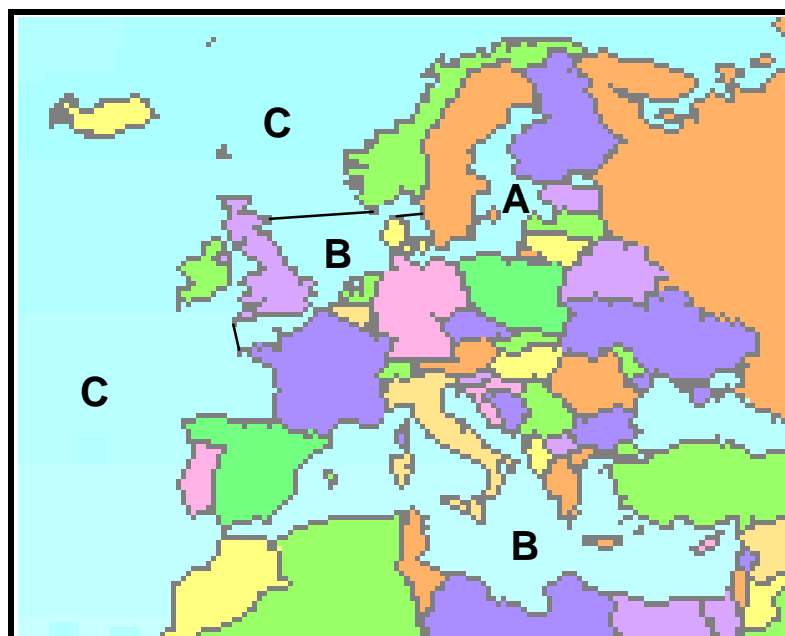
Rope size mm	Lashing capacity LC daN
8	1.120
10	1.750
12	2.500
14	3.500
16	4.500
18	5.650
20	7.000
22	8.500
24	10.000
26	12.000
28	14.000
32	18.000
36	23.000
40	28.000

Lashing capacity for lashing steel wire ropes
of 6 × 19 and 6 × 36 construction
with fibre core, termination with ferrules

8.6. QUICK LASHING GUIDE based on the IMO/ILO/UNECE method

8.6.1. QUICK LASHING GUIDE

Cargo Securing on CTU:s for Transportation on Road and in Sea Area A



Accelerations to be expected
expressed in parts of the gravity acceleration ($1g = 9.81 \text{ m/s}^2$)

Transport mode/ Sea area	Sideways		Forward		Backward	
	S	V	F	V	B	V
Road	0.5	1.0	1.0	1.0	0.5	1.0
A (Baltic Sea)	0.5	1.0	0.3	1 ± 0.5	0.3	1 ± 0.5

V = Vertical acceleration in combination with longitudinal or transverse acceleration

Goods; not rigid in form

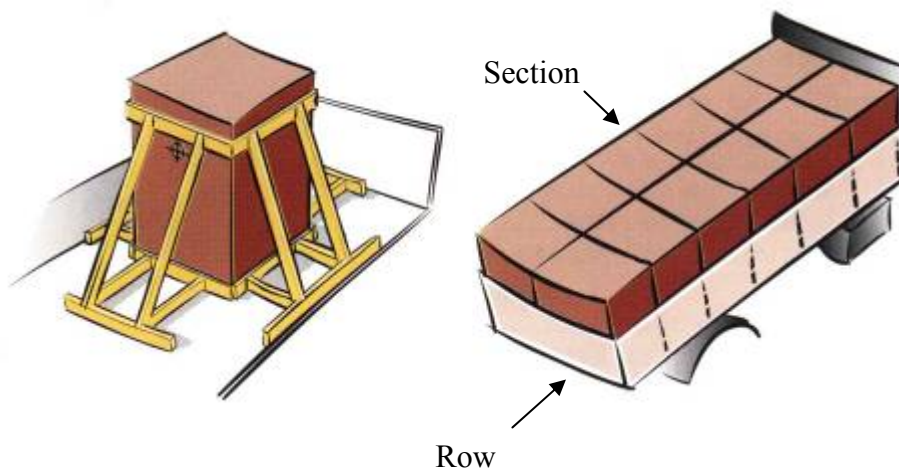
If the goods aren't rigid in form, more lashings than stipulated in this quick lashing guide could be required.

- All dimensions referred to as ton are equal to metric ton of 1000 kg.
- Sideways, forward and backward refers to a fore-and-aft stowed CTU.

BLOCKING

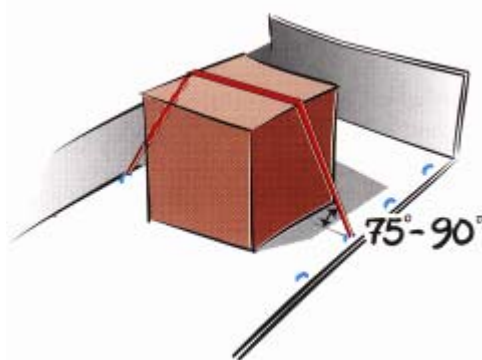
Blocking means that the cargo is stowed against fixed blocking structures and fixtures on the CTU. Clumps, wedges, dunnage, dunnage bags and other devices which are supported directly or indirectly by fixed blocking structures are also blocking.

Blocking is first of all a method to prevent the cargo from sliding, but if the blocking reaches up to or above the cargo's centre of gravity it also prevents tipping. Blocking should be used as far as possible.



LASHING METHODS

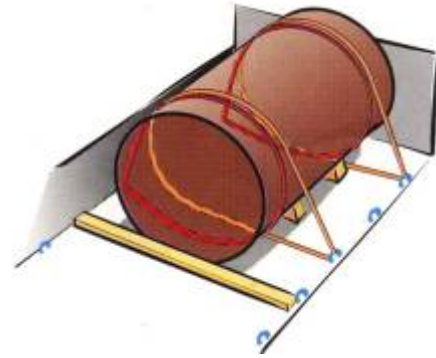
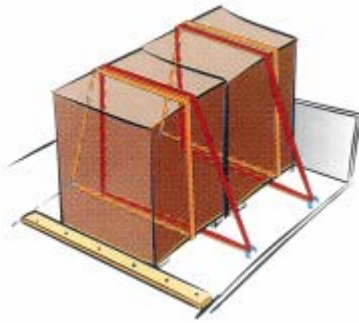
Top-over lashing



When using the tables for top-over lashing the angle between the lashing and the platform bed is of great importance. The tables are valid for an angle between 75° - 90° . If the angle is between 30° - 75° twice the number of lashings are needed. If the angle is smaller than 30° another cargo securing method should be used.

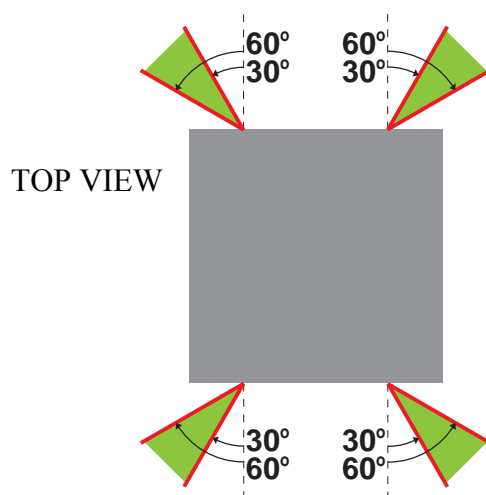
Loop lashing

A pair of loop lashings prevents the cargo from sliding and tipping sideways. Minimum one pair of loop lashings per section should be used.



When long cargo units are secured with loop lashings at least two pairs should be used to prevent the cargo from twisting.

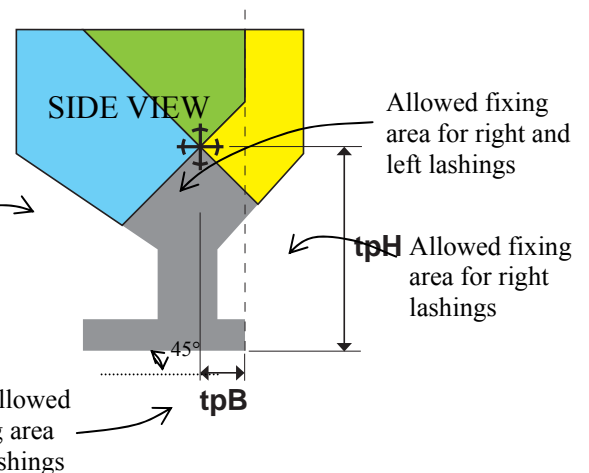
Straight/cross lashing



The tables are valid for an angle of 30 - 60° between the lashing and the platform bed. Sideways/lengthways the lashing angle should also be between 30 - 60°. If the cargo unit is blocked forward and backward, and the lashings are placed with an angle of 90° towards the longitudinal axle, the cargo weight in the tables may be doubled.

The allowable areas for fixing the lashings on the cargo unit is bounded by straight lines (one for each side), drawn through the centre of gravity in an angle of 45°.

Allowed fixing area for left lashings



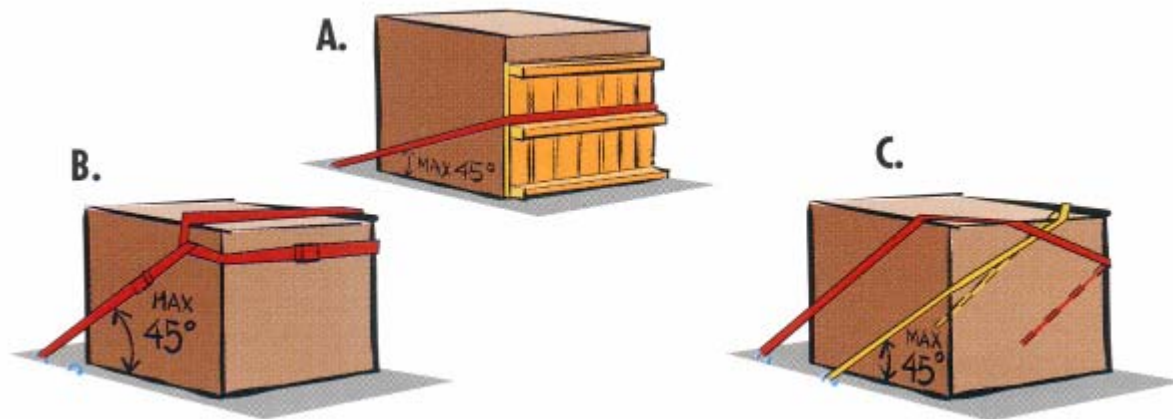
When the lashings are fixed above the centre of gravity, the unit may also have to be blocked in the bottom to prevent sliding.

Spring lashing

A spring lashing is mainly used to prevent cargo from sliding and tipping forward or backward.

The angle between the lashing and the platform bed should be maximum 45°.

There are a number of ways to apply a spring lashing. If the spring lashing doesn't act at the top of the cargo the weights in the tables for cargo weights prevented from tipping is decreased. Ex: if the spring lashing acts at half the height of the cargo it secures half the values in the table only.

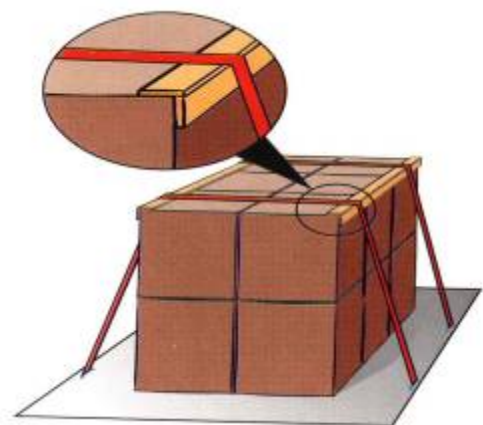


Note.

- Alternative A is not fully effective for avoiding tipping.
- Alternative C have two parts and secures twice the values in the tables.

SUPPORTING EDGE BEAM

In some cases less lashings are needed than the number of sections that are to be secured. Since each unit has to be secured, the effect of the lashings can in these cases be spread out with supporting edge beams. The edge beams can be manufactured profiles or be home made of deals (minimum 25×100 mm) nailed together. At least one lashing should be applied per each end section and per every second section.



FRICITION

Different material contacts have different coefficients of friction. The table below shows recommended values for the coefficient of friction. The values are valid provided that both contact surfaces are **dry, clean and free from frost, ice and snow**. The values are valid for the static friction.

If the cargo starts to slide the friction is changed from static to sliding friction. Sliding friction is lower than the static friction. When using a cargo securing method permitting the cargo to move a little the friction to be used should be 70% of the static friction. This effect is included in the tables for loop, spring and straight/cross lashings.

MATERIAL COMBINATION IN THE CONTACT AREA	COEFFICIENT OF FRICTION μ-static
SAWN TIMBER/WOODEN PALLET	
Sawn timber against plywood/plyfa/wood	0.5
Sawn timber against grooved aluminium	0.4
Sawn timber against steel metal	0.4
Sawn timber against shrink film	0.3
SHRINK FILM	
Shrink film against plyfa	0.3
Shrink film against grooved aluminium	0.3
Shrink film against steel metal	0.3
Shrink film against shrink film	0.3
CARDBOARD (UNTREATED)	
Cardboard against cardboard	0.5
Cardboard against wooden pallet	0.5
BIG BAG	
Big bag against wooden pallet	0.4
STEEL AND SHEET METAL	
Flat steel against sawn timber	0.5
Unpainted rough sheet metal against sawn timber	0.5
Painted rough sheet metal against sawn timber	0.5
Unpainted rough sheet metal against unpainted rough sheet metal	0.4
Painted rough sheet metal against painted rough sheet metal	0.3
Painted metal barrel against painted metal barrel	0.2

When a combination of contact surfaces is missing in the table above or if it's coefficient of friction can't be verified in another way, the maximum allowed μ -static

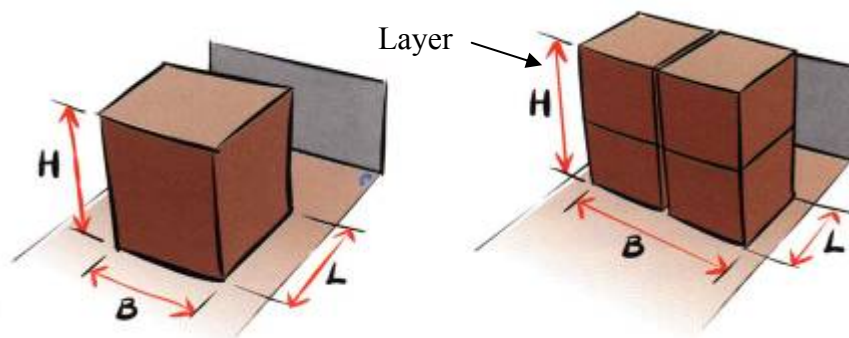
to be used is 0.3^{1*}. μ -static used on open CTU:s to be maximum 0.3 as the surfaces can be wet during the sea transport.

^{1*} See also CSS annex 13 § 7.2.1 and valid road regulations

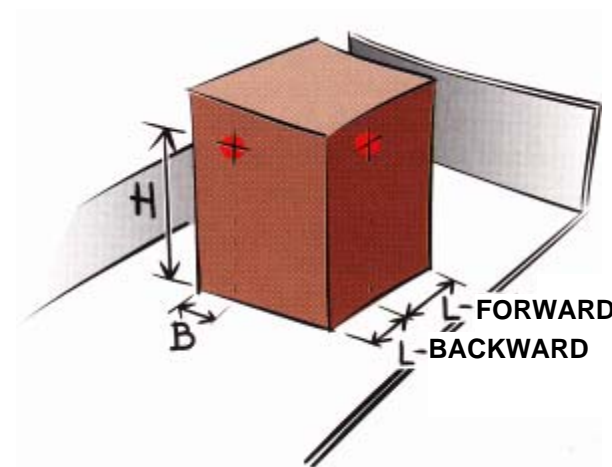
LASHING EYES

The lashing eyes should have at least the same strength in MSL as the lashings. For loop lashings the lashing eyes should at least have the strength of $1.4 \times \text{MSL}$ of the lashings if both ends of the lashings are fixed to the same eye.

TIPPING



Definition of H , B and L which are to be used in the tables for tipping for cargo units with the centre of gravity close to its geometrical centre.



Definition of H , B and L which are to be used in the tables for tipping for cargo units with the centre of gravity away from its geometrical centre.

REQUIRED NUMBER OF LASHINGS

The required number of lashings to prevent sliding and tipping is calculated by the help of the tables on page 7 – 11 according to the following procedure:

1. Calculate the required number of lashings to prevent sliding
2. Calculate the required number of lashings to prevent tipping
3. The largest number of the above is selected

Even if there is neither sliding nor tipping risk, it is recommended to always use at least one top-over lashing per every 4 ton of cargo to avoid wandering for non blocked cargo.

WEBBING



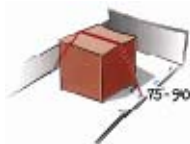
The tables are valid for **webbing** with a pre tension of minimum 4000 N (400 kg).

The values in the tables are proportional to the lashings' pre tension.

The weights in the tables are valid for one top-over lashing.

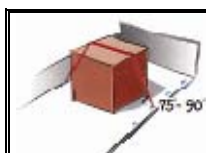
TOP-OVER LASHING

TOP-OVER LASHING SLIDING



Cargo weight in ton prevented from sliding

μ	SIDEWAYS	FORWARD	BACKWARD
0.0	0	0	0
0.1	0.2	0.1	0.2
0.2	0.5	0.2	0.5
0.3	1.2	0.3	1.2
0.4	3.2	0.5	3.2
0.5	No sliding	0.8	No sliding
0.6	No sliding	1.2	No sliding
0.7	No sliding	1.8	No sliding



TOP-OVER LASHING - TIPPING

Cargo weight in ton prevented from tipping

SIDEWAYS							FORWARD	BACKWARD
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section	per section
0.6	No tipping	No tipping	No tipping	6.8	3.1	0.6	No tipping	No tipping
0.8	No tipping	No tipping	5.9	2.2	1.5	0.8	No tipping	No tipping
1.0	No tipping	No tipping	2.3	1.3	1.0	1.0	No tipping	No tipping
1.2	No tipping	4.9	1.4	0.9	0.7	1.2	4.0	No tipping
1.4	No tipping	2.4	1.0	0.7	0.6	1.4	2.0	No tipping
1.6	No tipping	1.6	0.8	0.6	0.5	1.6	1.3	No tipping
1.8	No tipping	1.2	0.6	0.5	0.4	1.8	1.0	No tipping
2.0	No tipping	0.9	0.5	0.4	0.3	2.0	0.8	No tipping
2.2	7.9	0.8	0.5	0.4	0.3	2.2	0.7	8.0
2.4	4.0	0.7	0.4	0.3	0.3	2.4	0.6	4.0
2.6	2.6	0.6	0.4	0.3	0.2	2.6	0.5	2.7
2.8	2.0	0.5	0.3	0.2	0.2	2.8	0.4	2.0
3.0	1.6	0.4	0.3	0.2	0.2	3.0	0.4	1.6

A top-over lashing preventing tipping forward and backward has to be placed centred on the cargo.

WEBBING

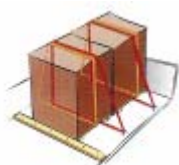


The tables are valid for **webbing** with a MSL of 13 kN (1.3 ton) and a pre tension of minimum 4000 N (400 kg).

The weights in the tables below are valid for one pair of loop lashings.

LOOP LASHING

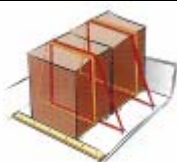
LOOP LASHING SLIDING



Cargo weight in ton prevented from sliding

μ	SIDEWAYS
0.0	2.6
0.1	3.3
0.2	4.2
0.3	5.5
0.4	7.7
0.5	No sliding

The values in the table are proportional to the lashings' maximum securing load (MSL).



LOOP LASHING - TIPPING

Cargo weight in ton prevented from tipping

SIDEWAYS

H/B	1 row	2 rows	3 rows	4 rows	5 rows
0.6	No tipping	No tipping	No tipping	13,4	6.6
0.8	No tipping	No tipping	10,2	4.4	3.3
1.0	No tipping	No tipping	4.1	2.6	2.2
1.2	No tipping	7.1	2.5	1.9	1.6
1.4	No tipping	3.5	1.8	1.4	1.3
1.6	No tipping	2.3	1.4	1.2	1.1
1.8	No tipping	1.7	1.2	1.0	0.9
2.0	No tipping	1.4	1.0	0.8	0.8
2.2	8,0	1.1	0.8	0.7	0.7
2.4	4.0	1.0	0.7	0.7	0.6
2.6	2.6	0.8	0.7	0.6	0.6
2.8	2.0	0.7	0.6	0.5	0.5
3.0	1.6	0.7	0.5	0.5	0.5

The values in the table are proportional to the lashings' pre tension.

WEBBING

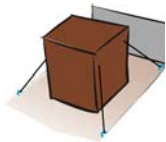


The tables are valid for **webbing** with a MSL of 13 kN (1.3 ton) and a pre tension of minimum 4000 N (400 kg). The values in the tables are proportional to the lashings' maximum securing load (MSL).

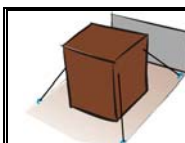
All weights are valid for one straight/cross lashing.

STRAIGHT/CROSS LASHING

STRAIGHT/ CROSS LASHING SLIDING



Cargo weight in ton prevented from sliding			
μ	SIDEWAYS per side	FORWARD	BACKWARD
0.0	0.6	0.3	0.6
0.1	0.9	0.4	0.9
0.2	1.3	0.5	1.3
0.3	1.9	0.7	1.9
0.4	2.9	0.9	2.9
0.5	No sliding	1.1	No sliding or 4,9
0.6	No sliding	1.4	No sliding



STRAIGHT/CROSS LASHING - TIPPING

Cargo weight in ton prevented from tipping

H/B	SIDEWAYS per side	H/L	FORWARD	BACKWARD
0.6	No tipping	0.6	No tipping	No tipping
0.8	No tipping	0.8	No tipping	No tipping
1.0	No tipping	1.0	No tipping	No tipping
1.2	No tipping	1.2	3.6	No tipping
1.4	No tipping	1.4	2.0	No tipping
1.6	No tipping	1.6	1.4	No tipping
1.8	No tipping	1.8	1.1	23
2.0	No tipping	2.0	1.0	10
2.2	10	2.2	0.8	6.6
2.4	5.6	2.4	0.8	5.1
2.6	4.0	2.6	0.7	4.0
2.8	3.1	2.8	0.7	3.1
3.0	2.6	3.0	0.6	2.6

WEBBING



The tables are valid for **webbing** with a MSL of 13 kN (1.3 ton) and a pre tension of minimum 4000 N (400 kg). The values in the tables are proportional to the lashings' maximum securing load (MSL).

The weights in the tables are valid for one spring lashing.

SPRING LASHING

SPRING LASHING SLIDING



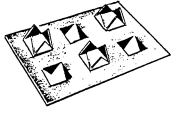
Cargo weight in ton prevented from sliding		
μ	FORWARD	BACKWARD
0.0	1.8	3.7
0.1	2.1	4.6
0.2	2.4	5.9
0.3	2.8	7.8
0.4	3.3	10,9
0.5	3.9	No sliding
0.6	4.6	No sliding
0.7	5.5	No sliding



SPRING LASHING - TIPPING Cargo weight in ton prevented from tipping

H/L	FORWARD	H/L	BACKWARD
0.6	No tipping	0.6	No tipping
0.8	No tipping	0.8	No tipping
1.0	No tipping	1.0	No tipping
1.2	22,6	1.2	No tipping
1.4	13,1	1.4	No tipping
1.6	10,0	1.6	No tipping
1.8	8.4	1.8	No tipping
2.0	7.5	2.0	No tipping
2.2	6.9	2.2	82,9
2.4	6.4	2.4	45,2
2.6	6.1	2.6	32,6
2.8	5.8	2.8	26,3
3.0	5.6	3.0	22,6

TABLES TO BE USED IN COMBINATION WITH TABLE FOR TOP-OVER LASHING

<div>  TAG WASHER Approx. cargo weight in ton prevented from sliding by one tag washer in combination with top-over lashing only </div>							
Friction ^{**}	SIDEWAYS/BACKWARD						
	Ø 48	Ø 62	Ø 75	Ø 95	30×57	48×65	130×130
Open CTU – Road ($\mu = 0.2$)	0.40	0.55	0.75	1.0	0.40	0.55	1.2
Open CTU – Sea ($\mu = 0.3$)	0.60	0.85	1.1	1.5	0.60	0.85	1.8
Covered CTU ($\mu = 0.4$)	1.2	1.7	2.2	3.0	1.2	1.7	3.7
	FORWARD						
	Ø 48	Ø 62	Ø 75	Ø 95	30×57	48×65	130×130
Open CTU – Road ($\mu = 0.2$)	0.10	0.20	0.25	0.35	0.10	0.20	0.45
Open CTU – Sea ($\mu = 0.3$)	0.15	0.25	0.30	0.40	0.15	0.25	0.50
Covered CTU ($\mu = 0.4$)	0.20	0.30	0.35	0.50	0.20	0.30	0.60

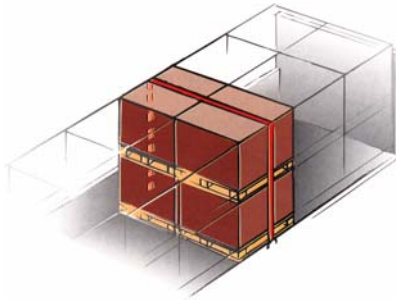
^{**} Between tag washer and platform bed/cargo. For tag washers in shrink film the rows for friction 0.3 to be used.

4" - NAIL Approximate cargo weight in ton prevented from sliding by one nail in combination with top-over lashing only						
Friction ^{***}	SIDEWAYS		FORWARD		BACKWARD	
	per side, 4"- nail blank	galvanised	4"- nail blank	galvanised	4"- nail blank	galvanised
Open CTU – Road, $\mu = 0.2$	0.35	0.50	0.10	0.20	0.35	0.50
Open CTU – Sea, $\mu = 0.3$	0.55	0.80	0.15	0.20	0.55	0.80
Covered CTU, $\mu = 0.4$	1.1	1.6	0.15	0.25	1.1	1.6
Covered CTU, $\mu = 0.5$	No slid.	No sliding	0.20	0.30	2.3	3.2
Covered CTU, $\mu = 0.6$	No slid.	No sliding	0.25	0.40	No slid.	No sliding
Covered CTU, $\mu = 0.7$	No slid.	No sliding	0.35	0.50	No slid.	No sliding

^{***} Between cargo and platform bed.

Methods to be used when calculating the number of required top-over lashings for cargo stowed in more than one layer

Method 1 (simple)



1. Determine the number of lashings to prevent sliding using the weight of the entire section and the lowest friction of any of the layers.
2. Determine the number of lashings to prevent tipping.
3. The largest number of lashings in step 1 and 2 are to be used.

Method 2 (advanced)

1. Determine the number of lashings to prevent sliding using the weight of the entire section and the friction for the bottom layer.
2. Determine the number of lashings to prevent sliding using the weight of the section's upper layer and the friction between the layers.
3. Determine the number of lashings for the entire section which is required to prevent tipping.
4. The largest number of lashings in step 1 to 3 are to be used.

8.6.2 Example how to use the IMO Quick Lashing Guide for Road/Sea Area A

To know exactly how much a lashing can bear and secure often requires a number of rather complex calculations. To make that work simpler these calculations are done and presented in tables in the IMO Quick Lashing Guides.

The normal procedure is to start with top-over lashings. To calculate the number of lashings required to prevent sliding and/or tipping, the following steps are made:

1. Find out the actual coefficient of friction
2. Calculate the required number of lashings to prevent sliding sideways, forward and backwards.
3. Calculate H/B, Number of rows and H/L
4. Calculate the required number of lashings to prevent tipping sideways, forward and backwards.
5. The largest number of top-over lashings above is selected

If the number of top-over lashings becomes unpractical some other securing method should be considered in combination or as a substitute to the top-over lashing like:

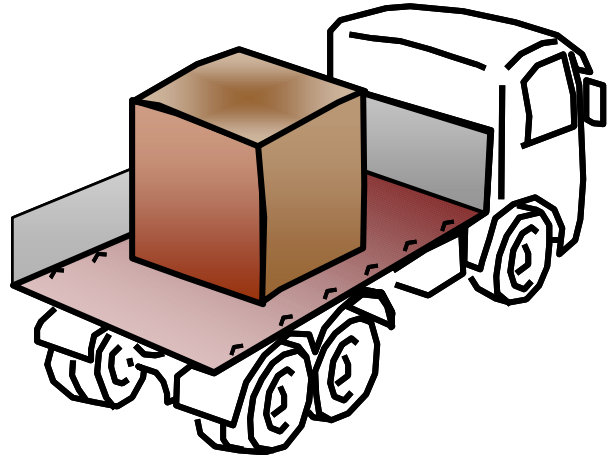
- Blocking if it is possible to arrange. At least forward bottom blocking normally reduces the number of lashings considerable.
- Loop lashing is an alternative lashing method in sideways direction.
- Spring lashing is an alternative lashing method lengthways.

Note – Even if there is neither sliding nor tipping risk, it is recommended to always use at least one top-over lashing per every 4 ton of cargo to avoid wandering for non blocked cargo!

Example 1 – Single Wooden Box

Top-over lashings are to be used to secure a wooden box with dimensions - height 2.4 m, breadth 2 m and length 1.8 m. The wooden box weighs 2.1 tons and it is placed on a wooden platform as shown in the picture. It is not blocked in any direction and the centre of gravity is at the box's midpoint.

The number of top-over lashings is estimated by use of the IMO Quick Lashing Guide for Road/Sea Area A.



First the number of lashings to prevent **sliding** must be calculated:

Step 1.

According to the table the coefficient of friction (μ) for a wooden box on a wooden platform is $\mu=0.5$.

MATERIAL COMBINATION IN THE CONTACT AREA	COEFFICIENT OF FRICTION μ -static
SAWN TIMBER/WOODEN PALLET	
Sawn timber against plywood/ply/la/wood	0.5
Sawn timber against grooved aluminium	0.4
Sawn timber against steel metal	0.4
Sawn timber against shrink film	0.3

Step 2.

In the Table for Sliding you can see that when the friction is $\mu=0.5$ there is no risk that the box will start sliding sideways. The figure for forward is that one single lashing prevents 0.8 tons (800 kilos) to slide. Similar for backwards is 8.0 tons.

The box weighs 2.1 tons which gives the following required number of lashings:

Forward sliding

$$2.1/0.8 = 2.63 \rightarrow 3 \text{ lashings}$$

Backwards sliding

$$2.1/8.0 = 0.26 \rightarrow 1 \text{ lashing}$$

TOP-OVER LASHING SLIDING



Cargo weight in ton prevented from sliding			
μ	SIDEWAYS	FORWARD	BACKWARD
0.0	0	0	0
0.1	0.2	0.1	0.2
0.2	0.5	0.2	0.5
0.3	1.2	0.3	1.2
0.4	2.2	0.5	2.2
0.5	No sliding	0.8	8.0
0.6	No sliding	1.2	No sliding
0.7	No sliding	1.8	No sliding

Now the number of lashings to prevent **tipping** has to be calculated:

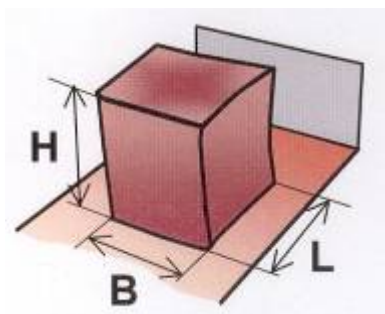
Step 3.

With the height $H=2.4$ m, breadth $B=2$ m and length $L=1.8$ m gives:

$$H/B = 2.4/2 = 1.2$$

$$H/L = 2.4/1.8 = 1.33 \cup 1.4$$

Number of rows: 1



Step 4.

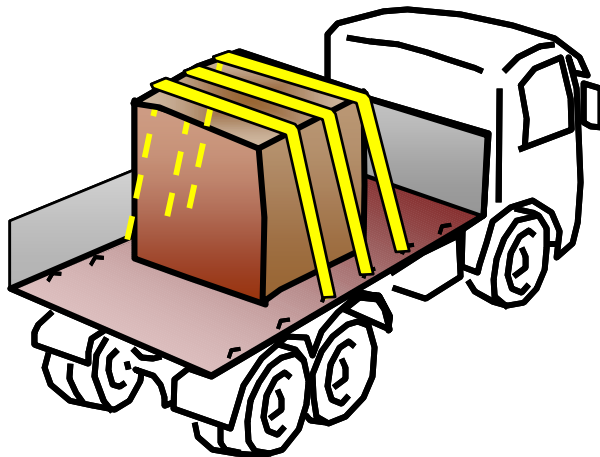
In the table for tipping you can then find that for $H/B = 1.2$ there is no risk of tipping sideways for one row of cargo, for $H/L = 1.4$ there is equally no risk of tipping backwards, while on the other hand there is a risk of tipping forwards and that each lashing secures 4 tons of cargo.

The box weighs 2.1 tons which gives:

Forward tipping

$$2.1 / 2.0 = 1.05 \rightarrow 2 \text{ lashings}$$

TOP-OVER LASHING - TIPPING									
Cargo weight in ton prevented from tipping									
SIDEWAYS						FORWARD		BACKWARD	
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section	per section	
0.6	No tipping	No tipping	No tipping	6.8	3.1	0.6	No tipping	No tipping	
0.8	No tipping	No tipping	5.9	2.2	1.5	0.8	No tipping	No tipping	
1.0	No tipping	No tipping	2.3	1.3	1.0	1.0	No tipping	No tipping	
1.2	No tipping	4.9	1.4	0.9	0.7	1.2	1.0	No tipping	
1.4	No tipping	2.4	1.0	0.7	0.6	1.4	2.0	No tipping	

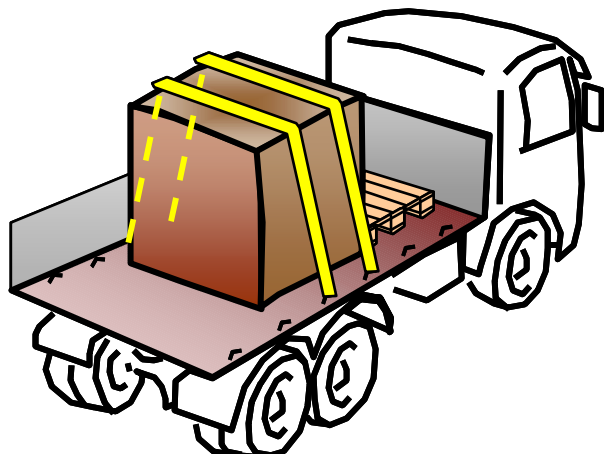


Step 5.

The number of lashings required to prevent forward sliding is the largest number of lashings calculated in steps 1 to 4.

Therefore three top-over lashings are required to secure the box in the example above.

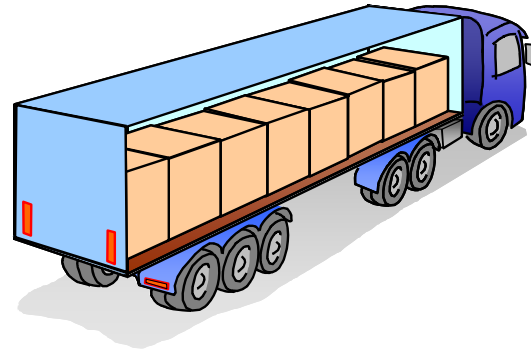
If, on the other hand, the box was forward blocked⁵ with a pallet for example, there is no risk of forward sliding any more, and two single lashing would be required to prevent forward tipping or backward sliding.



⁵ Strength of the blocking device – see Appendix A

Example 2 – Full load of Wooden Boxes

Eight wooden boxes are loaded on a semi-trailer with a platform of grooved aluminum. Each wooden box has the dimension - height 2.0 m, breadth 2.0 m, length 1.6 m and weight 3 050 kg. The boxes are stowed in one row flush to each other and forward blocked against the headboard¹ as shown in the picture.



The required number of top-over lashings is estimated by use of the IMO Quick Lashing Guide for Road/Sea Area A.

First the number of lashings to prevent **sliding** must be calculated:

Step 1.

According to the table the coefficient of friction (μ) for a wooden box on a grooved aluminum platform is $\mu=0.4$.

MATERIAL COMBINATION IN THE CONTACT AREA	COEFFICIENT OF FRICTION μ -static
SAWN TIMBER/WOODEN PALLET	
Sawn timber against ply wood/ply tar wood	0.4
Sawn timber against grooved aluminium	0.4
Sawn timber against steel metal	0.4
Sawn timber against shrink film	0.3

Step 2.

In the Table for Sliding you can see that when the friction is $\mu=0.4$ one single lashing prevents 3.2 tons of cargo from sliding sideways and backwards. Similar for forward is 0.5 tons but in this case the wooden boxes are blocked in forward direction and thus no lashings are needed to prevent forward sliding¹.

Each wooden box weighs 3.05 tons which gives the following required number of lashings:

Sideways sliding

$$3.05/3.2 = 0.95 \rightarrow 1 \text{ lashing}$$

Backwards sliding

$$3.05/3.2 = 0.95 \rightarrow 1 \text{ lashing}$$

TOP-OVER LASHING SLIDING



Cargo weight in ton prevented from sliding			
μ	SIDEWAYS	FORWARD	BACKWARD
0.0	0	0	0
0.1	0.2	0.1	0.2
0.2	0.5	0.2	0.5
0.3	1.2	0.3	1.2
0.4	3.2	0.5	3.2
0.5	No sliding	0.8	8.0
0.6	No sliding	1.2	No sliding
0.7	No sliding	1.8	No sliding

¹ Strength of the blocking device – see Appendix A

Now the number of lashings to prevent **tipping** has to be calculated:

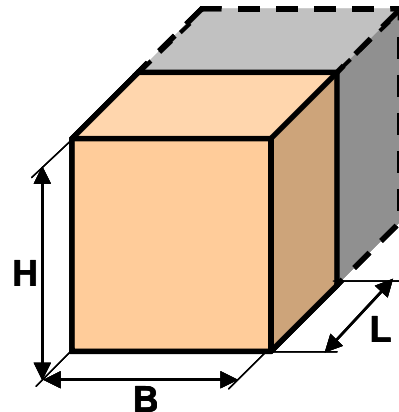
Step 3.

The height $H=2.0$ m, breadth $B=2.0$ m and length $L=1.6$ m gives:

$$H/B = 2.0/2.0 = 1.0$$

$$H/L = 2.0/1.6 = 1.25 \cup 1.4$$

Number of rows: 1



Step 4.

In the table for tipping you can then find that for $H/B = 1.0$ there is no risk of tipping sideways for one row of cargo. With $H/L = 1.4$ there is also no risk of tipping backwards, while on the other hand there is a risk of tipping forwards and each lashing secures 2 tons of cargo according to the table. But once again the wooden boxes are forward blocked and no lashing to prevent forward tipping is required¹.

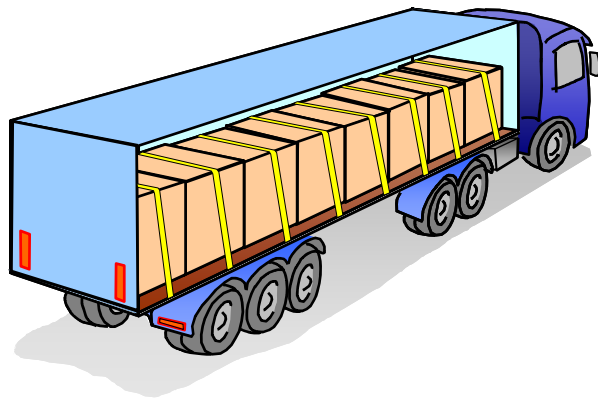
Consequently, there is no need of any lashing to prevent tipping.

TOP-OVER LASHING - TIPPING									
Cargo weight in ton prevented from tipping									
SIDEWAYS						FORWARD		BACKWARD	
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section	per section	
0.6	No tipping	No tipping	No tipping	6.8	3.1	0.6	No tipping	No tipping	
0.8	No tipping	No tipping	5.9	2.2	1.5	0.8	No tipping	No tipping	
1.0	No tipping	tipping	2.3	1.3	1.0	1.0	No tipping	No tipping	
1.2	No tipping	4.9	1.4	0.9	0.7	1.2	4.0	No tipping	
1.4	No tipping	2.4	1.0	0.7	0.6	1.4	2.0	No tipping	

Step 5.

The number of lashings required to prevent sideways (and backwards) sliding is the largest number of lashings calculated in steps 1 to 4.

Therefore one top-over lashing per cargo section is required to secure the wooden boxes in the example above, i.e. 8 lashings in total.



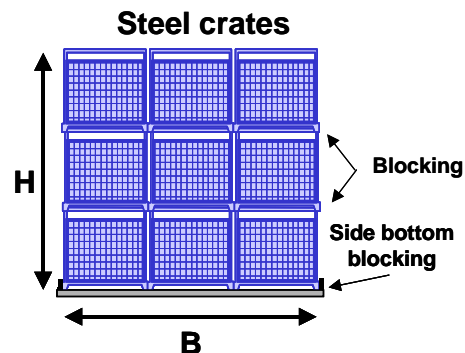
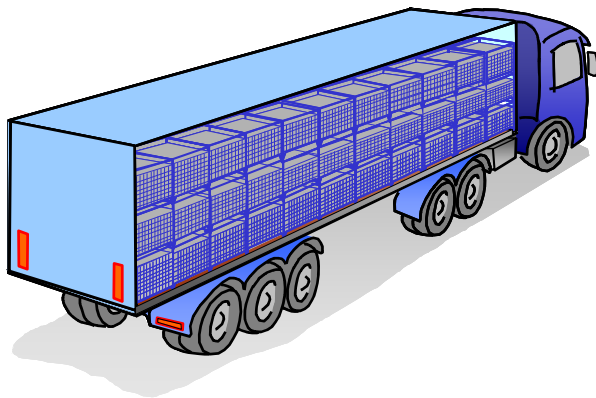
¹ Strength of the blocking device – see Appendix A

Example 3 – Full load of Steel Crates

Steel crates are loaded on a semi-trailer in 11 cargo sections in 3 rows and 3 layers – in total 99 steel crates. Each cargo section has the dimension - height 2.4 m, breadth 2.4 m, length 1.2 m and weight 2 tons. Total cargo weight is 22 tons.

The crates in the second and third layer are blocked to the layer below. The cargo sections are sideways bottom blocked, forward blocked against the headboard¹ and backward against the rear doors with empty pallets as shown in the picture.

The required number of top-over lashings is estimated by use of the IMO Quick Lashing Guide for Road/Sea Area A.



Step 1-2 to calculate the number of lashings to prevent **sliding** is unnecessary to do since the crates are prevented from sliding by blocking.

The number of lashings to prevent **tipping** has to be calculated:

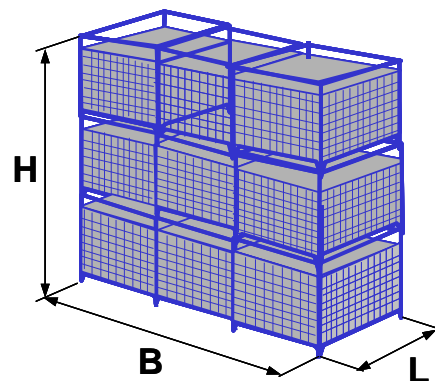
Step 3.

The height $H=2.4$ m, breadth $B=2.4$ m and length $L=1.2$ m gives:

$$H/B = 2.4/2.4 = 1.0$$

$$H/L = 2.4/1.2 = 2.0$$

Number of rows: 3



Step 4.

In the table for tipping you can then find that for $H/B = 1.0$ there is a risk of tipping sideways for three rows of cargo and that each lashing secures 2.3 tons of cargo. With $H/L = 2.0$ there is risk of tipping forward and backward and that each lashing secures 0.8 tons respectively 8.0 tons of cargo according to the table.

Since the crates are forward blocked over the centre of gravity there is no risk of forward tipping¹.

¹ Strength of the blocking device – see Appendix A

Each cargo section weighs 2.0 tons that gives the following required number of lashings:

Sideways tipping

$$2.0/2.3 = 0.87 \rightarrow 1 \text{ lashing}$$

Backwards tipping

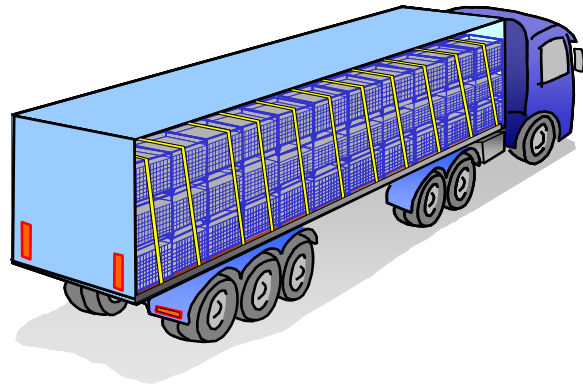
$$2.0/8.0 = 0.25 \rightarrow 1 \text{ lashing}$$

TOP-OVER LASHING - TIPPING									
Cargo weight in ton prevented from tipping									
SIDEWAYS						FORWARD		BACKWARD	
H/B	1 row	2 rows	3 rows	4 rows	5 rows	H/L	per section	per section	
0.6	No tipping	No tipping	No tipping	6.8	3.1	0.6	No tipping	No tipping	
0.8	No tipping	No tipping	5.9	2.3	1.5	0.8	No tipping	No tipping	
1.0	No tipping	No tipping	2.3	1.3	1.0	1.0	No tipping	No tipping	
1.2	No tipping	4.0	1.4	0.9	0.7	1.2	4.0	No tipping	
1.4	No tipping	2.4	1.0	0.7	0.6	1.4	2.0	No tipping	
1.6	No tipping	1.6	0.8	0.6	0.5	1.6	1.3	No tipping	
1.8	No tipping	1.2	0.6	0.5	0.4	1.8	1.0	2.0	
2.0	No tipping	0.9	0.5	0.4	0.3	2.0	0.8	8.0	

Step 5.

The number of lashings required to prevent sideways (and backwards) tipping is the largest number of lashings calculated in steps 1 to 4.

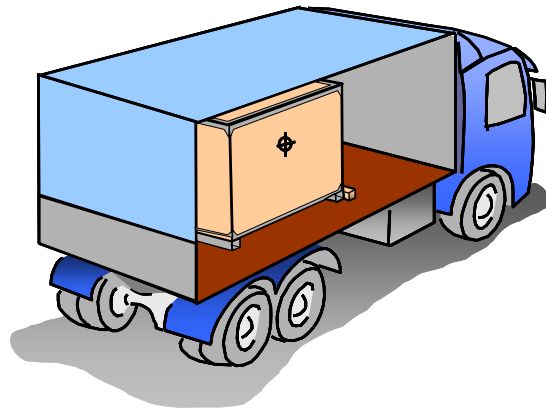
Therefore one top-over lashing per cargo section is required to secure the steel crates in the example above, i.e. 11 lashings in total.



Example 4 – Heat Exchanger

A heat exchanger in a reinforced wooden box with metal feet and corners is loaded on a lorry with a platform of wood. The box has the dimension - height 2.0 m, breadth 0.9 m, length 2.1 m and weights 2 tons. The box's centre of gravity is off centre at the distances $h \times b \times l = 1.35 \times 0.45 \times 1.05$ m.

The box is bottom blocked in forward direction by a nailed wooden batten as shown in the picture.



The required number of top-over lashings is estimated by use of the IMO Quick Lashing Guide for Road/Sea Area A.

First the number of lashings to prevent **sliding** must be calculated:

Step 1.

The material combination steel on wooden platform is not found direct in the table of friction. But in this example the coefficient of friction (μ) for steel on a wood platform $\mu=0.4$ can be used.

MATERIAL COMBINATION IN THE CONTACT AREA	COEFFICIENT OF FRICTION μ -static
SAWN TIMBER/WOODEN PALLET	
Sawn timber against plywood/plyfa/wood	0.5
Sawn timber against grooved aluminium	0.4
Sawn timber against steel metal	0.4
Sawn timber against steel film	0.3
SHRINK FILM	
Shrink film against plyfa	0.3
Shrink film against grooved aluminium	0.3

Step 2.

In the Table for Sliding you can see that when the friction is $\mu=0.4$ one single lashing prevents 3.2 tons of cargo from sliding sideways and backwards. Similar for forward is 0.5 tons but the box is blocked in forward direction and therefore no lashing is needed to prevent sliding in forward direction.

The heat exchanger weighs 2 tons which gives the following number of required lashings:

Sideways sliding

$$2.0/3.2 = 0.63 \rightarrow 1 \text{ lashing}$$

Backward sliding

$$2.0/3.2 = 0.63 \rightarrow 1 \text{ lashing}$$

TOP-OVER LASHING SLIDING



Cargo weight in ton prevented from sliding			
μ	SIDEWAYS	FORWARD	BACKWARD
0.0	0	0	0
0.1	0.2	0.1	0.2
0.2	0.5	0.2	0.5
0.3	1.2	0.3	1.2
0.4	3.2	0.5	3.2
0.5	No sliding	0.8	8.0
0.6	No sliding	1.2	No sliding
0.7	No sliding	1.8	No sliding

Now the number of lashings to prevent **tipping** has to be calculated:

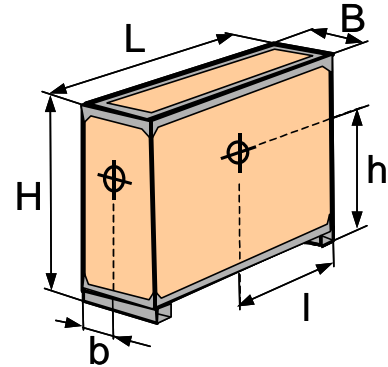
Step 3.

The centre of gravity is off centre and therefore the distances $h \times b \times l$ are used to calculate the ratio H/B and H/L . The height $h=1.35\text{m}$, breadth $b=0.45\text{ m}$ and length $L=1.05\text{m}$ gives:

$$H/B = h/b = 1.35/0.45 = 3.0$$

$$H/L = h/l = 1.35/1.05 = 1.28 \cup 1.4.$$

Number of rows: 1



Step 4.

In the table for tipping you can then find that for $H/B = 3.0$ there is a risk of tipping sideways for one row of cargo and each lashing secures 1.6 tons of cargo. With $H/L = 1.4$ there is no risk of tipping backwards, while on the other hand there is a risk of tipping forwards and each lashing secures 2 tons of cargo according to the table.

The heat exchanger weighs 2 tons which gives the following number of required lashings:

Sideways tipping

$$2.0/1.6 = 1.25 \rightarrow 2 \text{ lashing}$$

Forward tipping

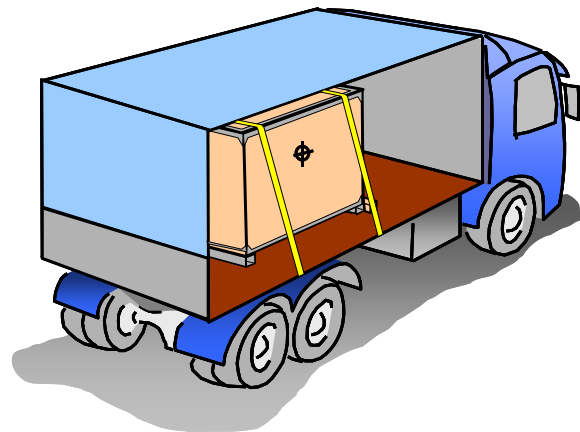
$$2.0/2.0 = 1.0 \rightarrow 1 \text{ lashing}$$

TOP-OVER LASHING - TIPPING									
Cargo weight in ton prevented from tipping									
H/B	SIDEWAYS					H/L	FORWARD	BACKWARD	
	1 row	2 rows	3 rows	4 rows	5 rows		per section	per section	
0.6	No tipping	No tipping	No tipping	6.8	3.1	0.6	No tipping	No tipping	
0.8	No tipping	No tipping	5.9	2.2	1.5	0.8	No tipping	No tipping	
1.0	No tipping	No tipping	2.3	1.3	1.0	1.0	No tipping	No tipping	
1.2	No tipping	4.9	1.4	0.9	0.7	1.2	4.0	No tipping	
1.4	No tipping	2.4	1.0	0.7	0.6	1.4	2.0	No tipping	
1.6	No tipping	1.6	0.8	0.6	0.5	1.6	1.3	No tipping	
1.8	No tipping	1.2	0.6	0.5	0.4	1.8	1.0	2.0	
2.0	No tipping	0.9	0.5	0.4	0.3	2.0	0.8	8.0	
2.2	7.9	0.8	0.5	0.4	0.3	2.2	0.6	5.0	
2.4	4.0	0.7	0.4	0.3	0.3	2.4	0.5	3.6	
2.6	2.6	0.6	0.4	0.3	0.2	2.6	0.5	2.6	
2.8	2.0	0.5	0.3	0.2	0.2	2.8	0.4	2.0	
3.0	1.6	0.4	0.3	0.2	0.2	3.0	0.4	1.6	

Step 5.

The number of lashings required to prevent sideways tipping is the largest number of lashings calculated in steps 1 to 4.

Therefore two top-over lashings are required to secure the heat exchanger in the wooden box in the example above.



Number of nails

One condition for the securing arrangements above is that the wooden batten is fastened with enough nails. With the IMO Quick Lashing Guide for Road/Sea Area A an approximated number of nails can be calculated.

The vehicle is a covered CTU with the coefficient of friction $\mu=0.4$ between the heat exchanger and the platform. If the nails are galvanised the approximated cargo weight prevented from sliding by one nail is according to the table 0.25 ton in forward direction.

4" - NAIL						
Approximate cargo weight in ton prevented from sliding by one nail in combination with top-over lashing only						
Friction****	SIDEWAYS per side, 4"- nail		FORWARD 4"- nail		BACKWARD 4"- nail	
	blank	galvanised	blank	galvanised	blank	galvanised
Open CTU – Road, $\mu = 0.2$	0.35	0.50	0.10	0.20	0.35	0.50
Open CTU – Sea, $\mu = 0.3$	0.50	0.60	0.15	0.25	0.55	0.80
Covered CTU, $\mu = 0.4$	1.1	1.6	0.15	0.25	1.1	1.6
Covered CTU, $\mu = 0.5$	No slid.	No sliding	0.20	0.30	2.3	3.2
Covered CTU, $\mu = 0.6$	No slid.	No sliding	0.25	0.40	No slid.	No sliding
Covered CTU, $\mu = 0.7$	No slid.	No sliding	0.35	0.50	No slid.	No sliding

The weight of the heat exchanger is 2 tons and it can be reduced by 1 ton which the two top-over lashings are preventing from sliding forward (0.5 ton per lashing), see step 2.

The remaining weight $2 - 1 = 1$ ton shall be prevented from sliding forward by the nailed wooden batten. Required number of nails is thus:

$$1.0/0.25 = 4.0 \rightarrow 4 \text{ nails}$$

Appendix A – Strength of the blocking device

Example 1:

One alternative in example 1 is to block the box against the headboard. The two top-over lashings will reduce the acting weight on the headboard with

$$2 \times 0.8 = 1.6 \text{ tons } (\mu=0.5)$$

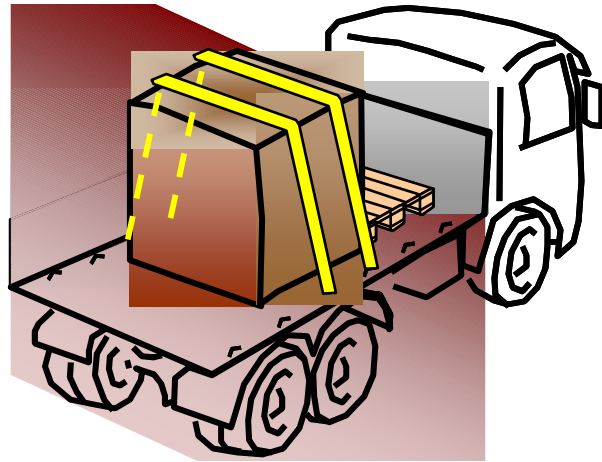
Since the weight of the box is 2.1 tons the remaining weight will be

$$2.1 - 1.6 = 0.5 \text{ ton}$$

The friction force from the “remaining” weight can also reduce the load on the headboard. With $\mu=0.5$ the load on the headboard will be

$$0.5 - 0.5 \times 0.5 = 0.25 \text{ ton}$$

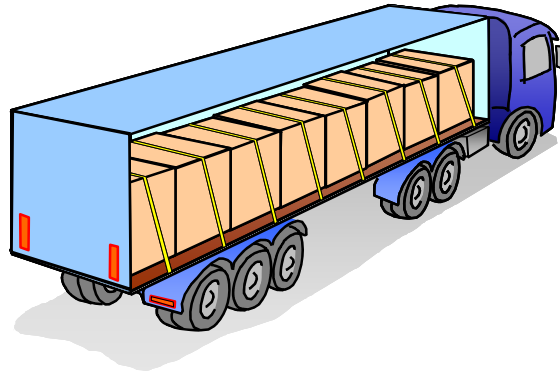
It is assumed that a headboard built according to standard EN12642 will support a load of 0.25 ton at the bottom part of the headboard.



Example 2:

Sliding

The row of boxes in example 2 is blocked against the headboard. According to the table one top-over lashing prevents 0.5 tons of cargo from sliding forward if $\mu=0.4$. The 8 top-over lashings will then prevent -



$8 \times 0.5 = 4.0$ tons of cargo from sliding forward

Since the weight of each box is 3.05 tons the remaining weight to secure will be

$24.4 - 4.0 = 20.4$ tons

The friction force from the “remaining” weight can also reduce the load on the headboard. With $\mu=0.4$ the load on the headboard will be

$20.4 - 20.4 \times 0.4 = 12.2$ tons

It is assumed that a headboard built according to standard EN12642 will support a load of 12.2 ton at the bottom part of the headboard.

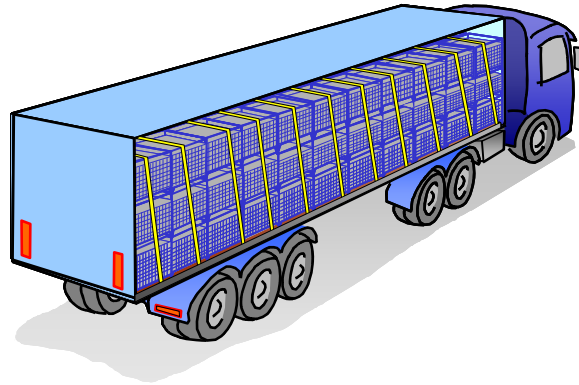
Tipping

Stowing several packages closely behind each other increases tipping stability considerably (“stowing effect”) according to TFK report 1998:2 paragraph 5.0.7. It is assumed that a headboard built according to standard EN12642 will , if necessary, prevent the load from forward tipping.

Example 3:

Sliding

The steel crates in example 3 are blocked against the headboard in forward direction and against the vehicle's blocking edge in sideways direction. According to the table one top-over lashing prevents 0.5 tons of cargo from sliding forward if $\mu=0.4$. The 11 top-over lashings will then prevent



$$11 \times 0.5 = 6.5 \text{ tons of cargo from sliding forward}$$

Since the total cargo weight is 22 tons the remaining cargo weight to secure will be

$$22.0 - 6.5 = 15.5 \text{ tons}$$

The friction force from the “remaining” weight can also reduce the load on the headboard. With $\mu=0.4$ the load on the headboard will be

$$15.5 - 15.5 \times 0.4 = 9.3 \text{ tons}$$

It is assumed that a headboard built according to standard EN12642 will support a load of 9.3 ton at the bottom part of the headboard.

Tipping

Stowing several packages closely behind each other increases tipping stability considerably (“stowing effect”) according to TFK report 1998:2 paragraph 5.0.7. It is assumed that a headboard built according to standard EN12642 will, if necessary, prevent the load from forward tipping.

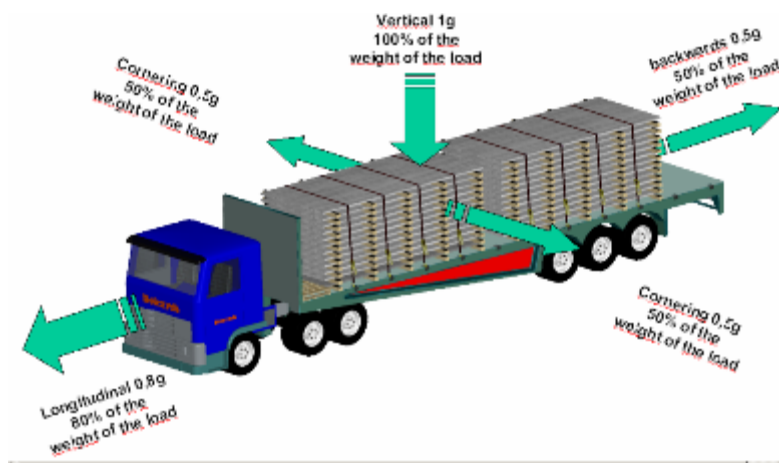
8.7 QUICK LASHING GUIDE based on STANDARD EN12195-1

Friction alone is never sufficient to stop unsecured cargo from sliding. When the vehicle is moving, vertical movements caused by bumps or bad road will reduce the restraining force due to friction. Friction can even momentarily disappear if the load leaves the bed of the truck.

In combination with top over lashing and other restraining methods, friction contributes to adequate cargo securing. The contribution from friction depends on the surface structure of the material in the contact area, some samples are given in EN 12195-1.

Experimental work was carried out, and actual acceleration, braking and centrifugal forces were determined through scientific measurements. These were used to formulate the minimum requirements given in EN12195-1. Since then the following maximum values of the inertial forces for normal traffic driving conditions (these conditions include, for instance, emergency braking) have been estimated in order to calculate the required cargo securing forces. When starting from a standstill the load acts with an inertial force directed towards the rear of the vehicle equal to $0,5 \times$ the weight of the load, when braking the inertial force directed towards the front of the vehicle may equal $0,8 \times$ the weight of the load; when cornering the lateral inertial force may reach $0,5 \times$ the weight of the load. In the case of loads that are not stable, such as items that may not be safe against tilting, an additional roll factor of $0,2 \times$ the weight of the load is included:

- 1) $0,8 \text{ g}$ deceleration in the forward direction;
- 2) $0,5 \text{ g}$ acceleration in the rearward direction and
- 3) $0,5 \text{ g}$ acceleration in the lateral direction.



Note: for other transportation modes like rail or sea, other acceleration coefficients must be used, see EN12195-1.

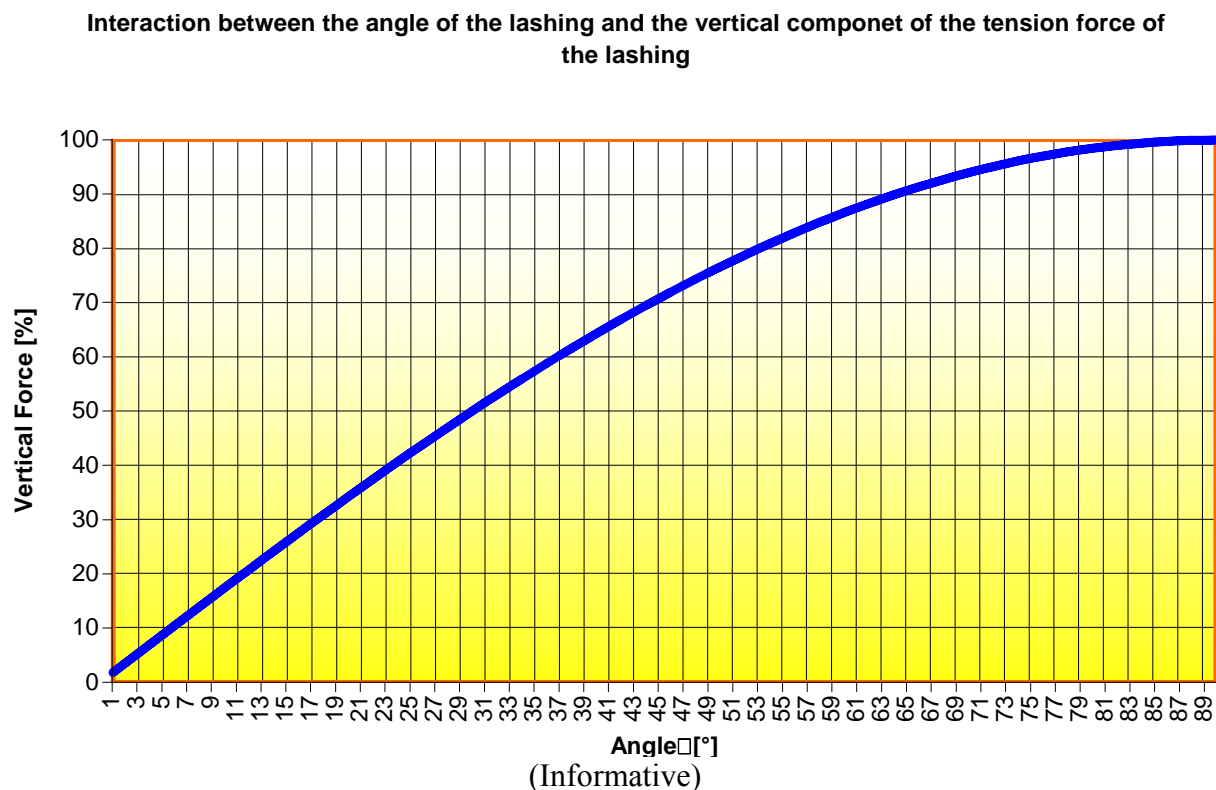
The maximum rated load of tie downs shall not exceed the Lashing Capacity (LC), regardless whether textile lashings, chains or wire ropes are used. The maximum pretension of the tie downs shall not exceed 50% of their Lashing Capacity (LC).

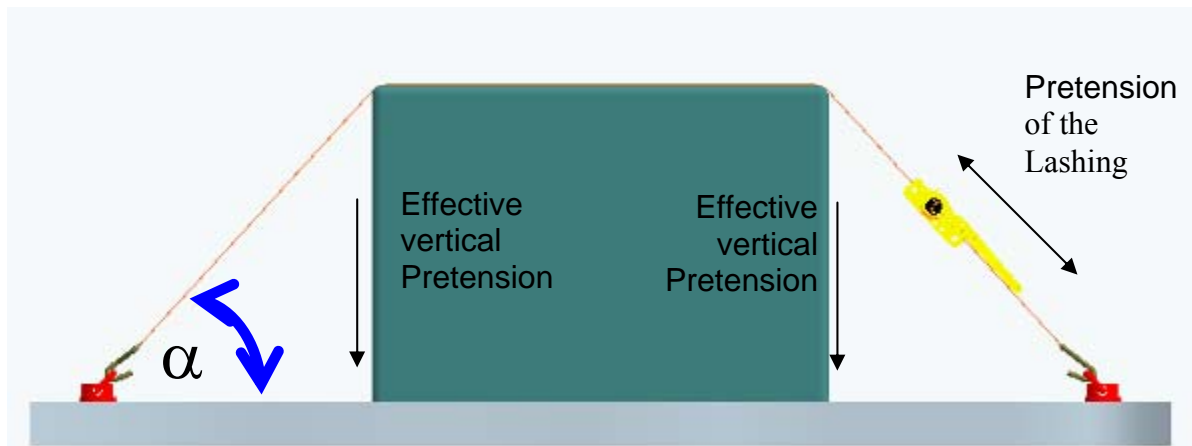
Frictional Lashing method:

There is a distinction between frictional (top over-) lashing and diagonal (direct-) lashing. Frictional lashing consists of tensioning the lashings to increase the pretension force and consequently the friction coefficient between the load and the supporting surface to prevent the load from sliding.

The higher the pretension force or the friction between load and supporting surface, the less the number of the required tie-downs or the more load can be secured, respectively. Consideration should be given to the angle between the tie-down and load/cargo that affects the vertical component of the pretension force (see chart below).

The **Standard Tension Force (STF)** of one standard ratchet (50mm, LC 2500 daN) counts for 250 daN; to reach this value a hand-force of 50 daN is required. The achievable STF has to be marked on the label of the tensioning device. If long lever ratchets are used, with the principle of pulling down instead of pushing, up to 1000 daN can be achieved. If tension indicators are used, the actual pre-tension can be used for calculation.



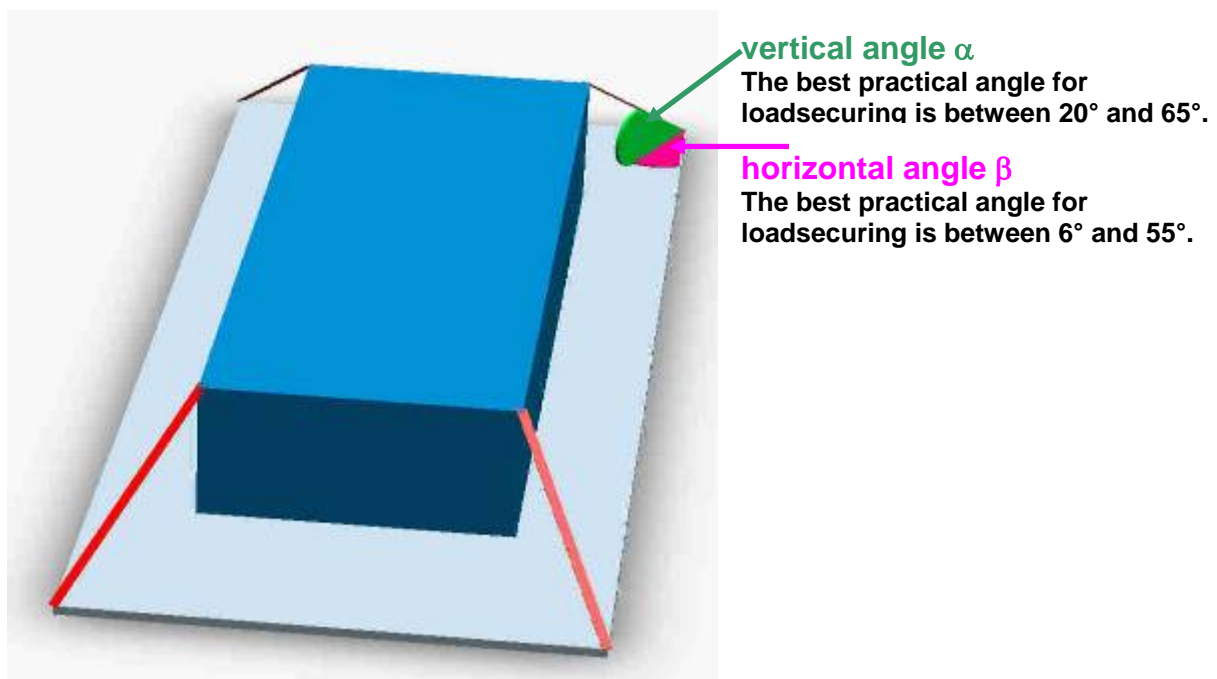


Due to friction between the lashing and the load over the two edges, there is a reduction of the pretension force on the opposite side of the load. According EN12195-1, $k = 1,5$ when using one tensioning device for the lashing, $k \leq 2,0$ when using a lashing with two tensioning devices per lashing, or if the value is proven by a tension force indicator on the opposite side of the tensioning device.

Direct lashing method:

Diagonal lashing (or direct lashing) consists in attaching the load directly. The lashings are fixed directly to the solid parts of the load or to lashing points intended for this purpose. The lashing should be tensioned by the standard hand force.


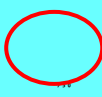
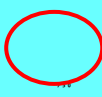
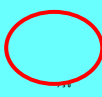
Consideration should be given to the angle α between the tie-down and load carrier in the plane of the loading area. Consideration should also be given to the longitudinal angle β between lashing and longitudinal axis of a load carrier in the plane of the loading area.



Important for this lashing method are the angles between the lashing and the load (α and β), the friction factor μ and the **Lashing Capacity (LC)** of the lashings. The lashing capacity LC is the maximum force that a lashing is allowed to sustain when in use.

The pretension forces in the lashings are balanced and therefore unable to counter horizontal accelerations. Minor shifts of the load across the loading surface (resulting from horizontal accelerations) raise the tension in the loaded lashings, while the tension in the lashings on the opposite side will be reduced. The pretension in the lashings should not exceed 10% of the WLL (Working Load Limit or LC) because higher values will reduce the safety margin of the lashing.

Frictional Lashing according EN12195-1: The chart has the following conditions: The acceleration coefficient for forward direction is 0,8. There is a freestanding load, i. e. no other securing like blocking or direct lashing.
To secure a load, a minimum of at least 2 lashings are required

Weight [to]	G	1					2					3					4				
Angle[°]	α	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90
Pretension	μ																				
	0,1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	*	12	10	9	8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,3	8	7	6	5	5	*	*	11	10	9	*	*	*	*	*	*	*	*	*	*
	0,4	5	4	4	3	3	10	8	7	6	6	*	12	10	9	8	*	*	*	12	11
	0,5	3	3	2	2	2	6	5	4	4	4	9	7	6	5	5	12	10	8	7	7
	0,6	2	2	2	2	2	4	3	3	2	2	5	4	4	3	3	7	6	5	4	4
	0,1	*	*	11	10	10	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	7	6	5	5	4	*	12	10	9	8	*	*	*	*	12	*	*	*	*	*
	0,3	4	4	3	3	3	8	7	6	5	5	12	10	8	7	7	*	*	11	10	9
	0,4	3	2	2	2	2	5	4	4	3	3	7	6	5	5	4	10	8	7	6	6
	0,5	2	2	2	2	2	3	3	2	2	2	5	4	3	3	3	6	5	4	4	4
	0,6	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	4	3	3	2	2
	0,1	11	9	8	7	7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	5	4	4	3	3	10	8	7	6	6	*	12	10	9	8	*	*	*	12	11
	0,3	3	3	2	2	2	6	5	4	4	3	8	7	6	5	5	11	9	7	7	6
	0,4	2	2	2	2	2	4	3	3	2	2	5	4	4	3	3	7	6	5	4	4
	0,5	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	4	4	3	3	3
	0,6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2
	0,1	9	7	6	5	5	*	*	11	10	10	*	*	*	*	*	*	*	*	*	*
	0,2	4	3	3	3	2	7	6	5	5	4	11	9	7	7	6	*	12	10	9	8
	0,3	2	2	2	2	2	4	4	3	3	3	6	5	4	4	4	8	7	6	5	5
	0,4	2	2	2	2	2	3	2	2	2	2	4	3	3	3	2	5	4	4	3	3
	0,5	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	3	3	2	2	2
	0,6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Example 1: Frictional Lashing:

For a 2 tonne load, an angle of 60° and a friction factor $\mu = 0,5$, 4 lashings are required if a standard-ratchet with STF 250 daN is used.

If STF = 750 or 1000 daN, only 2 lashings are required. To reach this high tension, a long-lever ratchet with the principle of pulling instead of pushing is required.

For table cells marked with an asterisk (*) a high number of lashings are required. In these cases, securing with frictional lashing only is not efficient. It is possible to change the securing method or to combine it with other securing methods like blocking, direct lashing or anti sliding material to reduce the required number of lashing. The minimum number of lashings is 2 for a freestanding load.

Frictional lashing according EN12195-1: The chart has the following conditions: The acceleration coefficient for forward direction is 0,8. There is a freestanding load, i. e. no other securing like blocking or direct lashing.

To secure a load, a minimum of at least 2 lashings are required

Weight [t]	α	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90
Angle [°]	α	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90
Pretension	μ																				
STF 250 [daN]	0,1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,5	*	*	12	10	10	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,6	10	8	7	6	6	*	11	9	8	8	*	*	*	12	11	*	*	*	*	*
STF 500 [daN]	0,1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,4	*	12	10	9	8	*	*	*	12	11	*	*	*	*	*	*	*	*	*	*
	0,5	9	7	6	5	5	12	10	8	7	7	*	*	12	10	10	*	*	*	*	*
	0,6	5	4	4	3	3	7	6	5	4	4	10	8	7	6	6	*	11	9	8	8
STF 750 [daN]	0,1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,3	*	*	11	10	9	*	*	*	*	12	*	*	*	*	*	*	*	*	*	*
	0,4	10	8	7	6	6	*	11	9	8	8	*	*	*	12	11	*	*	*	*	*
	0,5	6	5	4	4	4	8	7	5	5	5	12	10	8	7	7	*	*	10	9	9
	0,6	4	3	3	2	2	5	4	3	3	3	7	6	5	4	4	9	7	6	5	5

Sample 2 Frictional lashing:

For a 16 tonne load, an angle of 75-90° and a friction factor $\mu = 0,6$, 5 lashings are required if a standard-ratched with STF 750 daN is used.

Direct (diagonal) lashing according EN12195-1

The chart has the following conditions: The acceleration coefficient for forward direction is 0,8, for side- and backward direction 0,5.

There is a freestanding load, i.e. no other securing like blocking or direct lashing. The angle α is between 20°- 65° the angle β is between 6°- 55°.

To secure a load, 2 pairs of lashing with an LC as following are required.

Weight of the load [kg]	Required LC of the lashing $\mu=0,1$	Required LC of the lashing $\mu=0,2$	Required LC of the lashing $\mu=0,3$	Required LC of the lashing $\mu=0,4$	Required LC of the lashing $\mu=0,5$	Required LC of the lashing $\mu=0,6$
50000	-----	-----	-----	20000	16000	10000
48000	-----	-----	-----	16000	16000	10000
46000	-----	-----	-----	16000	10000	6300
44000	-----	-----	-----	16000	10000	6300
42000	-----	-----	-----	16000	10000	6300
40000	-----	-----	20000	16000	10000	6300
35000	-----	-----	20000	16000	10000	6300
30000	-----	-----	16000	10000	10000	4000
28000	-----	-----	16000	10000	6300	4000
26000	-----	-----	16000	10000	6300	4000
24000	-----	-----	16000	10000	6300	4000
22000	-----	20000	16000	10000	6300	4000
20000	-----	20000	10000	10000	6300	4000
18000	-----	20000	10000	6300	4000	2500
16000	-----	16000	10000	6300	4000	2500
14000	-----	16000	10000	6300	4000	2000
12000	20000	16000	6300	4000	4000	2000
10000	16000	10000	6300	4000	2500	1500
9000	16000	10000	6300	4000	2000	1500
8000	16000	10000	4000	4000	2000	1500
7000	16000	6300	4000	2500	1500	1000
6000	10000	6300	4000	2000	1500	1000
5000	10000	6300	2500	2000	1500	750
4000	6300	4000	2000	1500	1000	750
3000	6300	4000	1500	1000	750	500
2500	4000	2500	1500	1000	750	500
2000	4000	2000	1000	750	500	500
1500	2500	1500	750	500	500	250
1000	1500	1000	500	500	250	250
500	750	500	250	250	250	250
250	500	250	250	250	250	250

The required LC calculated for the worst angles pairs in all directions.

The user has to ensure that these angles are between α 20°- 65° and β 6°- 55°.

Example 2:

For a 3 tonne load, 2 pairs of lashings with an LC of 1000 daN each are required.

For a 35 tonne load, 2 pairs of lashings with an LC of 6300 daN each are required (for example 8 mm chain).





Table cells marked with “---- “: no lashing equipment with such a high LC is available; in this case more lashings or additional securing methods like blocking have to be used.

Dynamic friction factors of some usual goods μ_D

Combination of materials in the contact surface	Friction factor μ_D
Sawn wood	
Sawn wood against wood	0,35
Sawn wood against grooved aluminium	0,3
Sawn wood against steel sheets	0,3
Sawn wood against crimped foils	0,2
Crimped foils	
Crimped foils against fabric base laminate/plywood	0,3
Crimped foils against grooved aluminium	0,3
Crimped foils against steel sheets	0,3
Crimped foils against crimped foils	0,3
Cardboard boxes	
Cardboard box against cardboard box	0,35
Cardboard box against wood pallet	0,35
Large bags	
Large bags against wood pallet	0,3
Steel and metal sheets	
Oiled metal sheets against oiled metal sheets	0,1
Flat steel bars against sawn wood	0,35
Unpainted rough steel sheets against sawn wood	0,35
Painted rough steel sheets against sawn wood	0,35
Unpainted rough steel sheets against unpainted rough steel sheets	0,3
Painted rough steel sheets against painted rough steel sheets	0,2
Painted steel barrel against painted steel barrel	0,15
Concrete	
Wall on wall without intermediate layer (concrete/concrete)	0,5
Finished part with wooden intermediate layer on wood (concrete/wood/wood)	0,4

Combination of materials in the contact surface	Friction factor μ_D
Ceiling on ceiling without intermediate layer (concrete/lattice girder)	0,6
Steel frame with wooden intermediate layer (steel/wood)	0,4
Ceiling on steel frame with wooden intermediate layer (concrete/wood/steel)	0,45
Pallets	
Resin bonded plywood, smooth – Europallet (wood)	0,2
Resin bonded plywood, smooth – box pallet (steel)	0,25
Resin bonded plywood, smooth – plastic pallet (PP)	0,2
Resin bonded plywood, smooth – wooden pressboard pallets	0,15
Resin bonded plywood, sieve structure – Europallet (wood)	0,25
Resin bonded plywood, sieve structure – box pallet (steel)	0,25
Resin bonded plywood, sieve structure – plastic pallet (PP)	0,25
Resin bonded plywood, sieve structure – wooden pressboard pallets	0,2
Aluminium beams in the load-carrying platform (punched bars) – Europallet (wood)	0,25
Aluminium beams in the load-carrying platform (punched bars) – box pallet (steel)	0,35
Aluminium beams in the load-carrying platform (punched bars) – plastic pallet (PP)	0,25
Aluminium beams in the load-carrying platform (punched bars) – wooden pressboard pallets	0,2

Frictional Lashing according EN12195-1: The chart has the following conditions: The acceleration coefficient in forward direction is 0,8. Freestanding load, i.e. there is no other securing like blocking or direct lashing.
To secure a load, a minimum of 2 lashings are required

Angle[°]	α	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90	35	45	60	75	90
Pretension	μ																				
	0,1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	*	12	10	9	8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,3	8	7	6	5	5	*	*	11	10	9	*	*	*	*	*	*	*	*	*	*
	0,4	5	4	4	3	3	10	8	7	6	6	*	12	10	9	8	*	*	*	12	11
	0,5	3	3	2	2	2	6	5	4	4	4	9	7	6	5	5	12	10	8	7	7
	0,6	2	2	2	2	2	4	3	3	2	2	5	4	4	3	3	7	6	5	4	4
	0,1	*	*	11	10	10	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	7	6	5	5	4	*	12	10	9	8	*	*	*	*	12	*	*	*	*	*
	0,3	4	4	3	3	3	8	7	6	5	5	12	10	8	7	7	*	*	11	10	9
	0,4	3	2	2	2	2	5	4	4	3	3	7	6	5	5	4	10	8	7	6	6
	0,5	2	2	2	2	2	3	3	2	2	2	5	4	3	3	3	6	5	4	4	4
	0,6	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	4	3	3	2	2
	0,1	11	9	8	7	7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0,2	5	4	4	3	3	10	8	7	6	6	*	12	10	9	8	*	*	*	12	11
	0,3	3	3	2	2	2	6	5	4	4	3	8	7	6	5	5	11	9	7	7	6
	0,4	2	2	2	2	2	4	3	3	2	2	5	4	4	3	3	7	6	5	4	4
	0,5	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2	4	4	3	3	3
	0,6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2
	0,1	9	7	6	5	5	*	*	11	10	10	*	*	*	*	*	*	*	*	*	*
	0,2	4	3	3	3	2	7	6	5	5	4	11	9	7	7	6	*	12	10	9	8
	0,3	2	2	2	2	2	4	4	3	3	3	6	5	4	4	4	8	7	6	5	5
	0,4	2	2	2	2	2	3	2	2	2	2	4	3	3	3	2	5	4	4	3	3
	0,5	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	3	3	2	2	2
	0,6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Direct (diagonal) lashing according EN12195-1
The chart has the following conditions: The acceleration coefficient is 0,8 for forward direction, 0,5 for side- and backward direction.
Freestanding load, i.e. there is no other securing like blocking or direct lashing. The angle α is between 20°- 65° the angle β is between 6°- 55°.
To secure a load, 2 pairs of lashing with an LC as following are required.

eight of the load [kg]	Required LC of the lashing $\mu=0,1$	Required LC of the lashing $\mu=0,2$	Required LC of the lashing $\mu=0,3$	Required LC of the lashing $\mu=0,4$	Required LC of the lashing $\mu=0,5$	Required LC of the lashing $\mu=0,6$
50000	-----	-----	-----	20000	16000	10000
48000	-----	-----	-----	16000	16000	10000
46000	-----	-----	-----	16000	10000	6300
44000	-----	-----	-----	16000	10000	6300
42000	-----	-----	-----	16000	10000	6300
40000	-----	-----	20000	16000	10000	6300
35000	-----	-----	20000	16000	10000	6300
30000	-----	-----	16000	10000	10000	4000
28000	-----	-----	16000	10000	6300	4000
26000	-----	-----	16000	10000	6300	4000
24000	-----	-----	16000	10000	6300	4000
22000	-----	20000	16000	10000	6300	4000
20000	-----	20000	10000	10000	6300	4000
18000	-----	20000	10000	6300	4000	2500
16000	-----	16000	10000	6300	4000	2500
14000	-----	16000	10000	6300	4000	2000
12000	20000	16000	6300	4000	4000	2000
10000	16000	10000	6300	4000	2500	1500
9000	16000	10000	6300	4000	2000	1500
8000	16000	10000	4000	4000	2000	1500
7000	16000	6300	4000	2500	1500	1000
6000	10000	6300	4000	2000	1500	1000
5000	10000	6300	2500	2000	1500	750
4000	6300	4000	2000	1500	1000	750
3000	6300	4000	1500	1000	750	500
2500	4000	2500	1500	1000	750	500
2000	4000	2000	1000	750	500	500
1500	2500	1500	750	500	500	250
1000	1500	1000	500	500	250	250
500	750	500	250	250	250	250
250	500	250	250	250	250	250

$$LC = \frac{m \cdot g \cdot (c_{x,y} - \mu_D \cdot c_z)}{2 \cdot \cos \alpha \cdot \cos \beta_{x,y} + \mu_D \cdot \sin \alpha} = \frac{12000 \cdot (0,8 - 0,1 \cdot 1)}{2 \cdot \cos 65^\circ \cdot \cos 55^\circ + 0,1 \cdot \sin 65^\circ} = 12611 daN \Rightarrow 16000 daN$$

**Weight
of the
load
[kg]**

Required LC of the lashing

μ	0,1	0,2	0,3	0,4	0,5	0,6
50000	-----	-----	-----	20000	16000	10000
48000	-----	-----	-----	16000	16000	6300
46000	-----	-----	-----	16000	10000	6300
44000	-----	-----	-----	16000	10000	6300
42000	-----	-----	-----	16000	10000	6300
40000	-----	-----	20000	16000	10000	6300
35000	-----	-----	20000	16000	10000	6300
30000	-----	-----	16000	10000	10000	4000
28000	-----	20000	16000	10000	6300	4000
26000	-----	20000	16000	10000	6300	4000
24000	-----	20000	16000	10000	6300	4000
22000	-----	16000	16000	10000	6300	4000
20000	-----	16000	10000	10000	6300	4000
18000	20000	16000	10000	6300	4000	2500
16000	20000	16000	10000	6300	4000	2500
14000	16000	10000	10000	6300	4000	2000
12000	16000	10000	6300	4000	4000	2000
10000	16000	10000	6300	4000	2500	1500
9000	10000	10000	6300	4000	2000	1500
8000	10000	6300	4000	4000	2000	1500
7000	10000	6300	4000	2500	2000	1000
6000	10000	6300	4000	2000	1500	1000
5000	6300	4000	2500	2000	1500	750
4000	6300	4000	2000	1500	1000	750
3000	4000	2500	1500	1000	750	500
2500	4000	2000	1500	1000	750	500
2000	2500	1500	1000	750	500	500
1500	2000	1500	750	500	500	250
1000	1500	750	500	500	250	250
500	750	500	250	250	250	250
250	500	250	250	250	250	250

8.8. Blocking of cargo against cover stake superstructure

Many types of packages may in general be secured by blocking and if necessary by lashing. Securing the cargo only by blocking against the cover stake superstructure boards or panels may be practised if the following conditions are fulfilled:

- The cargo that is blocked by the cover superstructure boards or panels should not exceed a certain weight (see the table below);
- The load carriers cover superstructure fulfils the required strength in the standard EN12642 for body structure on commercial vehicles;
- The boards or panels in the cover superstructure are in serviceable condition;
- Except for the upper cargo layer, all other cargo layers should present a horizontal over side.

The cargo's weight must, as far as possible, be equally distributed along the boards or panels.

Maximum cargo weight in daN that can be blocked against the superstructure cover boards or panels per metre of platform length.

Max. number of superstructure cover boards ¹	Loaded superstructure cover boards	Maximum authorised platform load		
		P (daN/m) P=2000	P=2200	P=2400
3	1	133	146	159
	2	266	292	319
	3 (or panels)	400	440	480
4	1	100	110	120
	2	200	220	240
	3	300	330	360
	4 (or panels)	400	440	480
5	1	80	88	96
	2	160	176	192
	3	240	264	288
	4	320	352	384
	5 (or panels)	400	440	480
6	1	66	72	79
	2	133	146	159
	3	200	220	240
	4	266	292	319
	5	333	366	399
	6 (or panels)	400	440	480

¹ The maximum number of boards is the number that the cover superstructure is designed for. If the cargo is heavier than the cover stake superstructure body blocking capacity, according to the table above, the cargo must also be secured by other means.

Packages are often fragile and can easily be damaged by lashings. By use of edge protectors or empty pallets on top of the cargo, damages from the application of lashings can usually be avoided.

8.9. Securing of steel products and of packaging for chemicals

8.9.1. Steel products

8.9.1.1. Vehicle requirements ⁶

Introduction

The vehicle should be fitted with the equipment mentioned below. The equipment can be freely chosen provided it is safe and cargo can be safely loaded, transported and unloaded. For example safe loading requires that the side-curtain can be removed and the side-boards can be lowered.

The vehicle should be in such a condition that work can safely be executed. For example the boards of the loading platform of the vehicle should not be damaged.

The general equipment should be available as a minimum; for the transport of special steel products it should be supplemented with additional equipment. Both are specified below and considered hereafter in this chapter.

For any steel product the following general equipment should be available as a minimum:

- safe headboard
- loading platform
- securing points
- securing devices

Equipment for special cases:

- groove(s) for coils
- (cross-)beam or H-beam
- wedge bed
- cover

Content

1. General equipment
2. Equipment for special cases (Special Provisions)

⁶ Based upon requirements of CORUS Staal BV, IJmuiden, the Netherlands
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1. General equipment

Headboard

The vehicle should be fitted with a headboard between the cabin and the loading platform.

Loading platform

The surface of the loading platform should be even and closed (no missing or broken boards). The cargo should not become wet from below. Before loading, the loading platform should be dry and clean.

Securing points

The securing points should be an integral part of the vehicle construction.

Securing devices

Two kinds of securing devices can be used: chains or synthetic fibre straps.

The tensioner should be such to make it easy to tighten the lashing. The tensioner should be secured against inadvertent loosening.

Securing, tensioning and/or securing should always be done before the transport starts, even if the ride is short.

Only safe securing devices should be used, this is checked by a visual inspection. Damaged devices should not be used.

It is recommended to use synthetic fibre straps.

2. Special provisions

Groove

A groove is recommended for coils of 4 tons or more and mandatory for coils of 10 tons or more.

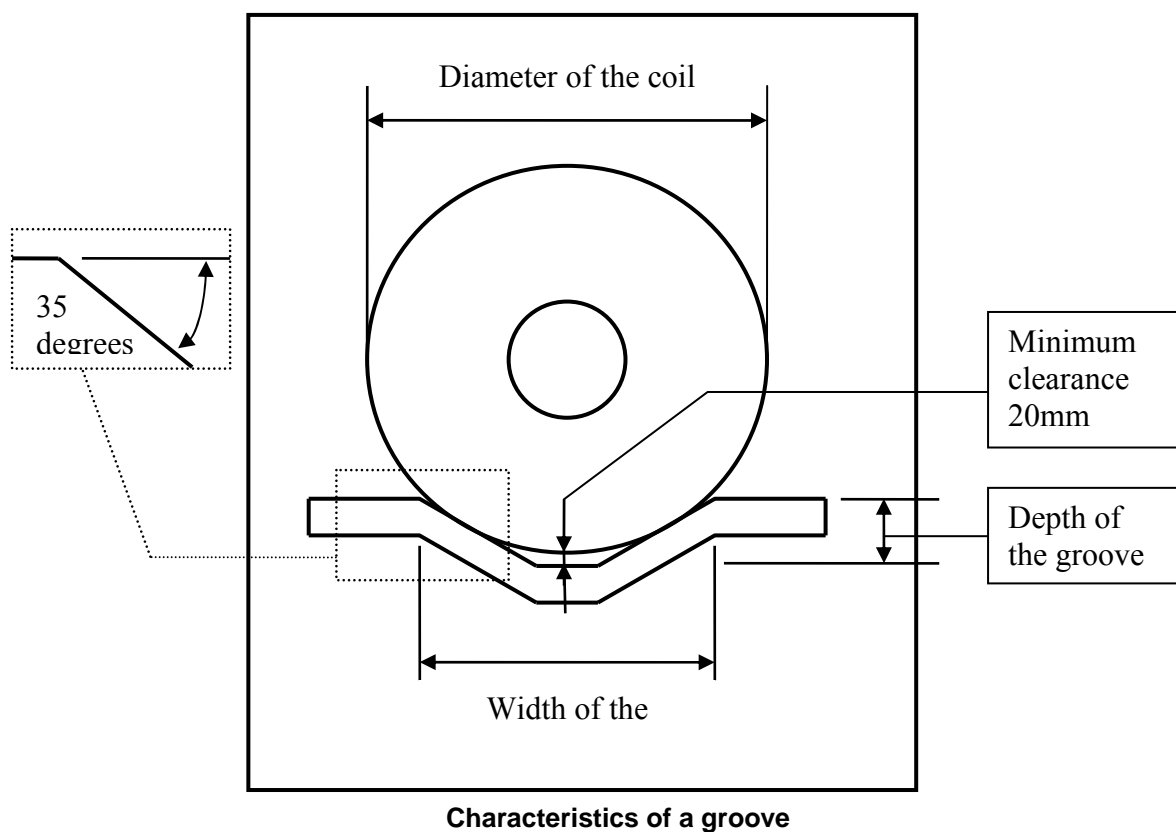
For coils of 4 to 10 tons a wedge bed may also be used (see “Wedge bed” hereafter).

Requirements for a groove are:

- the slopes should have an angle of 35 degrees to the horizontal;
- the coils, if placed in the groove, should have a minimum clearance of 20mm to the bottom.

Furthermore:

- the width/height ratio of the coils should not be lower than 0.7;
- if lower than 0.7, the coils have to be stowed against a support;
- rule of thumb: “width of groove = at least 60% of coil diameter”;
- the contact area of the coil should clearly be below the top of the groove.



(Cross-)beam or H-beam

The use of a (cross-)beam is highly recommended as it is a good device to fix coils. It is used both for coils bore horizontal in a groove and for coils bore vertical on a pallet. See also the chapter for securing the cargo.

There are different good constructions for a (cross-)beam. The example of a (cross-)beam given below has protection strips (in this case synthetic) on the touch side of the (cross-)beam.

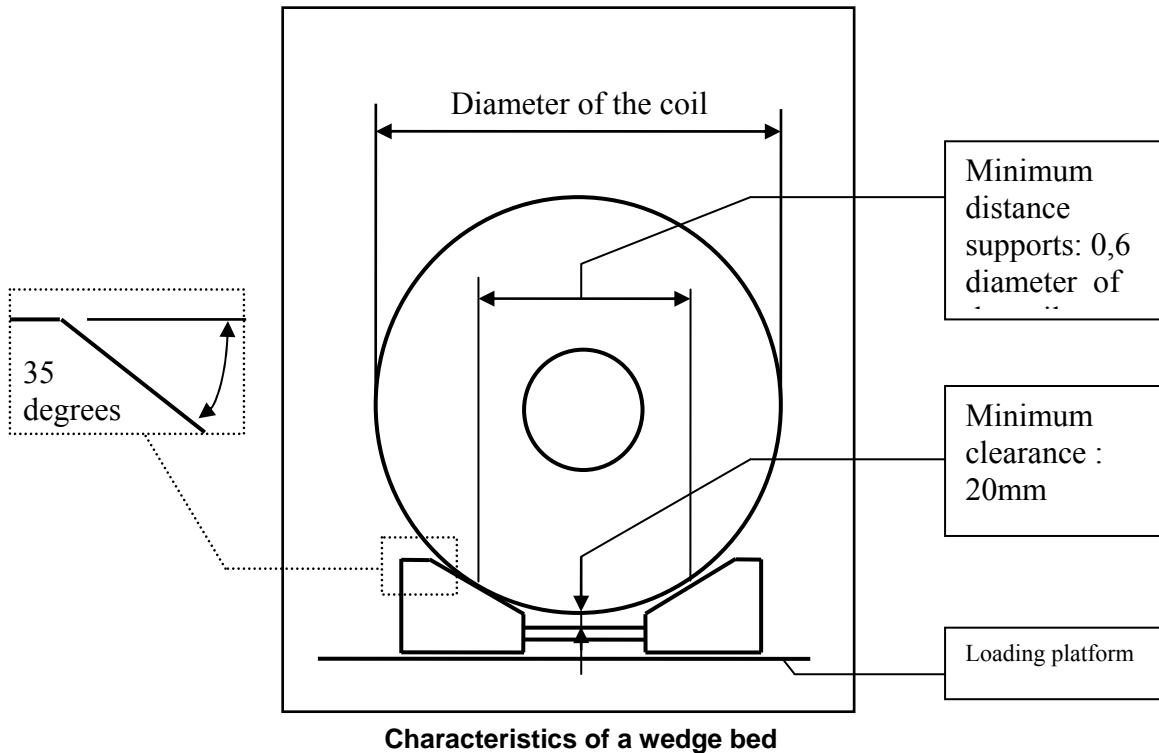


Example of a (cross)beam

Wedge bed

A wedge bed is a construction for a coil with bore horizontal:

- the wedges on which the coil rests ought to go over the whole width of the coil;
- there should be a provision to fix the spacing between the wedges of the wedge bed;
- stable support and free space under the coil similar as for the groove-method;
- use of anti-slip mats between the wedge bed and loading platform highly recommended.



Cover

When products have to remain dry during the transport, they should be covered in such a way that they stay dry under all weather conditions.

If a cover is used it must be able to be removed without hampering the (un)loading operation. The cover should be at least 10 cm above the cargo and should not touch it. The cover should not be damaged (e.g. being torn), to avoid the risk of leaks.

8.9.1.2. Securing of steel products

Introduction

The methods mentioned should be considered as minimum provisions. These provisions do not preclude additional measures if felt necessary.

Content

- A. Bore horizontal coils
 - A1. Coil supports;
 - A2. Securing of coils in a groove;
 - A3. Summary of securing bore horizontal coils with different weights
- B. Roll strips
- C. Flat racks

A. Bore horizontal coils

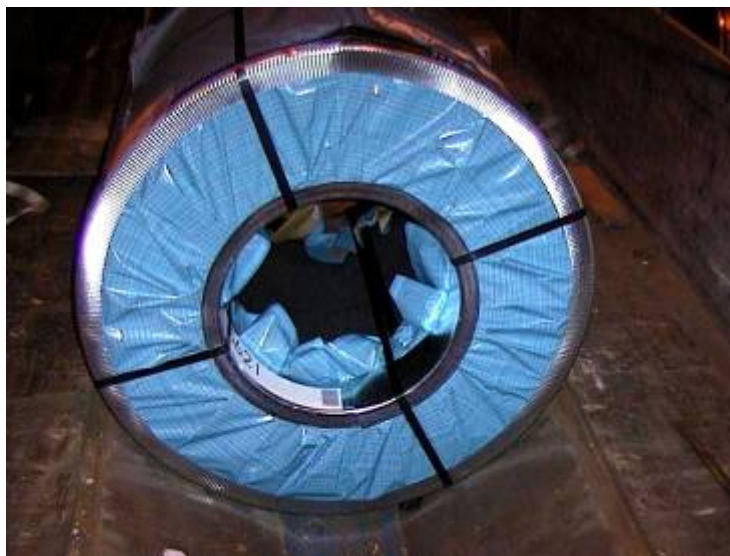
A1. Coil supports

The support required depends on the weight of the coil:

- Coils with a weight < 4 ton can be stowed directly on a flat loading platform.
- Coils with a weight ≥ 4 ton have to be stowed on the whole width of the coil on the slopes of the supports. A groove is highly recommended. Coils weighing from 4 to 10 ton may also be stowed into a bin.
- Coils with a weight ≥ 10 ton have to be stowed into a groove.



Note: if the groove is made of steel the use of rubber mats or dunnage (abeam against the slopes) is obligatory.

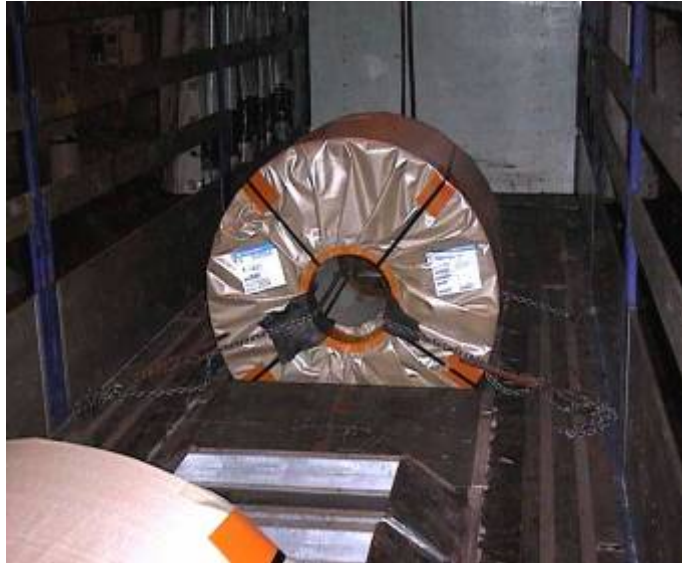


The coil should rest on the slopes of the groove. The clearance between the coil and the bottom of the groove should be minimum 20mm.

Note: for drawings of the bin or groove see chapter for vehicle requirements.

A2. Securing of coils in a groove

The coil should be secured by two chains or two fibre straps, as shown in the pictures below.



No void space is allowed between the front of the coil and the hatch; the hatches have to be placed in such a manner that the coil can not move forward.



Use a (cross)beam to avoid forward movement. The (cross)beam should not dent the coil. Therefore protect the (cross)beam at the contact surfaces with e.g. synthetic fabrics.

A3. Summary of securing bore horizontal coils of different weights

	Coils \leq 4 ton ("baby"-coils)	Coils of 4 to 10 ton (choose between the following options)	Coils \geq 10 ton
Type of loading platform	Flat loading platform	Flat loading platform	Groove
Extra supports for the coil	Wedges or stop-blocks	Bin	Coil to be fixed on the front-side by a (cross)beam or H-beam in the groove
Stowage of coil	Horizontal bore transverse to the driving direction	Horizontal bore preferably transverse to the driving direction	Horizontal bore parallel to the driving direction Stowed into the groove
Securing device	Synthetic fibre strap (LC 2,5 ton, safety factor 3)	Synthetic fibre strap (LC 2,5 ton, safety factor 3) or steel chain, (LC 3 ton, safety factor 3) When using chains: use edge protectors or rubber mats or strips	
Number of securing devices	At least one securing device (through the axle hole) and one wedge per coil Block stowage is allowed	Two securing devices per coil (through the axle hole)	

LC: Lashing Capacity

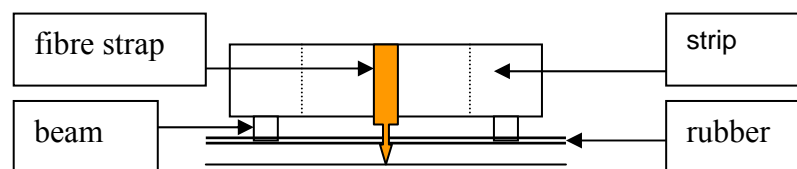
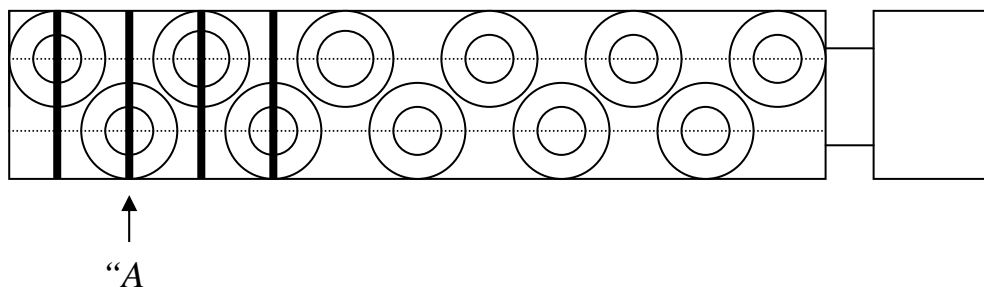
B. Roll strips

Way of transport

Roll strips are transported bore vertical on two wooden beams, which are bundled (i.e. fastened with steel straps) to the roll strips.

Cargo height and distribution:

- Roll strips may be loaded one tier high only.
- The whole loading platform should be covered by rubber mats. (Quality PE, Regupol anti-slip 10 millimetres thick. (e.g. 3 strips: width 500mm and length 12 meter).
- Roll strips should be evenly distributed on the loading platform in such a way that they form a so-called “honeycomb structure”. Normally 10 to 12 roll strips can be transported per shipment.
- At the rear side a minimum of 4 roll strips should be secured to the trailer by fibre straps. To secure the rolls in the middle chains can be attached between the securing eyes of the trailer; the hooks of the fibre straps can be hooked to links of the chain close to the middle of the roll.



VIEW "A"

C. Flat-racks

Requirements groove/wedge bed

- The minimum width of the groove/wedge bed should be 60% of the coil diameter.
- The slopes should have an angle of 35 degrees to the horizontal.
- The minimum clearance between the coil and the bottom of the groove/wedge bed should be 20mm.
- The ratio width/height should be at least 0,7.
- Below 0,7 the coils should be supported by (cross)beams.
- The contact surfaces of the coil should be under the upper side of the groove/wedge bed.
- Coils to be secured (through the reel hole) by 2 fibre straps and 1 fibre strap across the coil (see picture below).

Securing points

- The basic principle is that the securing points withstand the strength of the used securing devices. There are different designs of securing points. The construction should be such that it forms an integral part of the chassis (e.g. by welding). The construction may not result in a reduction of the strength.

Securing devices

- If the securing device is damaged, it should be discarded.
- To be used: synthetic fibre straps (LC: 2,5 ton, safety factor: 3) or steel chains (LC: 2,5 ton, safety factor: 3)
- When the securing devices are chains edge protectors or rubber strips should be used.
- To tighten steel chains only use adequate appliances.
- It is highly recommended to use synthetic fibre straps instead of steel chains (less risk of damaging the coils).

Swap bodies (30 tons) with grooves abeam can be used, provided that they have beams to fix the coils.



Flatrack with a cover and groove



Straps through and across the coil

8.9.1.3. Bore vertical coils (ETTS) and packages

Introduction

For bore horizontal coils, roll strips and flat-racks see here before.

In this chapter methods are given for bore vertical coils ('Eye To The Sky' - **ETTS**) and (tinplate) packages.

The methods indicated should be regarded as minimum provisions. These provisions do not preclude additional measures if felt necessary.

Content

A, B, C and D. see 3.7.2

E. Securing of bore vertical coils ('Eye To The Sky' - ETTS)

F. Assistance band (Spin)

G. Packages

E. Securing of bore vertical coils (Eye To The Sky - ETTS)

Bore vertical coils should be transported on a pallet or a platform.

There are two models of platforms:

- Round synthetic platform.
- Square wooden platform (sometimes with rounded edges) and provided with a cone.

Securing of the coil

Pallet is placed upon on antiskid strips, pallet itself does not need to be secured.

Coil will be across secured by two fibre straps.

Note: fibre straps should be long enough, minimum recommended length is 8,5 meter.

It is recommended to put a beam on the front of the coil.

Use rubber protection strips between the coil and fibre straps.

The following pictures illustrate this securing method.



Step 1: photo left
Step 2: photo top right
Step 3: photo bottom right

Fasten strap 1 to the trailer, lead it along the front of the coil and behind OVER, on the rubber protection strip, the coil and along the front and fasten to the trailer.
Keep the spanner on the rear of the coil (regarding the driving direction).



Step 4: photo left

Step 5: photo top right

Step 6: photo bottom right

Fasten strap 2 to the trailer, lead it along the front of the coil and behind OVER, on the rubber protection strip, the coil and along the front and fasten to the trailer. Keep the spanner on the rear of the coil (regarding the driving direction).

The picture below shows where to place the rubber protection strip on the coil.



F. Assistance band (spin)

Addition to the securing method for bore vertical coils (ETTS).

It is allowed to use an assistance band (“spin”) to avoid slide off of the fibre straps. If a “spin” is used the corners of the coil have to be protected by means of rubber protection strips.

The fibre straps have to be attached in the same manner as indicated before, here also attention is attracted to the fact that the spanner is kept on the rear of the coil (relative to the driving direction).

The coil should be placed upon antiskid strips or a beam may be affixed in front of the coil.

It is also recommended to put a beam on the front the coil. If needed additional securing measures may be used if felt necessary.

An example of this method is shown below.



G. Packages

- It is important that the friction between the cargo and the loading platform is sufficient. Therefore a loading platform with a wooden platform is preferred. If other loading platforms have non-wood floors, extra attention should be given to avoid sliding.
- It is recommended to use antiskid strips in all cases.
- It is recommended to secure the cargo by fibre straps to avoid damage to the cargo (chains often causes indent damages).

Cargo height and distribution:

- Packages should not be stacked.
- Packages should not tower above the head- and/or sideboards.
- Packages should be stowed in continuous rows of two, on the vehicle/trailer.

8.9.2. Some examples of stowage and securing of the most commonly used packages for chemical goods in road transport (FTL shipments)

Introduction

In the following sections examples are described of possible ways of securing various types of packages and loads. It is not the objective of these guidelines to provide a comprehensive overview of all possible techniques of securing loads in the different types of cargo transport units.

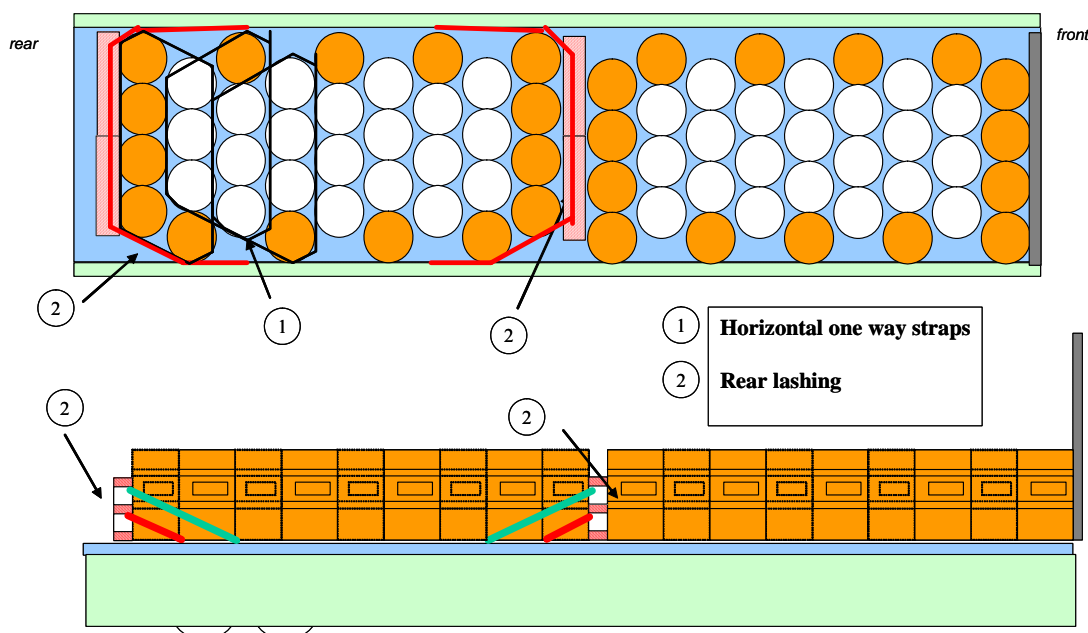
Alternative methods may exist which provide an equivalent or even better standard of cargo securing

Content

1. Loose drums in an open sided trailer (cover/stake body types or tilt trailer).
2. Palletized drums in combination with top-over lashing in a curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).
3. Palletized drums in combination with form-locked securement in an open sided trailer (cover/stake body types or tilt trailer).
4. Palletized IBC's in combination with top-over lashing in a curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).
5. Bags on pallets in combination with form-locked securement in an open sided trailer (cover/stake body types or tilt trailer).
6. Bags on pallets in combination with form-locked securement in an open sided trailer (cover/stake body types or tilt trailer).
7. Big bags in combination with top-over lashing in a curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).
8. Big bags in combination with form-locked securement in an open sided trailer (cover/stake body types or tilt trailer).
9. Octabins in a certified curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).
10. Loose drums double-stacked in a container.
11. IBCs double stacked in a container
12. Palletized bags with chemical goods loaded in a container.

8.9.2.1. Loose drums in an open sided trailer (cover/stake body types or tilt trailer)

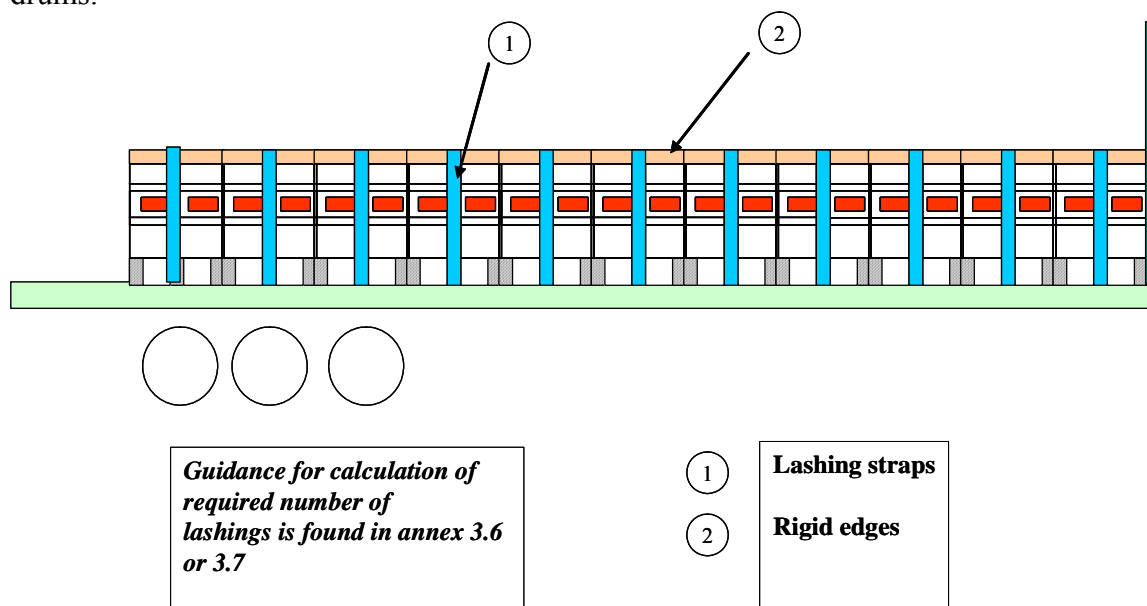
Drums are loaded against the head board and shifted row by row to one side to create a form lock. The drums colored in dark-orange protrude. Two rear lashings are applied, one at the back and one at the middle supporting the headboard. Horizontal one-way straps block the last rows.



8.9.2.2. Palletized drums in combination with top-over lashing in a curtain sider or in an open sided trailer (cover/stake body types or tilt trailer)

Drums are loaded against the head board, two pallets on one row. At every row, one top over lashing is used.

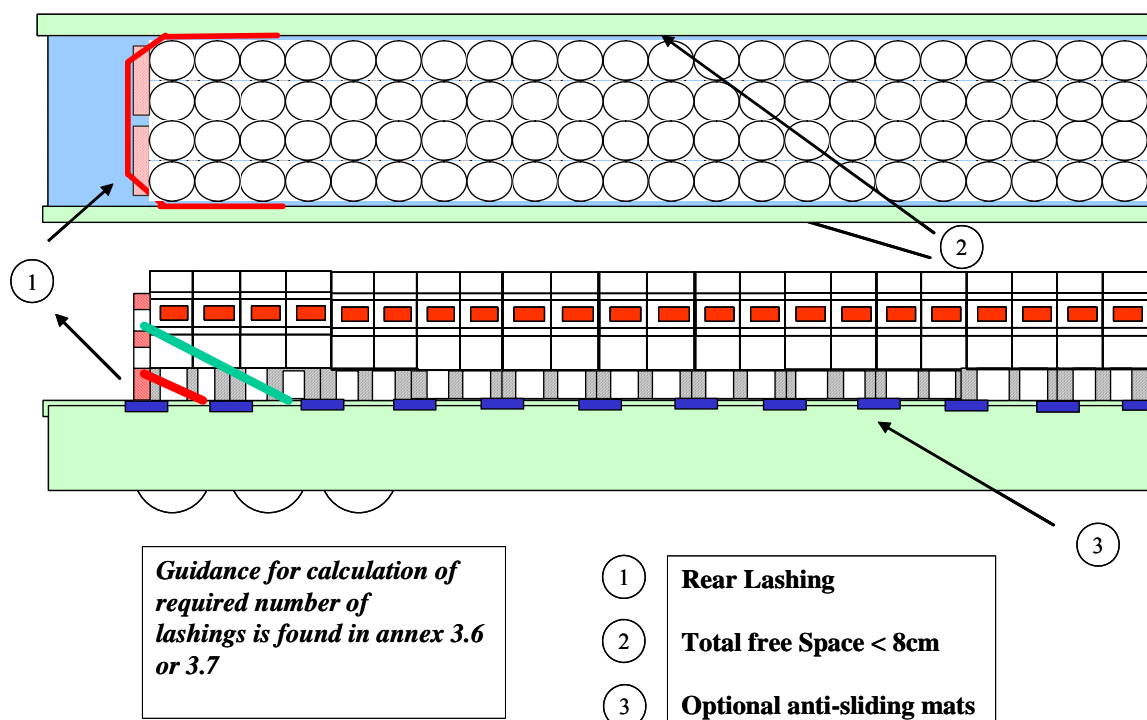
The lashing straps are supported by rigid edges to prevent the lashes to slip between the drums.



8.9.2.3. Palletized drums in combination with form-locked securement in an open sided trailer (cover/stake body types or tilt trailer).

Drums are loaded against the head board, two pallets on one row. Total free space side by side is less than 8 cm. Otherwise free spaces should be filled with filler material to have proper form locked securement. At the end a rear lash with two pallets and two lashings are used.

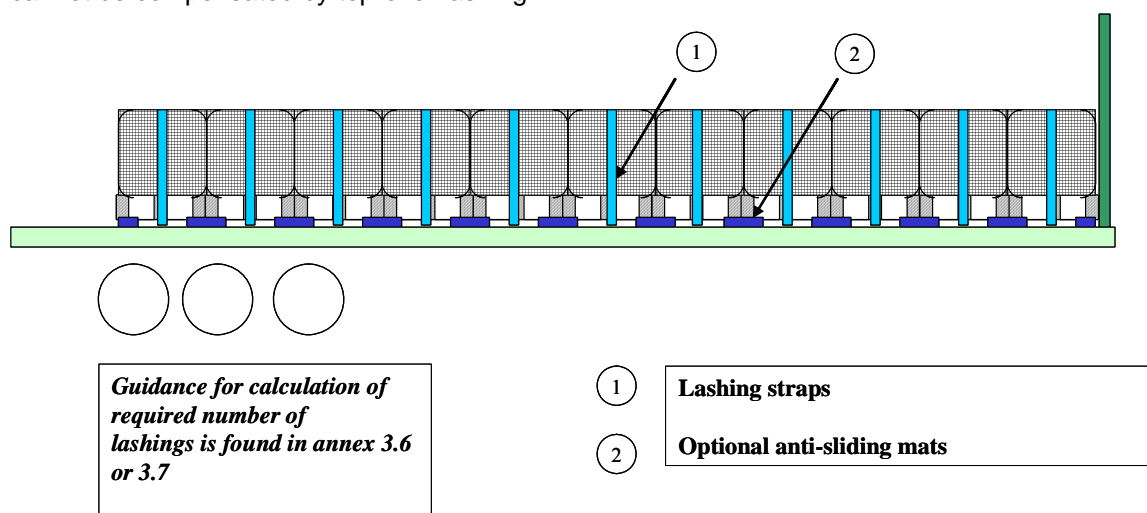
Extra friction material should be used in case the friction between load and floor is low.



8.9.2.4. Palletized IBC's in combination with top-over lashing in a curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).

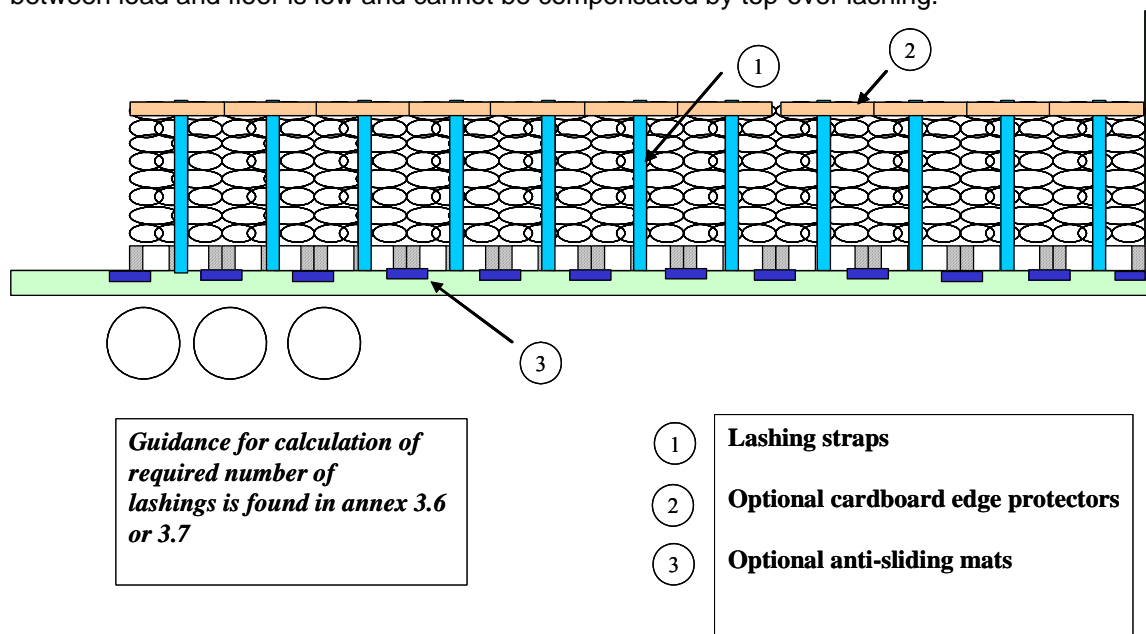
IBC's are loaded against the head board. One top-over lashing should be used for every row of two IBC's.

Extra friction material should be used in case friction between load and floor is low and cannot be compensated by top-over lashing.



8.9.2.5. Bags on pallets in combination with top-over lashing in a curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).

One top-over lashing should be used for every row of two bags. Optional card board edge protectors should be used to prevent damage of the bags. Extra friction material should be used in case friction between load and floor is low and cannot be compensated by top-over lashing.

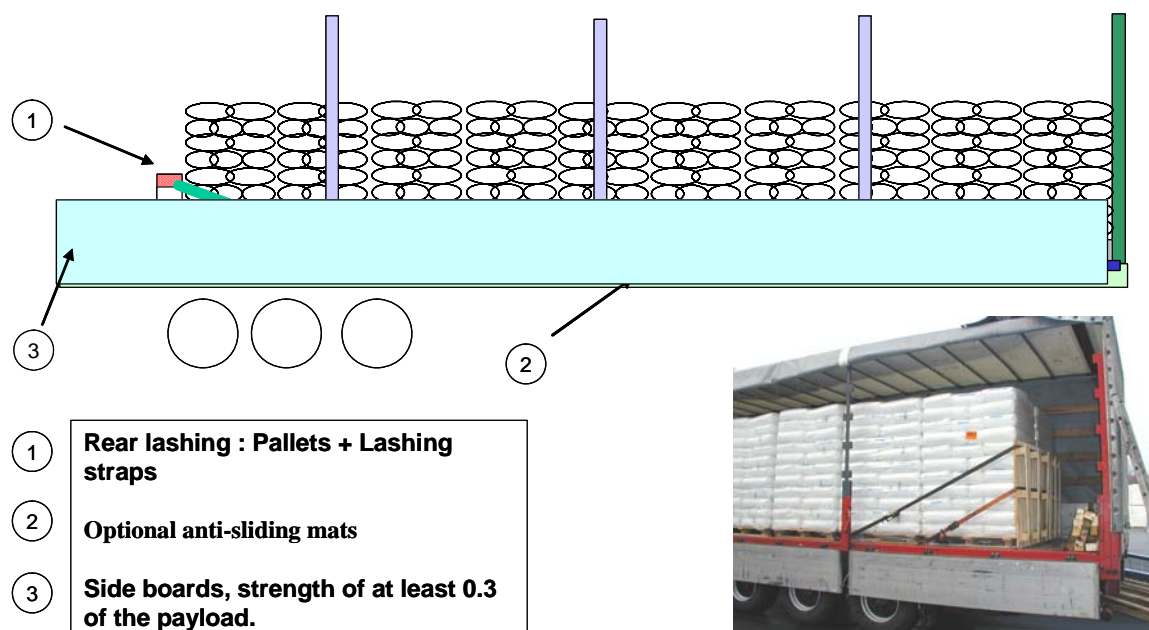


8.9.2.6. Bags on pallets in combination with form-locked securement in an open sided trailer (cover/stake body types or tilt trailer).

Total free space side by side is less than 8 cm. Otherwise free space should be filled with filler material to have proper form locked securement.

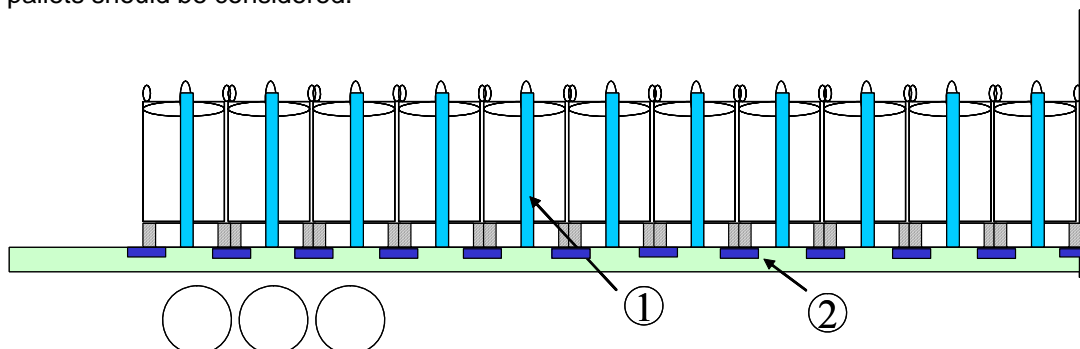
At the end a rear lash with two pallets and two lashings should be used.

In case the friction of the load floor in combination with the pre-tension of the top-over lashing is not sufficient, anti-sliding mats under the pallets should be considered.



8.9.2.7. Big bags in combination with top-over lashing in a curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).

One top-over lashing should be used for every row of two bags. In case the friction of the load floor in combination with the pre-tension of the top-over lashing is not sufficient, anti-sliding mats under the pallets should be considered.



Guidance for calculation of required number of lashings is found in annex 3.6 or 3.7

- ① Lashing straps
- ② Optional anti-sliding mats

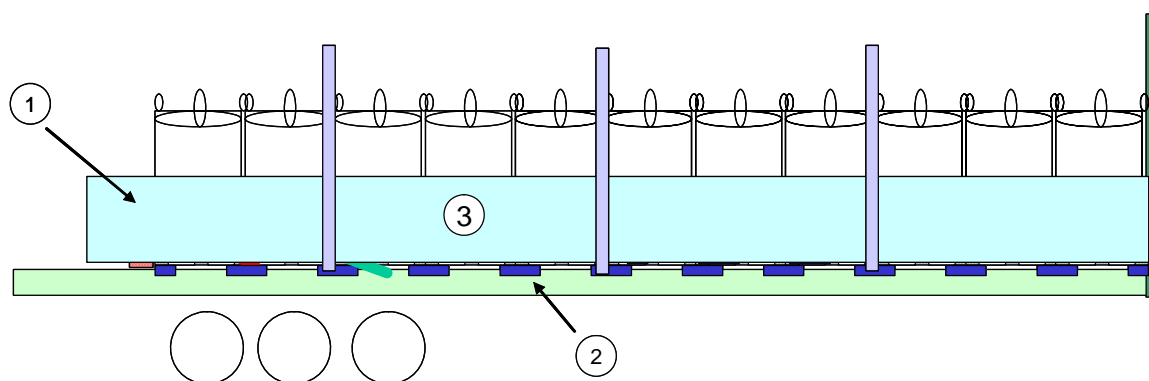


8.9.2.8. Big bags in combination with form-locked securement in an open sided trailer (cover/stake body types or tilt trailer).

Total free space side by side is less than 8 cm. Otherwise free space should be filled with filler material to have proper form locked securement.

At the end a rear lash with two pallets and two lashings should be used.

In case the friction of the load floor in combination with the pre-tension of the top-over lashing is not sufficient, anti-sliding mats under the pallets should be considered.

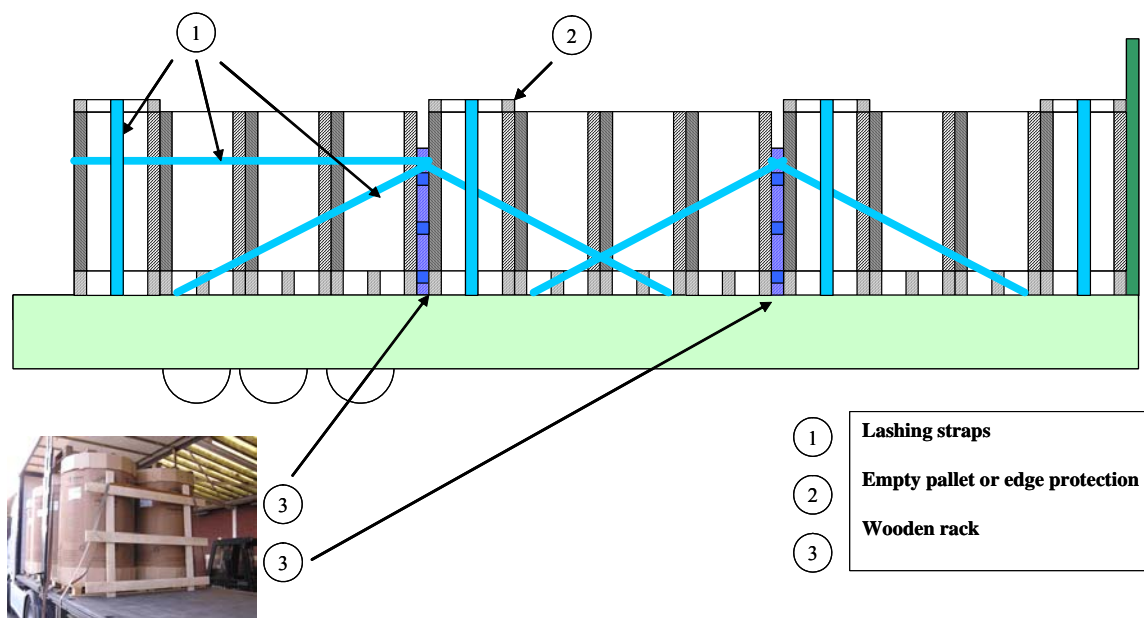


- ① Rear lashing : Pallets + Lashing straps
- ② Optional anti-sliding mats
- ③ Side boards, strength of at least 0.3 of the payload



8.9.2.9. Octabins in a certified curtain sider or in an open sided trailer (cover/stake body types or tilt trailer).

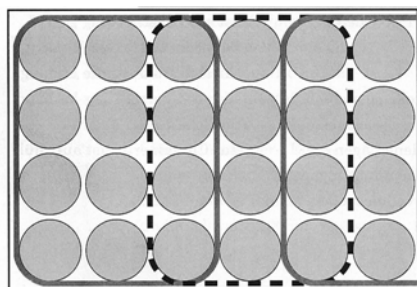
A full load of 24 octabins is separated in three groups with wooden racks in between. The wooden racks assure that the slope lashing stay in position. The top-over lashing is strapped over an empty pallet on top of the octabin to prevent damage of the package. The last eight octabins are grouped together with a horizontal lashing. * Footnote: This type of cargo securing can only be used in vehicles with a side protection that can withstand 30% of the maximum cargo weight.



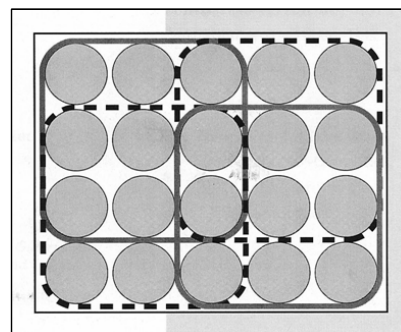
8.9.2.10. Loose drums double-stacked in a container.

Both layers are strapped in an Olympic ring formation. Sturdy cardboard sheets or equivalent should be used to cushion and increase friction between the layers, to prevent cargo damage and movement.

Equally-sized packages, e.g. 200L drums, should be tightly blockstowed to fill the whole CTU loading platform, then bound together by overlapping securing straps in a ring formation



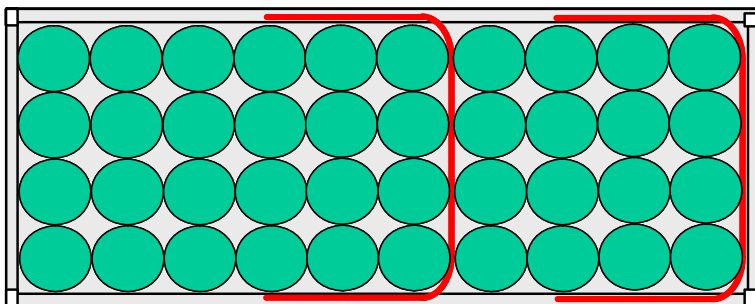
"Olympic Ring" Formation (Top view)



Steel drums, block-stowed and secured with overlapping straps.



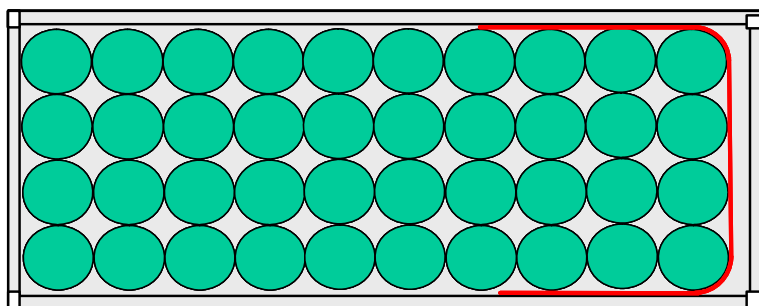
Steel drums, double-stacked in a block stow, and secured by tensionable straps which are fixed to the framework of the container.



Top view



Steel drums secured by high strength self-adhesive polymer film, which is stuck firmly onto the inner side-walls of the container. Humidity may lower the security effect.

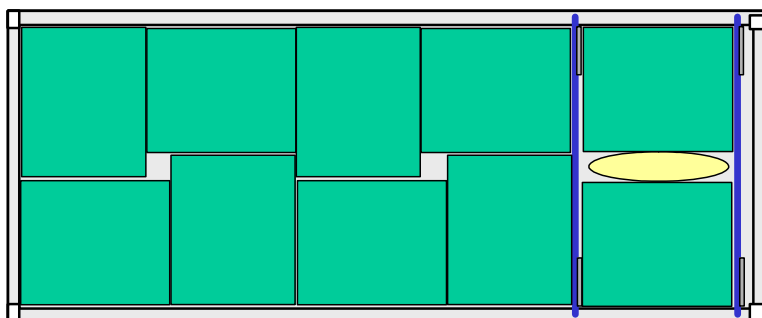


Top view



8.9.2.11. IBCs double stacked in a container.

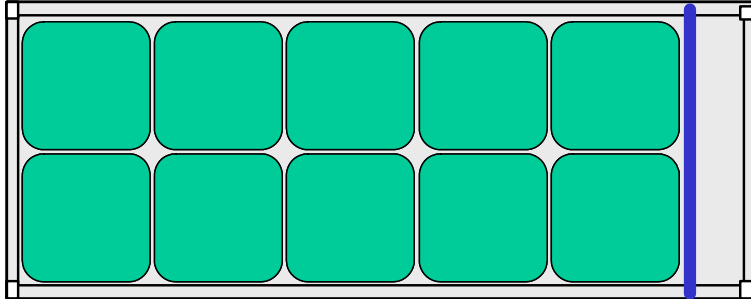
IBCs, blocked by horizontally inserted timber planks, and void spaces filled with air bags or equivalent packing material.



8.9.2.12. Palletized bags with chemical goods loaded in a container.

Palletized chemical goods loaded in a container. Double stacking of palletized goods, blocked by horizontal timber planks, fixed by vertical timber battens.

Damage to soft packages from the blocking equipment may be prevented with sturdy cardboard sheets or similar.

**Top view**

8.10 *Planning*

Cargoes handled in the transport chain represent a high economical value. Therefore it is of great importance that the transport is performed in such a way that cargo damage is avoided. This has also an influence on the safety of the persons directly or indirectly involved in the transport chain and increases the importance of a good performance.

Correct handling of transported products also requires knowledge about packing, loading and securing of the cargo. A general awareness of the necessity of cargo care is basic for a good result.

Awareness of good cargo care diminishes the importance and frequency of cargo damages achieving at the same time, a better work environment and less wear of transport vehicles, cargo units, equipment, etc..

8.10.1 **Choice of route and transport mode.**

Transport lead-time and cost have a big influence when choosing route and transport mode in order for the consignee to get the products delivered as fast and cheap as possible. But the success of the transport operation depends also whether the consignee gets the right product, right quantity, right quality and right information to the right place.

Therefore when negotiating transport services it is necessary to have full information regarding transport options and to choose the way the transport is fulfilled and thereby the transport quality accordingly. Even if a specific mode of transport must be used the choice between different types of services, e.g. forwarding companies and vehicles, makes that the transport can be performed in better or worse conditions.

Reloading is a weak point in the transport chain. Cargo damages often happen directly or indirectly during loading/reloading at terminals, for instance between different transport modes or between different CTUs. For this reason it is worth reducing the number of reloading points (hubs) and to quality assure them where possible.

8.10.2 **Cargo transport planning.**

Planning is required to achieve good result when stowing and packing a cargo transport unit (figure 8.10.2 1). Recurrent as well as occasional shipments should be planned with the aim to use the cargo transport unit best adapted to the mode of transport and the cargo.

It is also essential that all personnel involved in loading and securing have good education and training in cargo handling especially regarding the forces acting on the cargo and the cargo transport unit during the transport. A basic requirement is that adequate equipment and material for loading and securing of the cargo in question is provided prior to the transport.

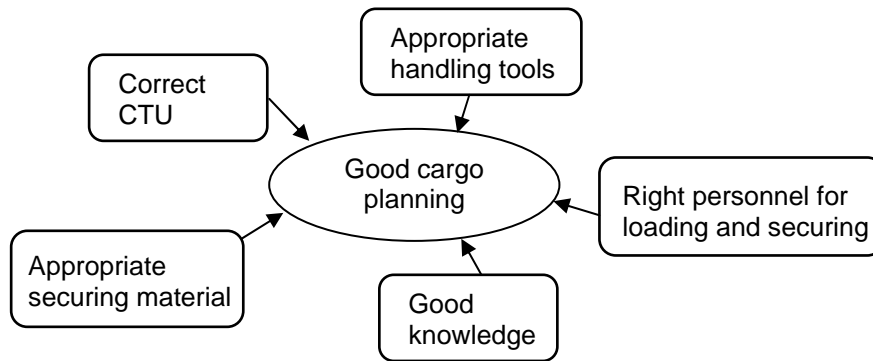


Figure 8.10.2-1: Necessary elements for good cargo transport planning

8.10.3 Choice of cargo transport unit (CTU)

When choosing a CTU for a particular transport a number of factors have to be considered (figure 8.10.3 1). For certain transport operations CTUs with strong walls like containers or box type trailers are required. In other cases semi-trailers or swap bodies may be adequate.

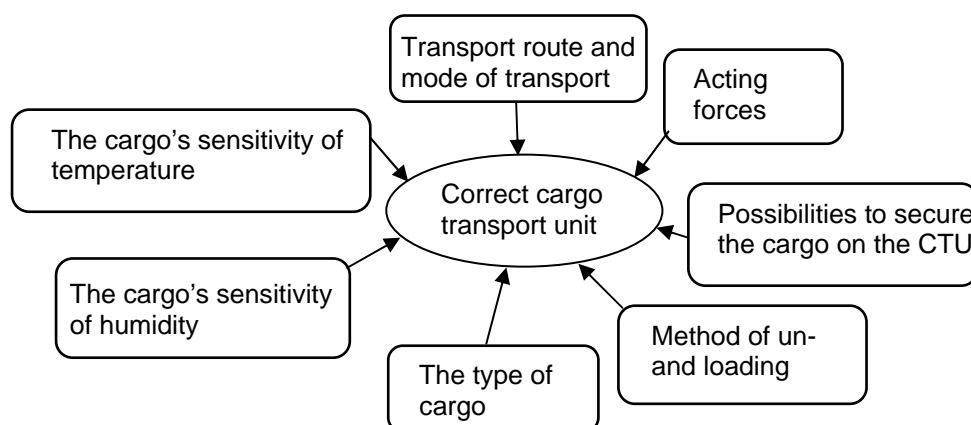


Figure 8.10.3-1: Factors influencing the choice of CTU

8.10.4 Utilisation of the volume and weight capacity of the cargo transport unit

Transportation involves great costs. It is therefore important to utilise as much as possible the volume as well as weight capacity of the CTU. For optimal results it is necessary to plan and calculate the loading procedure and to choose a suitable CTU.

Prior to packing it is advisable to draw a sketch showing the positions of the different packages in the unit. With such a cargo plan it will be possible to see if there is space for all the intended pieces of cargo in the unit, how the cargo should be secured and how the weight will be distributed in the unit.

8.10.5 CTU Cargo securing manual

If the same type of cargo is repeatedly loaded on the same type of CTU it could be appropriate to prepare a cargo securing manual for the manufacturer's products. Such a manual will contain standardised methods for loading and securing the products in different CTUs, for different modes of transport and different routes. The manual shall also describe how the cargo should be secured by assigning type, strength and number of different securing equipment (figure 8.10.5 1).

OY SHELL AB
1999-10-08
MariTerm AB
Page 1 (2)

CARGO SECURING CERTIFICATE

1.A. Drum pallets stowed in one or two layers in trailers with drop sides for road and Baltic Sea transport.

① Top-over lashing, 4-ton web. Two per section.
② Empty pallet
③ Corner protection

• Additional instructions are found on page 2

This is to certify that the dimensioning basis is according to this certificate	This is to certify that the cargo securing method in this certificate, correct performed, fulfils the Swedish Road Regulations TSVP-S 1978:10 paragraph 1.3.2 and the regulations of the Swedish Maritime Administration SIOFS 1994:27 paragraph 7	This is to certify that loading and securing has been performed according to instructions in this certificate.
HELSINKI 1999-10-08 Dick Barklund Office Manager OY Shell AB P.O. Box 30 FIN-00031 Helsinki Tel. +358 204 43 2850 Fax. +358 204 43 2851	HÖGANÄS 1999-10-08 Peter Andersson MariTerm-TSAB AB P.O. Box 74 SE-263 21 Höganäs Tel. +46 42 35 31 00 Fax. +46 42 35 31 02	See letter from the Swedish Maritime Administration dated 1997-07-20 Direct/packat

Figure 8.10.5-1: CTU Cargo securing manual

8.10.6 Requirements from the receiver of the cargo regarding cargo packing.

For the packing of a cargo the conditions of the unloading place have to be considered. As an example two-way pallets loaded from the rear can be seriously damaged if they have to be unloaded from the side (figure 8.10.6 1). It is therefore important to perform the loading as far as possible according to the requirements of the receiver.

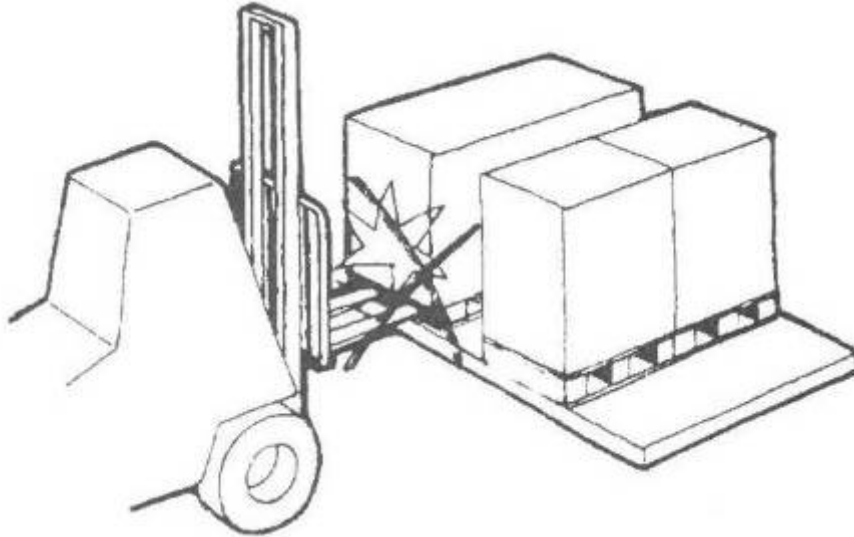


Figure 8.10.6-1: Complications may occur if the requirements of the receiver are not considered

8.10.7 Inspection of CTUs.

A cargo unit is submitted to tough wear and tear conditions. Therefore it is of great importance that the unit is carefully inspected before being used. The inspector must especially consider the modes of transport along the unit's itinerary towards the final destination. The following checklist should be followed:

1. The framework of the unit is essential for the total strength and should therefore be intact (figure 8.10.7 1). If the framework is twisted, shows cracks or other signs of damage , the unit should not be used.

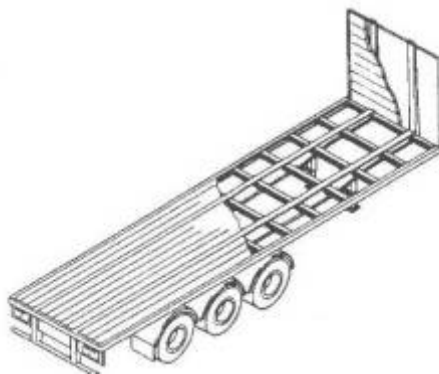
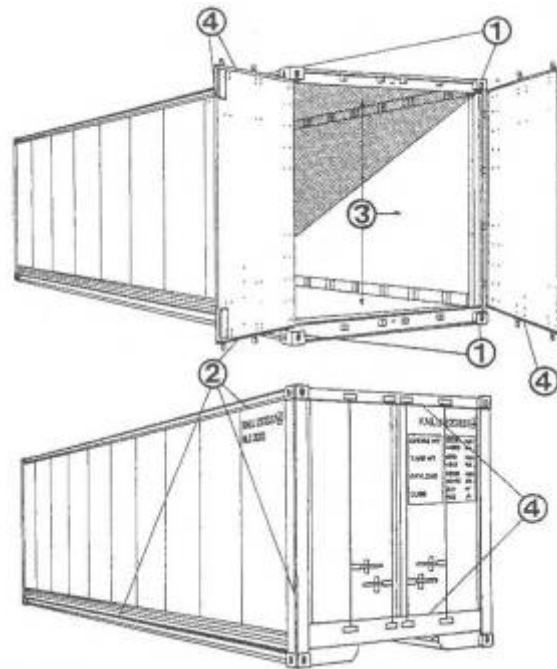


Figure 8.10.7-1: It is important to check the framework of the unit

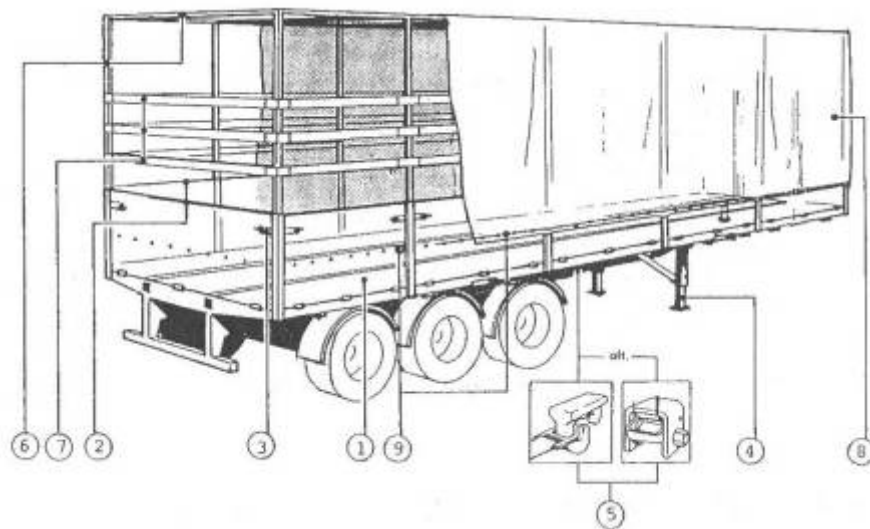
2. Walls, floor and roof should be in good condition. Doors, sideboards, canopy and other parts of the unit must be undamaged and in good working condition. It should also be possible to safely close and seal the. It must be possible to shut and lock doors and even secure them in open positions. Sealing in doors and ventilation openings must be

undamaged (figures 8.10.7 2 and 8.10.7 3).



- 1) Corner fittings
- 2) Welding in framework and walls
- 3) Walls, floor and roof
- 4) Door sealing

Figure 8.10.7-2: Inspection of a container



- 1) Load platform
- 2) Sideboards
- 3) Locking device
- 4) Support legs
- 5) Cargo securing device
- 6) Cover stanchions
- 7) Cover laths
- 8) Canopy
- 9) Canopy seal

Figure 8.10.7-3: Inspection of a semi-trailer

3. A container on international traffic should be affixed with a valid International Convention for Safe Containers (CSC) safety approval plate (figure 8.10.7 4). The Convention is published by the International Maritime Organization (IMO). A swap-body may be required to have a yellow code plate fixed at its side wall, which proves that it has been codified in conformity with the safety rules of European railways. Details are to be found from International Union of Railways (UIC).



Figure 8.10.7-4: Safety approval plate on container

Information on the safety approval plate:

- 1) Country of approval and certificate number
 - 2) Date of manufacture (month and year)
 - 3) Manufacturer's identification number
 - 4) Maximum gross weight (kg and lb)
 - 5) Allowed stacking weight (kg and lb)
 - 6) Racking test load value (kg and lb)
 - 7) Strength of end walls. Only if end walls are designed to sustain forces other than 40% of the payload.
 - 8) Strength of side walls. Only if end walls are designed to sustain forces other than 60% of the payload.
 - 9) Date for latest in-house condition check (month and year)
4. Irrelevant dangerous goods labels and instructions on the cargo unit should be removed or masked (figure 8.10.7 5).

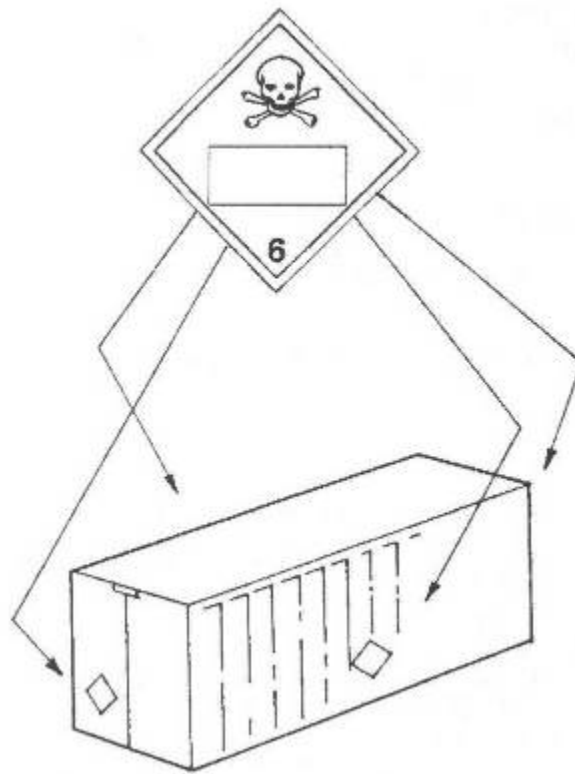


Figure 8.10.7-5: Remove or mask all irrelevant dangerous goods labels and instructions on the cargo unit.

5. If the unit is to be transported on different modes of transport it must be equipped with suitable securing devices (figures 8.10.7 6 and 8.10.7 7).

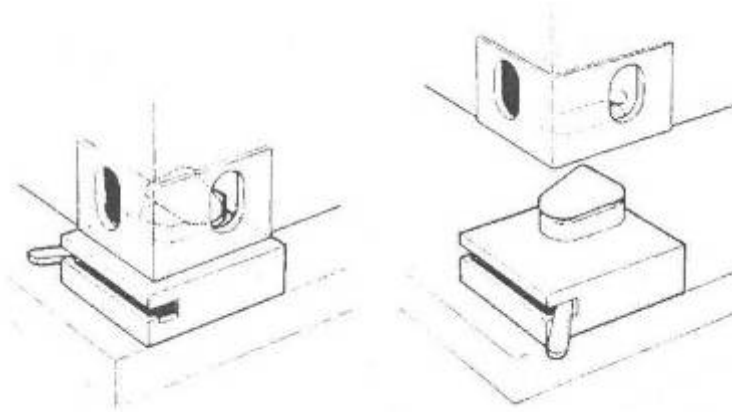


Figure 8.10.7-6: Corner fittings on a container or a swap body for securing on truck, railway wagon or ship

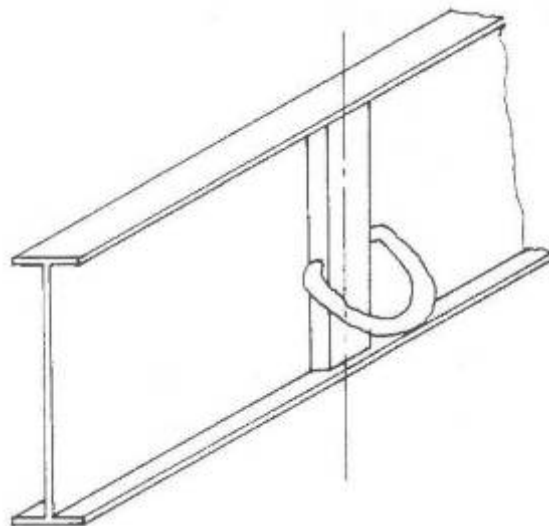


Figure 8.10.7-7: Lashing point suitable for securing a semi-trailer onboard a ship

6. A closed cargo unit should normally be weatherproof. Previous repairs should be carefully checked. Potential points of leakage may be detected by observing if any light enters a closed unit.
7. Check that the inside of the unit is undamaged and that the floor is in good condition. Protruding nails, bolts etc. which could cause injury to persons or damage to the cargo should be removed.
8. Lashing and blocking points inside the unit should be in good condition and well anchored.
9. The unit should be clean, dry and free from residues and odours from previous cargoes.
10. A folding unit with movable or removable main components should be correctly assembled. Care should be taken to ensure that removable parts not in use are packed and secured inside the unit.

8.11 *Acceleration and deceleration forces*

ACCELERATIONS TO BE CONSIDERED			
Total horizontal and vertical Accelerations acting at the same time			
		a _h (g)	a _v (g)
Road, forwards		1.0 ¹	1.0 (¹ 0.8 according to CEN)
backwards		0.5	1.0
sideways		0.5 ²	1.0 (² +0.2 for unstable goods acc to CEN)
Rail, forward/backwards		1.0 ³	1.0 (³ 0.6 for tipping over calculations)
to the side		0.5	0.7 ⁴ (⁴ 1.0 for tipping over calculations)
Sea, forward/backwards	Sea area A	0.3	0.5
	Sea area B	0.3	0.3
	Sea area C	0.4	0.2
Sea, sideways	Sea area A	0.5	1.0
	Sea area B	0.7	1.0
	Sea area C	0.8	1.0

Source: IMO/ILO/UN ECE Guidelines for packing of cargo in Transport units

8.12 *List of abbreviations and acronyms*

ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
CEN	European Committee for Standardisation
CTU	Cargo Transport Unit
CV	
EN	European Norm
EU	European Union
ILO	International Labour Organisation
IMO	International Maritime Organisation
ISO	International Standard Organisation
LC	Lashing Capacity
SHF	Standard Hand Force
SNRA	Swedish National Road Administration
STF	Standard Tension Force
TFK	Transport Research Institute of Sweden
TSVFS	Trafiksäkerhetsverkets Författningssamling
UN	United Nations
UNECE	
MSL	Maximum Securing Load
WLL	Working Load Limit

8.13 *Literature overview and references*

- Code of Practice, Safety of Loads on vehicles ISBN 011 552547 5
- TFK Handbook 1982:6E,
Loading and Securing Cargo on Load Carriers ISBN 91 869 44 479
- Safe packing of cargo transport units, Model Course ISBN 92-801-5116-9
- SNRA regulation,
Securing of Cargo on Vehicle During Transport ISSN 1401- 9612
- IMO/ILO/UNECE,
Guidelines for packing of cargo transport units (CTUs) ISBN 92-01-1443-3
- IMO/ILO/UNECE
Model course 3.18 Safe Packing of Cargo Transport Units
Course ISBN 92-801-5127-4
Working book ISBN 92-801-5116-9
- CARGO CARE
Loading and securing of cargo to increase delivery quality ISBN 91-972436-5-6
TYA, A Simple Guide on Securing of Cargo
- SNRA regulation, TSVFS 1978:9, BOF 10
Föreskrifter om utrustning för säkring av last
- SNRA regulation, TSVFS 1978:10, FT 3.15.1
Föreskrifter om säkring av last på fordon under färd
- CEN Standards
- EN12195 Load restraint assemblies on road vehicles
Part 1: Calculation of lashing forces
Part 2: Web lashings made from man-made fibres
Part 3: Lashing chains
Part 4: Wire lashing ropes
- Ladungssicherung auf Fahrzeugen BGI 649
BGL-/BGF-Praxishandbuch Laden und Sichern
VDI 2700 Ladungssicherung auf Straßenfahrzeugen
- Blatt 1: Ladungssicherung auf Straßenfahrzeugen - Ausbildung und Ausbildungsinhalte
 - Blatt 2: Ladungssicherung auf Straßenfahrzeugen – Zurrkräfte
 - Blatt 3: Ladungssicherung auf Straßenfahrzeugen - Gebrauchsanleitung für Zurrmittel
 - Blatt 4: Ladungssicherung auf Straßenfahrzeugen – Lastverteilungsplan
 - Blatt 5: Ladungssicherung auf Straßenfahrzeugen - Qualitätsmanagement-Systeme
 - Blatt 6: Ladungssicherung auf Straßenfahrzeugen - Zusammenstellung von Stückgütern

- Blatt 7: Ladungssicherung auf Straßenfahrzeugen - Ladungssicherung im Kombinierten Ladungsverkehr (KLV)
- Blatt 8: Ladungssicherung auf Straßenfahrzeugen - Sicherung von Pkw und leichten Nutzfahrzeugen auf Autotransportern
- Blatt 9: Ladungssicherung auf Straßenfahrzeugen - Ladungssicherung von Papierrollen

VDI 2700a Ausbildungsnachweis Ladungssicherung

VDI 2703 Ladungssicherung auf Straßenfahrzeugen -
Ladungssicherungshilfsmittel

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abbreviations
A-blocks
abrasion
accident
acids
acronyms
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angle
attachment
axles
bags
bales
band
barrels
bars
battens
beams
bending
blocking
boards
booms
bore
bounding
box type
boxes
braces
bracing
braking
breaks
bulk
bundles
calculation
cardboard
carpets
carts
castings
CEN
centre of gravity
certificate
chain
clamp
clearance

closure force
coefficient
coil
combined transport
concentration
concrete
construction equipment
containers
corner
corrosion
cover, cover stake
crushing
CTU
curtains
curtainsider
cushions
CV
cylinders, cylindrical
damage
dangerous goods
deformations
density
doors
drums
dunnage
edge profiles
elongation
EN standards
endboard
endwalls
engineering plant
EURO pallet
filler
filling
fissures
flaws
forces
frames
friction
gaps
gates
glass
gravity
gusset
GVW
hand force
handling
hanging load
headboard
heights

hoists
hooks
IMDG code
IMO/ILO/UNECE
inspection
ISO
kinks
landing legs
Lashings, lashing capacity
(LC)
laths
layer
levers
liability
lift truck
limit values
liquid
load
load distribution
loading
loading equipment
locking
locks
logs
loop
loose
lorries
lugs
machinery
maintenance
mass
mats
metric
modes of transport
movement
multimodal
nails
nets
Newton
open side
pallet
panels
paper
pillar
planks
planning
plastic
platform
polyamide
polyester

polypropylene
profile
protectors
pulley
rail
ratio
restraining
rigidity
road
rod
rollover
roll-type
roof
rope
round turn
rows
rubber
runners
sacks
sea
section
securing
semi-trailers
shape
sheet
ship
shocks
shrink
sideboards
sidewalls
sill
size
skip containers
sliding
spacers
speed
splits
spring
stacking
stanchions
steel
stowage
stowing
straddles
strands
straps
stretch
struts
swap bodies
tension force

tensioner
tensions
threads
threshold
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tipping
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transport modes
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trestles
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units
unloading
walking boards
walls
waterway
wear
webbing
wedges
vehicle
weight
well
velocity
wet
wheel
wheeled pallets
vibrations
wire
wood

8.15 Training on Cargo Securing

European Legislation

According to Commission Directive 2000/56 EC *"safety factors relating to the vehicle, the load and persons carried"* have to be contents of the driver license test for all categories of vehicles. Specifically, truck drivers' knowledge on *"Safety factors relating to vehicle loading: controlling the load (stowing and fastening), difficulties with different kinds of load (e.g. liquids, hanging loads, ...), loading and unloading goods and the use of loading equipment (categories C, C+E, C1, C1+E only)"* has to be tested.

According to Directive 2003/59 EC of 15 July 2003 the training for "professional drivers" has to contain (among many other issues):

- *ability to load the vehicle with due regard for safety rules and proper vehicle use;*
- *forces affecting vehicles in motion, use of gearbox ratios according to vehicle load and road profile, calculation of payload of vehicle or assembly, calculation of total volume, load distribution, consequences of overloading the axle, vehicle stability and centre of gravity, types of packaging and pallets;*
- *main categories of goods needing securing, clamping and securing techniques, use of securing straps, checking of securing devices, use of handling equipment, placing and removal of tarpaulins.*

This general description of contents should be complemented by more detailed information in national syllabuses, or at least in the syllabuses of the institutions carrying out this training.

Standards

Detailed information on the contents of cargo securing training is described in the German VDI standard "VDI 2700, Blatt 1" or the "IMO/ILO/UN ECE Guidelines for Packing of Cargo Transport Units". The following recommendations are partly based on these standards.

Personnel to be trained

- Truck drivers,
- personnel concerned with loading/unloading of vehicles,
- fleet managers,
- personnel concerned with planning of itinerary, loading and unloading locations,
- enforcement bodies

At least in bigger enterprises it is recommended to have at least one person with a very high qualification in cargo securing to support all other staff member in question of cargo securing, or even giving internal training on cargo securing and to handle difficult problems which cannot be solved by less trained staff members. In other areas such as dangerous good, waste treatment, working safety, maintenance of health such functions have been installed by European or national legislation.

Structure and contents of training

It is recommended to design courses, course types or course elements which consider the needs of the trained persons or can be combined to fit to these needs. Particularly the contents of all training measures should take into account

- the function of the trained persons,
- the type of cargo transported,
- the types of vehicles used,
- the branch

All training courses or lessons should be started by providing information on the basic issues of cargo securing:

- legislation on cargo securing, responsibilities and technical rules,
- national and international technical standards for cargo securing,
- other information sources,
- physical principles, weights and forces,
- basic principles and methods of cargo securing and
- restraining material.

As one approach, the following types of cargo and other fields of knowledge may be grouped in a useful way and distributed on different course types of course elements to be combined to a training measure fitting the customers' needs:

- mixed cargo on pallets or similar transportation devices
- standardised cargo containers, e.g. mixed cargo containers, containers on wheels
- self propelled machines (mobile cranes, concrete pumps, refuse lorries, concrete mixers)
- containers and swap bodies
- all cargo directly loaded onto the truck (not palletised load)
- stacked cargo
- all cargo with securing problems deriving from its shape (e.g. drums, rolls, tubes, sacks, etc.)
- wood (whole trees and sheet material)
- oversized cargo (e.g. boats, wood and concrete beams, etc.)
- sheet material (steel sheets, glass, concrete) in vertical, almost vertical and horizontal position
- liquid cargo and quasi-liquid cargo (e.g. powder)
- hanging loads
- animals
- vehicles
- exact calculation methods for cargo securing,
- load distribution plan
- standards for vehicle design, construction and equipment to support vehicle purchase decisions

All training sessions should include an appropriate share of practical training directly referring to its contents. A share of at least 30% of practical training is recommended.

It is recommended that road side checks are carried out using the same standards which are used for training for drivers and other staff. Road side checks should be carried out by specifically trained staff. All members of enforcement bodies concerned with traffic supervision should receive at least training about the basic issues of cargo securing, as mentioned above. Staff members carrying out dedicated supervision measures for heavy goods vehicles should be trained as experts also in all the other fields mentioned above.

8.16 Acknowledgements

The Commission wishes to thank all involved, and especially the following experts contributing to the elaboration of these guidelines, whose in-depth knowledge of the subject has been essential to the completion of this document.

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