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Container packing



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1. Introduction

Hapag-Lloyd's aim is to ensure safe and fast transportation for all types of cargo, despite the conditions that may influence the transport chain.

This brochure will provide you with information that will enable you to protect your cargo during shipment as well as our container and vessels.

Proper stowage and securing of the cargo will be explained. The facts observed in this brochure are based on the experience and knowledge from our stowage advisors, ship commands and an analysis of cargo damages.

The benefit of stowing cargo safely inside containers includes smooth transport processing without claims or extra costs, and customer satisfaction. In the beginning stowage equipment and man hours will be an expense, however at the end, you the customer will receive the benefit of transporting cargo with us.

Keep in mind that this manual will not answer all the questions you may have about packing cargo. If you need any further advice or information regarding shipments, the Hapag Lloyd sales office will link you to one of our experts.

Please contact us if you have any questions or comments. We will gladly advise you via fax, phone, e-mail and in person.

Hapag-Lloyd Container Line
Special Cargo Department

2. Strains caused by container transport

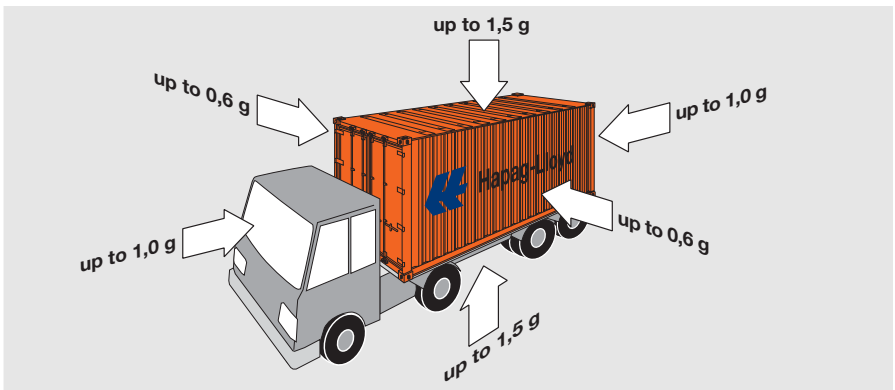
2.1. Mechanical strains

The cargo securing must withstand strains resulting from sea and land transport as well as from container handling. The closed container prevents any visual inspection of the cargo inside. Once packing has been done, correction of stowage can not be achieved. Thus the packing company has to know what kinds of strains occur during sea passage. Basically we differentiate between two types of mechanical strains.

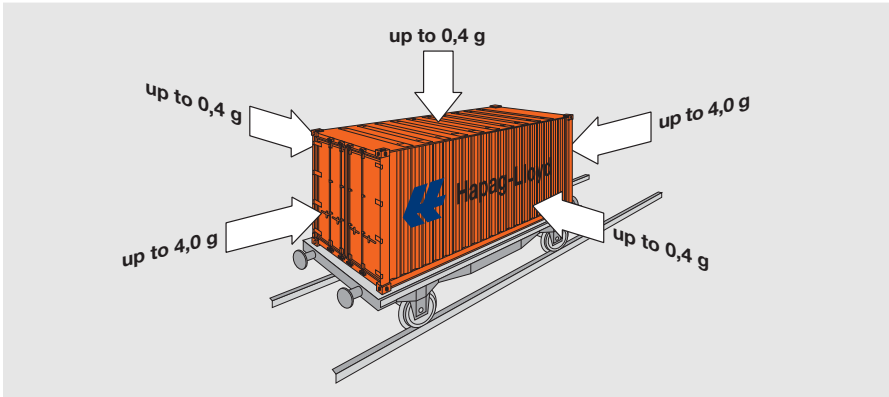
Static strains are caused by storage and stacking. The main factor is stacking pressure which results in bending and folding strains on the bottom layer of the cargo. The stacking pressure depends on the dimension, weight, shape and height of the units stacked.

Dynamic strains occur to the cargo during stuffing of the container, during land or sea transport and during handling of the container. There is a difference between acceleration, shock and vibration. Acceleration and shock occur during loading, braking, shunting, handling, lifting, setting down and in curves. At sea there will be continuously acceleration during rolling, pitching, yawing and vertical motion. Vibrations, caused by the ships engine, gear and propeller, truck suspension, road and railway surface, etc, occur in a wide range of frequencies and amplitudes.

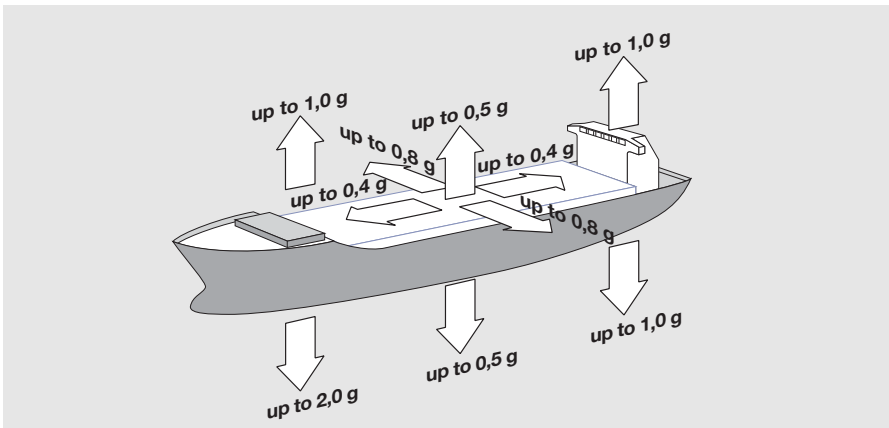
Normally it is not possible to know the acceleration in advance, which will affect the container during a voyage. One can work only by the rules of thumb. In this context please see the figures down below. The letter "g" means the gravitational acceleration ($g=9,81 \text{ m/s}^2$). It is possible, that during shocks and vibrations the acceleration is much higher/greater.



Potential acceleration during truck transport.



Potential acceleration during railway transport.



Potential acceleration during sea transport.

2.2. Climatic strains

Goods are quite often subject to considerable climatic strains while being transported. Initially they appear during storage and container packing. The strains are caused by being exposed to very alternating climatic zones while being transported by truck, rail or barge, during loading, but especially during sea transport. Extreme climatic strains can occur during shipments in the winter at temperatures below-zero and transport into or through tropical zones, as well as during transport from the tropics to temperate climates.

All closed containers protect the cargo inside against external climatic influences such as rain, snow, sea water, salt water spray, dust and the sun (heat and UV radiation).

Even if the cargo is protected against external influences, condensation may occur inside the container. Thus the relative humidity inside the container is determined by the temperature and air humidity at time of packing. Sources of humidity can be also the cargo itself, the packing material or the dunnage. Some cargoes emit plenty of humidity over a long period of time. Most packing, dunnage and some cargoes can absorb humidity.

Condensation may occur, when a drop in temperature coincides with a source of humidity inside the container. In particular, moisture condenses at the container walls, container roof or on the packages. Condensate humidity can drip from the roof onto the cargo. This may cause cargo damages like rust, mould, stain, discoloration, sticking together of wet cartons, peel off labels or collapse of the stack.



Condensed water at container roof.

The temperature inside a container depends on outside temperature and the stowage position on board. The container can be heated by direct incident solar radiation on deck or by heated fuel tanks in hatch. The air temperature within the container below the roof can diverge from outside temperature by 20 to 30°C and inside the cargo by 10°C. So a temperature up to 60°C is possible inside the container. Furthermore, the temperature can be affected by spontaneous heating of the cargo itself.

2.3. Biological strains

High temperature, humidity and less air flow inside the container promote an increase in insects, fungal, moulds, bacteria and micro-organisms. The cargo or dunnage is mostly contaminated before loading. Insect infestation from outside to a closed container is very seldom. Therefore the cargo is to be prepared very carefully to avoid biological strains.

Several countries regulate the fumigation of dunnage by law. The shipper needs a certificate, that the used wood is free of insects.

2.4. Chemical strains

Chemical strains depend on temperature, humidity and movement of the vessel. Some chemical products can heat themselves. The transport has to be arranged according to the dangerous goods regulations.

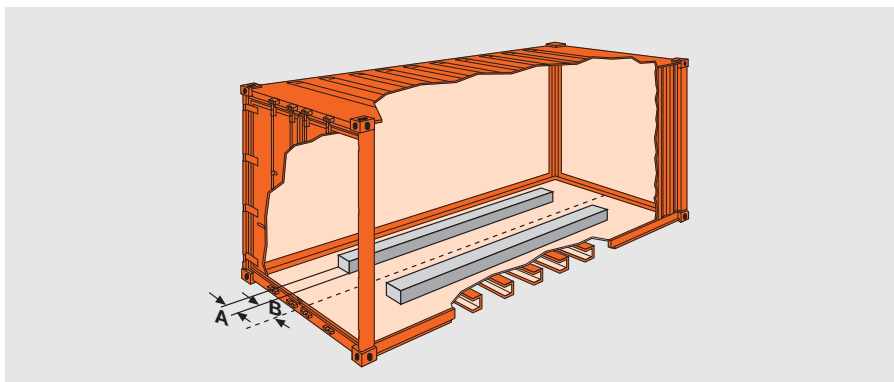
For further questions please contact our dangerous goods department or refer to the IMDG Code published by the International Maritime Organisation (IMO).

3. Preparations for container transport

3.1. Weight limits and weight distribution of standard containers

The weight limits of Hapag-Lloyd containers correspond to the international ISO standard 668. The permissible gross weight for most Hapag-Lloyd 20' standard containers and all 40' standard containers is 30480 kg. Containers with a higher gross weight might be possible in the future. Depending on the constructional series, the technical maximum payload results from the permissible gross weight minus tare of the container, and can vary. You will find more precise details in the Hapag-Lloyd-brochure "Container Specification". Apart from the constructional defined load capacity of the container, the permissible weight limits of road and rail transport in the respective countries must be considered. Details on the possibilities and restrictions of land transport can be obtained from our Hapag-Lloyd sales offices.

The bottom cross bars are the load support elements, which carry the cargoes weight. If the permissible payload is fully used, all bottom cross bars should be loaded by the cargo or in other words, the weight has to be distributed over the full length. The floors in the containers are not constructed for selective loads. If cargo length is shorter, the permissible load is reduced. The maximum spread load should not exceed 4,5t per running meter lengthwise for 20' container and 3t per running meter for 40' container. You can calculate this figure as follows: the weight in metric tons divided by the length of cargo in meters. Example: weight 10 t, length 4 m, line load: $10/4=2,5\text{ t/m}$.



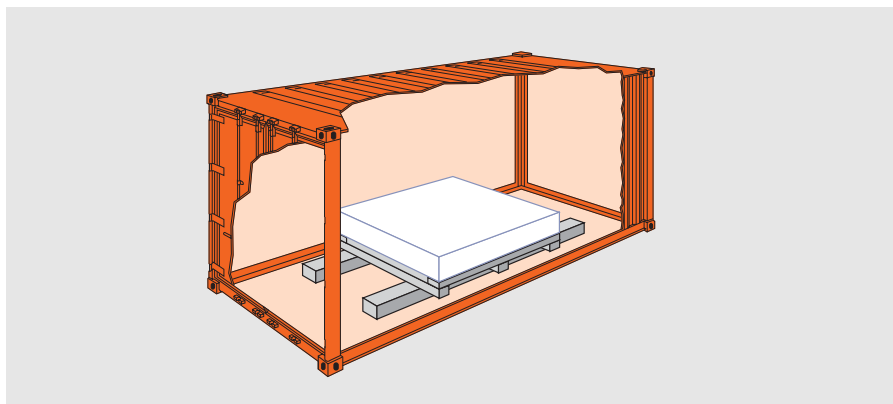
Construction of standard container floor and bedding required for heavy cargo.

Type of container		20'	40'
A	minimum width of square timber	10 cm	15 cm
B	minimum lateral distance of square timber from container Centre to line each	40 cm	40 cm

Square timber used for load distribution must have a certain minimum width and lateral distance from the centre-line of the container, due to the design of the standard container's floor.

A relatively heavy piece of cargo or a cargo unit with a small load transfer area must be loaded in such a way, that the load support area is elongated in order not to exceed the permissible floor loading limits.

This may be done by square timber, layered in alternate directions (the lowest layer lengthwise); or by using a sledge lengthwise below the cargo. The free end of the bedding should not be longer than 1 m on each end, but depending on the weight of the cargo and size of square timber.



Extended bedding to prolong contact area.

If a parcel exceeds these weight limits, flatracks must be used. They are constructed with special reinforced floor constructions. Our stowage advisors are at your disposal to advise you on how to take advantage of container transport, especially in doubtful situations.

In order to enable container stuffing by fork lift trucks, all Hapag-Lloyd containers meet the ISO recommendation ISO 1496/1. This means that fork lift trucks can drive into a container, when the following limits are not exceeded:

Item	Limit
Front axleload (payload + tare)	max. 5.460 kg
Contact area per wheel	min. 142 cm ²
Width of wheel	min. 18 cm
Width of track	min. 76 cm

The cargo weight distribution within the container should be balanced, i.e. the cargo's centre of gravity should stay within the following limits:

Type of container	20'	40'
Longitudinal direction	max. 60 cm from centre of the container	max. 90 cm
Transverse direction	in the centre of the container	
Height	at or below half height of container	

All Hapag-Lloyd containers meet the following test requirements laid down in the ISO 1496/1 for load strength of side walls, front walls, door and roof:

Construction element	Test load
Side walls	0.6 times the weight of the max. payload
Front wall and doors	0.4 times the weight of the max. payload
Roof	300 kg at surface of 60 x 30 cm

3.2. Stowage plan

There are three main reasons for preparing a stowage plan prior to stuffing a container:

- to achieve optimal utilisation of the container's capacity
- to simplify and increase the speed of packing and unpacking
- to calculate necessary cargo securing aids well in advance

For the stowage planning you will need precise details of exact weights and measurements of the cargo to be loaded and its packaging, as well as exact inside dimensions and permissible load limits of the containers. The container details for Hapag-Lloyd container can be found in our "Container Specification" brochure or under www.hlcl.com.

Prior to preparing the stowage plan, you will have to select the container type which is best suited for your shipment. The following should be observed:

- the load limits and the allowed weight distribution of the container
- the load limits for inland transport in shipper's and consignee's country
- the available facilities to unpack the container at consignee

There are different ways to prepare a stowage plan. You can draw a scaled drawing of different views, pre-stow your cargo in a rectangle drawn on the floor in original container size or you can use one of the software's, available on the market.

Please note that the dimensions of door and roof openings are normally smaller than the inside dimension of the container.

3.3. Function of packaging

Packaging has the following purpose:

- to protect the cargo
- to keep the goods suitable for storage
- to make the cargo transportable (e.g. for lashing)
- to ensure that they can be handled (e.g. for lifting)
- to provide information about the cargo and its handling

The container itself is both, a package as well as a means of transport. Nevertheless the cargo requires a package during transport within the container.

The kind and amount of package depends on the cargo, the way of transport and the used type of container. If cargo stowed together with different sizes and weights within a container, more stable packaging is required. If cartons or cases are stacked several layers on top of each other, the lowest layer must be capable of supporting the upper ones. The required stacking strength depends on the packaging material, transport duration and humidity conditions.

Standard containers can be equipped with special packaging for transport of dry bulk, clothes or to prevent cargo from humidity.

If the cargo is handled conventionally on flatracks during certain stages of transport, its packaging must be able to withstand the strains of climate, weather and conventional handling.

3.4. General rules for packing a container

Goods of the following nature are not allowed to be packed together:

- dusty goods and dust sensitive goods
- smell emitting goods and smell sensitive goods
- goods/packaging giving off moisture with moisture sensitive goods/packaging
- goods with protruding parts (sharp edges, corners) and goods in comparatively soft packaging (e.g. bags or bales)
- wet goods and dry goods
- heavy parcels not to be placed on top of light parcels

If joined packing cannot be avoided, you may put the wet goods below the dry ones and separate them by dunnage. In case of dangerous cargo the relevant rules of IMO (IMDG Code) and Hapag-Lloyd are to be followed. Additional dunnage or sawdust is to be placed below the wet goods.

Different types of packaging must be separated effectively from each other (e.g. cardboard boxes and wooden crates). Do not ship goods with damaged packaging, but repair the packaging carefully before loading. In order to ship sensitive goods use sheets of paper or plastic to lining the container. When loading smell sensitive goods, the container must be without smell, otherwise it should be cleaned before loading.

When packing odorous cargo or cargo that might damage the container by leakage, use plastic sheets to line the container and add absorbent materials (such as peat moss, sawdust or silica gel). This way unnecessary costly cleaning expenses can be avoided. Scrap metal or ore in containers will not be shipped by Hapag-Lloyd.

3.5. Securing facilities within a container

There are many facilities for securing the cargo inside a standard container. Lashing devices are fixed along the longitudinal rails at floor, at roof and close to corner posts each with Safe Working Load of 1 t.

The corrugated steel walls can be used for chocking the cargo in a longitudinal direction by transverse square timber. Make sure that side and front walls can take only large surface loads, and are not suitable for selective loads. The following table will give you an overview of securing facilities and their use.

Construction element	Cargo securing
Lashing bars on corner posts, roof and floor longitudinal rails or bull rings in the floor	For the fastening of ropes, plastic ribbons, metal hoops, quick fasteners, etc. (load limits see "Container Specification").
Corrugated steel walls	For cargo securing in longitudinal direction transverse timbers can be fitted into the recesses.
Corner posts	Suitable for the distribution of extreme point loads, e.g. by shoring.

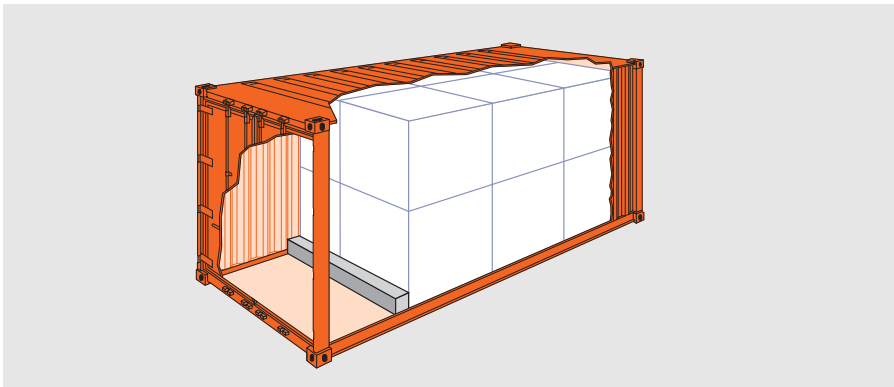


Lashing points (inside a standard container) on the roof, corner post and the small holes for compensation of air pressure.

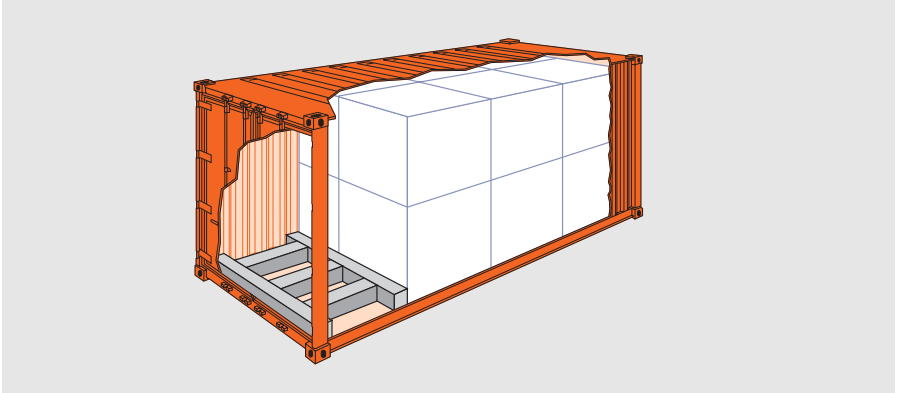
3.6. General rules for securing cargo

While packing a container or securing the cargo, attention should be given to the Guidelines for Packing and Securing Cargoes in Containers for Transport by Land or by Sea (Container Packing Guidelines) issued by the International Maritime Organisation (IMO) and the International Labour Organisation (ILO).

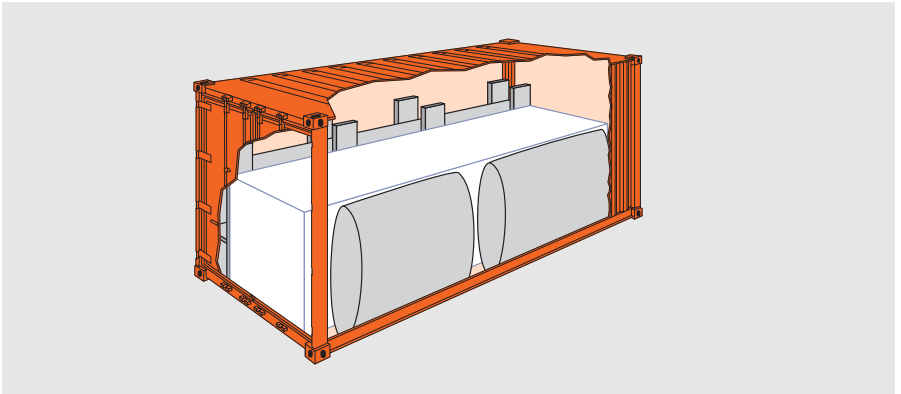
The cargo inside a container must be secured against rolling, tipping and shifting. The best way to securing the cargo is to distribute the cargo over the whole floor area without any gaps. If this is not avoidable, the gaps between packages and container sides must be filled. Air bags, dunnage or other stowage material should be used.



Cargo is secured by chocking towards the corrugation of side walls. For low profile corrugations the front ends of the square timber must be adapted to the shape of the channels.



Cargo is secured by chocking towards the door at the corner posts.



The crate is chocked against the side walls by large bearing area, on the left hand side by dunnage and on the right hand side by air bags.

For securing single cargo into a container, the offered lashing eyes on the longitudinal rails on the floor and roof should be used. In addition chocking against sliding is recommended.

3.7. Container check prior to packing

Every container used on international routes must have a valid CSC Safety Approval plate, as provided according to the International Convention on Safe Container of 02.12.1972. All Hapag-Lloyd containers are fitted with this plate.



CSC Plate of a 20' standard container.

In order to ensure that you receive a container in sound condition, all containers are checked before arriving or leaving port terminals as well as during inland depots. In addition to this inspection, we recommend that you always carry out a careful check of the container to prevent possible later damages to the cargo.

External check list:

1. No holes or cracks in walls and roof.
2. Doors can be operated easily.
3. Locking devices and handles function properly.
4. No adhesive labels from previous cargo, e.g. IMDG placards. Dangerous goods labels are only allowed, when dangerous goods are inside.

Special containers:

5. Flatracks: stanchions (if ordered) should be complete and inserted properly
6. Open top containers: roof bows should be complete and inserted properly.
7. Open top container: tarpaulins are undamaged, have correct size and their rope ends are not damaged.

8. Hard top container: the roof is undamaged; roof fastening fits properly and is accessible.

Internal check list:

9. Container is waterproof. Test method: stand inside the container, close both doors tightly and examine for any light coming through cracks, holes, door gasket etc.
10. Container is completely dry inside. Wipe out all condensation or white frost in order to avoid corrosion and moisture damage to the cargo.
11. Container is free of dirt and cargo residue, clean and odourless.
12. No nails or other protruding objects which might damage the cargo should be present.
13. In case you load your cargo into your own container, please ensure that the C.S.C. plate is valid. Otherwise the container must be handled as break bulk.

Please inform our Hapag-Lloyd Sales Office immediately of any differences, enabling them to provide you with undamaged equipment.

3.8. Container check after packing

We recommend that the following check list items be fulfilled after packing:

1. The container is packed appropriated for the cargo, anticipated transit stress and characteristics of the container. The cargo-weight must not exceed the containers payload.
2. A copy of the packing list is placed in a good visible location inside the container for custom inspection or the like.
3. If timber is used as a packaging material etc. it may, under certain circumstances, be necessary to comply with the quarantine regulations of the country of destination and a fumigation certificate or proof that the timber has been treated may have to be placed conspicuously in the container. The regulation and information may be obtained from the agriculture authorities of the countries concerned.
4. The doors and, if applicable, the roof covering should be carefully closed. Strong steel wire cables, curtain locks or high security seals provide protection from cargo theft.
5. Record the seal number.
6. For open top containers, tarpaulins are correctly fitted and tarpaulin ropes correctly threaded. (Customs approved closure)

7. If the cargo is covered with tarpaulins in special containers, please ensure that the tarpaulins are securely fastened.
8. Old adhesive labels have been removed.
9. For refrigerated containers, the correct temperature has been set, the correct amount of ventilation has been set, the temperature recorder is running and the temperature is displayed.
10. In case of loading dangerous cargo the relevant packing and segregation requirement must be fulfilled and the correct IMO placard must be placed outside. Necessary support will be given by the Hapag-Lloyd dangerous goods department.
11. All paperwork is duly completed.

Please note that in case of overloading the container or improper securing of the cargo your insurance may not cover possible damages.

3.9. Redelivery of the container

After transportation normally the container are returned to the depot. The container must be:

- in proper condition
- free of waste and smell
- without any nails or damages on the floor
- without any damages to the walls and doors
- without any placards
- without any damages to the tarpaulin of open top container

4. Climatic protection

4.1. Protection against humidity

Humidity is a main reason for cargo damages. We describe in chapter 2.2. what kind of climatic strains happen to the cargo during the transport. In the following we would like to offer some advices to protect the cargo.

Before loading the container it is necessary to decide, what sort of protection the cargo needs. The main weather conditions of the climatic zones and the direction you pass these zones should be taken into account. If the voyage is from a warmer to a colder zone, the risk of condensation is much higher than from colder to a warmer zone.

On modern container vessels there are more stowage positions for container on deck than under deck. The hatches can be ventilated by electrical fans. So the temperature and humidity around the container is similar to the outside conditions. Most of standard containers have very small openings for pressurisation. They are not useful for ventilation. If a fixed rate of fresh air exchange is compulsory, a reefer container must be used.

The relative air humidity inside the container depends on the moisture from cargo, dunnage and air during loading and from the outside temperature during the voyage. The following is a range of alternatives as a precaution against cargo damage:

- Do not pack moisture sensitive packages together with moisture emitting goods. If this is unavoidable, packages are to be well separated and protected
- Load cargo, packages and dunnage as dry as possible into the container. Store them in dry premises beforehand. If packages and dunnage are stored in open or damp space, they will absorb moisture from its surroundings
- Use cargo securing material, which cannot cause damage to the cargo as a result of climatic influences, e.g. stainless steel instead normal steel wire or straps)

When transporting moisture emitting goods use moisture absorbing material (i.e. paper) on top of the cargo or below the container roof. Several suppliers offer these products (e.g. Cargo Dry System, Dew Catcher, Moisture Grip, Non-Sweat paper, Sweatking). Plastic sheets are not suitable for this purpose.

Moisture absorbing materials for e.g. silica gel can prevent condensation, but they are only effective when used in absolutely air tight space. Hence, close to the cargo within cardboard box or products protected by shrink-wrap. For 1 m³ enclosed air, approximately 500g absorbent material is required. Silica gel to use for the whole container is not reasonable.

Despite the use of absorption material, damage by condensation water may occur. Under extreme conditions these materials may sweat out the previously absorbed moisture.

4.2. Cargo in temperature controlled container

For cargo, that has to maintain a constant temperature and/or a certain fresh air supply, Hapag-Lloyd provides refrigerated containers (reefer). They are equipped with an electrical cooling, heating and ventilation system. The electrical power will be provided by the vessel or the port terminal.

During transportation by truck, the electrical power to the reefer is provided by the truck, by an extra generator set fixed to the reefer or by an integrated generator system. All reefers are operated with environmental friendly refrigerants. Special dedicated equipment is used only for non foodstuff or chemical cargo. Some container types offer dehumidification or cold treatment (ASDA). Hapag-Lloyd is able to provide sealant free container.

Integrated data loggers record temperature and events hourly. The permitted setting temperature is between -25°C and $+25^{\circ}\text{C}$. Some containers even allow a set point as low as -35°C . These temperatures can be maintained, if the difference to the outside temperature does not exceed 42°C for heating and 65°C for cooling.

Please take into account, that temperature controlled container are designed to maintain the temperature required by the particular cargo. They can not cool down the cargo after loading. Consequently reefer cargo must be packed in pre-cooled conditions.

There are certain types of cargo, like fruits or vegetables, which react with the air around. During maturation they produce heat and consume the oxygen. In such cases, it may be necessary to replace the air within the container by fresh outside air. You can adjust the fresh air supply from 0 up to 280 m^3 per hour. When booking such cargo, please submit the appropriate set temperature and fresh air exchange rate.

The stowage and packing of cargo inside the reefer influence the air circulation and thus it is crucial to maintain the set temperature. The following must be observed:

1. The entire floor grating must be evenly loaded with cargo. In case this is not possible, free spaces must be covered with cardboard or similar material to prevent an objectionable airflow. This applies to any gaps as well as those that may occur between palletised cargos, by shape of packages and by packages not stowed exactly on top of the other. On the other hand, the stowage should be sufficiently loose to allow airflow upwards between the packages. This can be achieved by using a separating material like dunnage.
2. Free space of at least 12 cm must be left between the roof and the cargo. Markings on the side walls indicate the maximum permissible cargo height.



Maximum loading height is marked by a red line.

3. The packaging must be strong enough to bear the stack load, to protect the contents and must correspond with the properties of the product: e.g. cartons with ventilation holes should be used for the goods that need fresh air.
4. The stowage must be carried out in a way, that the cargo can withstand all dangers of street and sea transport. There are no real lashing points within the reefer container. So the securing has to be done by blocking and positive-fit stowage.

4.3. Cargo in controlled atmosphere container

In order to reduce the maturation process during the transport, the ambient air can be modified. In this case the amount of oxygen will be reduced down to 1-3% and the carbon dioxide increased up to 5-25%. The exact data depends on the individual products. In the controlled atmosphere container, the maturation process can be prolonged by 30-60%.

The ambient air will be modified by pumping in carbon dioxide. This will be produced from the outside air by means of a membrane or a Pressure-Swing-Absorption. Momentary, the essential use of controlled atmosphere is in the hatches of the general reefer cargo vessels. Some rental companies have a small stock of containers with integrated aggregates for controlled atmosphere. But they are very expensive.

A passive method is to fill the container with carbon dioxide after loading and regulating the oxygen by ventilation during the voyage. There are only few reefer containers in the market with this option. Presently Hapag-Lloyd does not offer any container for controlled atmosphere.

5. Cargo securing material

5.1. General

Several materials can be used to secure the cargo. Every type has advantages and disadvantages, depending on their use.

5.2. Materials to put beneath the cargo (bedding)

Before stowing the cargo into a container, it has to be decided whether the cargo can be put on the containers floor directly or not. The cargo can be loaded without special bedding, if the cargo is able to stand alone, the container floor will not be damaged by the cargo or the limit of weight per running meter is not exceeded. Examples of such cargo are cartons and light cases.

5.2.1. Pallets

Pallets are usual used to load and discharge cartons and several small cargoes faster. These small cargoes are secured by using shrinking foil or belts upon the pallets. In this case the pallet is seen as part of the cargo. The disadvantage of pallets is that the normal sizes used for trucks, do not fit into standard containers. Open gaps must be filled with securing material. The full height of the container can not be used in most cases.

5.2.2. Square timber and strong planks

Bedding is required for all cargoes with small resting areas and/or high weight to distribute the weight over a larger area. Depending on the constructions, which differ between standard container and flatracks, the direction of the bedding differs. Lay out the bedding lengthwise at standard container's floor and athwart at flat-racks.

Depending on the cargo, timber is used from strong planks (approximately 5 cm thick) to square timber (20x20cm). Sometimes it is necessary to prolong the resting area. But it makes no sense to have free ends longer than one meter, because the timber will bend upwards and does not transfer the weight to the outermost points.

5.2.3. Steel beams

Steel beams are normally used for heavy and concentrated cargoes. Anti-slip material must be placed, wherever steel rests on steel. This increases the friction coefficient, which is very small for steel to steel contact. Rubber mates should be preferred.

5.3. Lashing material

Lashing materials are used for securing the cargo. They prevent cargo against tipping, horizontal movement and bouncing. There are different terms and definitions to value

the possible load of a lashing. The breaking strength is the load in length direction which cuts the rope. The lashing must not be stressed with this load. Therefore a safety factor is introduced. This safety factor depends on the type of lashing and its use. The breaking strength divided by the safety factor result the Maximum Securing Load (MSL). Usually the MSL is written in the data specification or direct on the lashing material. Additional to the MSL the load must be reduced, when the lashing is bent around sharp edges.

Different lashing materials have different elastic stretch. Therefore it is not allowed to use different lashing materials on one cargo piece. If done so, and the cargo moves in one direction, the whole load will be hold by the lashings with the lowest elastic stretch. This lashing will brake and the remaining lashings will not be able to take the entire load. Mixing might be possible, if the force directions are completely different for each kind of material.

5.3.1. Fibre Ropes

Fibre ropes are made from natural material like hemp, manila or sisal, or from synthetic material. Depending on the material they are able to withstand several environmental influences.

The natural fibre ropes are sensitive to acids, alkalis and solvents. Natural fibres stretch when they absorb moisture and shrink on drying.

Synthetic fibres withstand more against environmental influences. The breaking strength is very weak. Therefore fibre ropes can only be used for securing light cargoes like tarpaulins, passenger cars, drums or light cases.

One special type of fibre rope named "Hercules" contains a thin steel wire as core. It has the same breaking strength as normal fibre ropes, but a shorter elastic stretch, is less flexible and improves the twisting.

5.3.2. Nylon Belt

The most common lashing materials are nylon belts. They are available in a wide range of Maximum Securing Load (MSL). They are easy to use and prevent the cargo against damages. Edge protection must be used on sharp edges. It is strongly forbidden to knot nylon belts. The connecting ends must fit to the lashing eyes of the container and the cargo.

5.3.3. Steel Strapping (Signode)

Steel Strapping is a flat steel band. It has nearly no elastic stretch. Therefore it can not be used for soft cargo like cases. If the wood eases, the steel strapping loses the lashing force completely. The same happens, when heavy cargo stays on weak wooden bedding. It is very important, that the cargo, fixed by steel strapping does not reduce its volume during the transport. At the other hand, steel strapping is very useful to fix

steel rolls or to bundle profiles. Installing steel of strapping lashings is very quick, but requires special tools. Signode must not be used on sharp and uneven edges.

5.3.4. Steel wire, turnbuckles, shackles and wire clips

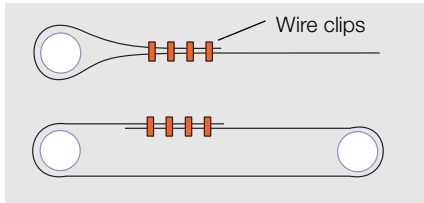
Steel wires are quite common for lashing heavy unpacked cargo. There are many different sizes and shapes in use. Steel wires can take strong forces, based on their diameter and have a short elastic stretch range. On the other hand, steel wires lose a lot of their breaking strength when they are bent along sharp edges or u-turns.

Additional equipment is required when steel wire is used for lashing. Shackles are taken as connection between turnbuckle, wire and lashing devices. Quite often a hook with a short chain is used between lashing device on the container and turnbuckle at the lower part of the lashing. This chain can be bent without losing its breaking strength. Wire clips are used to connect the ends of the steel wire. The whole lashing arrangement will be tightened by the turnbuckle.

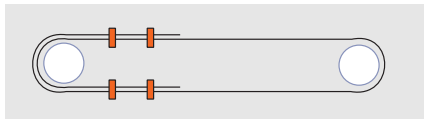


Correct lashing arrangement, not yet tightened. The steel wire is twisted to increase the friction.

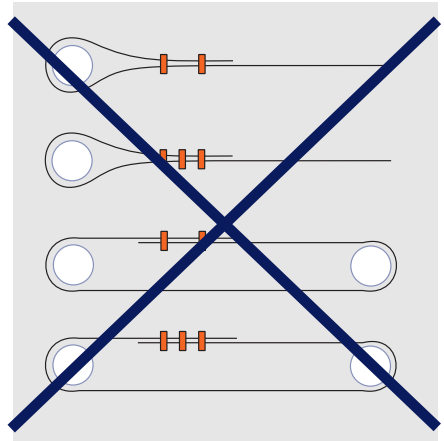
To connect the free ends of the steel wire only the correct size of wire clips and tightening torque must be used. Otherwise the wire can slip through the wire clips. Mostly the wire clips are the weakest part of a wire lashing. Therefore the way how to install them is very important. Following drawings show recommended and not recommended arrangements. A minimum of 4 wire clips must be used.



Wrong assembling of wire clips and wire ends; possible to use but only with less calculated force.



Best and recommended arrangement.



Not enough wire clips attached; not recommended.

5.3.5. Chains

Chains have a very high breaking strength. Mostly the lashing eyes on cargo or containers are weaker. They are often used for lashing very heavy cargo. They do not lose breaking strength on small edges, but the individual chain link must not be bent at corners.

Chains have nearly no elastic stretch. They are tightened by turnbuckle or tension lever and hook. Chains can be adapted to the required length by special claw hock and securing levers.

5.4. Filling material

A very simple and useful lashing method for securing against sliding forward and across is filling the space with filling material. It is important that the wall or cargo on the opposite side is strong enough to take the forces from the cargo.

5.4.1. Airbags

If pallets are stowed in a standard container, gaps will remain. Large scales of airbags with different sizes and shapes are available for filling these gaps. The airbags will be placed empty into a gap and will be filled by compressed air on site. This ensures that no space remains. Airbags are not designed to take forces of moving cargo during the transport and must not be placed over sharp edges.

5.4.2. Timber

Timber can also be used for securing cargo against sliding, especially for heavier cargo. Low forces can only be taken by the side and front walls of standard container. If blocking against the walls is necessary make sure there is a large contact area. The best way is to block the cargo against the corner posts. The block installation with square timber must be built in a way that it does not lose or fall off during vibrations while being transported.

6. Special advice on packing and securing various goods

6.1. Cartons, cases and crates

When loading cartons into a container the following should be kept in mind. Check, whether the cargo fills the entire volume of the container. If not, then stow the cases at an equal height so that the entire floor area is covered. Hence there is an equal weight distribution. Make full use of available space and do not leave gaps. If gaps are unavoidable, chock the cargo row by row by filling the space with air bags, pallets or dunnage. Moving cartons inside a container are subject to being crushed.

The height of stowage depends on the stability of the cartons. You can achieve a solid stow when you pack the units interlocking them like bricks. Intermediate layers of strong cardboard or wooden dunnage reduce the stacking forces to lower cases. Wet cartons have reduced stability. Therefore pay attention to the remarks in chapter “climatic strains”.

Large and heavy cargo units should be put into the centre of the container and should be chocked against the corner post, top- and bottom longitudinal rail. When chocking against the side walls a large bearing surface is to be ensured.



Cartons stowed positive fit.



Sofas stowed positive fit.

Stowage positive fit means, that no space left between cargo and container. No additional securing material is needed. Only a door securing to prevent cargo collapsing during opening the door at receiver’s side is recommended.

6.2. Pallets, fork lift adapted unit load

The attainable utilization of the container is determined by the dimensions of the pallets. The optimal size of the pallet depends on the internal dimension of the container. The packages on the pallets should cover the whole pallet surface and must be well secured, for example by lashing or using shrink wrap.

When stuffing the container, ensure that the centre of gravity is in the middle of the container in lengthwise and across direction. Proper securing of all pallets is also to be ensured.



Stowage of non-uniform pallets. The spaces are filled with airbags. The pallets on the second level are blocked against moving forward with 3 pieces wooden dunnage each.

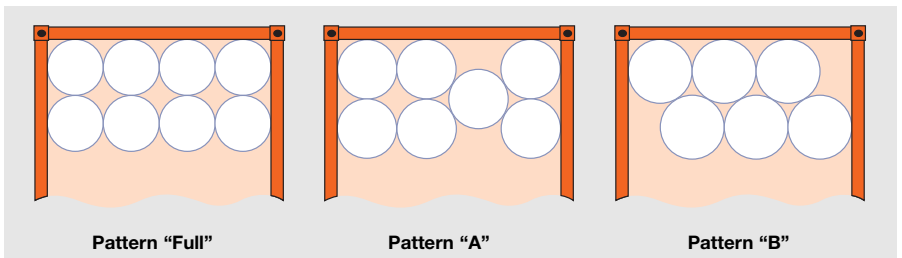


Size and structure of the packing for motor bikes are customised to the container dimensions.

6.3. Drums, barrels and plastic cans

Before loading, ensure that drums don't have any leakages. Never load leaking drums. If you stow the drums on dunnage, you can decrease damages to the packaging caused by a leaking drum.

Always stow drums and barrels with the drainage holes upwards. They are best stowed standing upright next to each other. The optimum arrangement of the units on the container floor can be determined by the relationship between the diameter of drum and the dimensions of the container inside. Different packing patterns are possible.



To calculate the number of rows lengthwise, you may use the following formula:

$$\text{Pattern Full and A: } n = \frac{L}{D} \qquad \text{Pattern B: } n = L + \frac{L - D}{0,866 \cdot D}$$

n: number of rows **D**: diameter of drum **L**: inner length of container

All drums must be loaded tight fit inside the container ensuring no space between the cargo and container. If gaps are unavoidable, they must be filled by dunnage, pallets or other securing material. The main securing work has to be done at the door. The most common way is to chock the drums by square timber. Alternatively you can lash the drums with steel straps in pattern like overlapping areas. This can be achieved, when one drum is secured together in a block of four drums and the same drum is connected to a second unit of four drums and so on. Furthermore the cans can be staggered. This can be achieved by different unit heights or using empty pallets.

Wooden barrels are not constructed to withstand pressure around the middle. When packed horizontally, the following precautions should be taken: Support the barrels at the ends with strips of wood, so that the middle does not touch the container floor. Prevent rolling by means of wedges.

When loading plastic cans, check them for leakage. One damaged unit can endanger the stability of the entire stowage. Cover all layers with segregating gratings or dunnage to ensure the stability within the stowage. Jolts from below or vibration can otherwise easily cause a layer to bulge and may collapse individual cans.

6.4. Bagged goods and bales

Insufficient handling and stuffing of bags may cause damages to the packaging of cargo, to the cargo itself, to the sidewalls of the container and can result in injuries when opening the doors of the container. To prevent these damages stack the bags in such way, that they can't shift when the vessel is moving in bad weather. Stow them properly fit, in alternate directions so that each tier binds the tier above and below it. Due to lower friction, this does not apply to plastic bags. The use of pallets may be even more economical than the relative time consuming packing and unpacking the container.

Most baled cargo is comparatively insensitive to mechanical strains, but can be easily damaged during packing or unpacking. Therefore take care, that the external covering of the bales is not damaged while loading. To facilitate unpacking by forklift, place wooden planks lengthwise on the floor of the container and between each layer of bales while packing. If the bales are not flushed with the doors, chocking against the corner posts is usually sufficient to secure the cargo.



Carpets protected by jute bag during stuffing.

6.5. Rolls and coils

Before loading rolls and coils in standard containers, pay attention to the maximum permissible load per running meter of the container. Please refer to chapter “3.1. Weight limits and weight distribution of standard container”. If the coils are heavier they have to be loaded on flatracks.

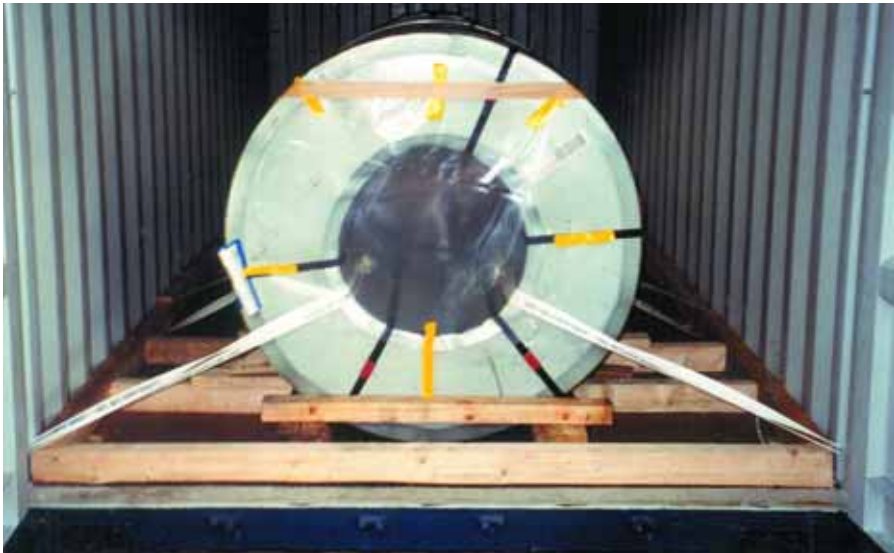
Rolls and coils can be placed with eye to sky, eye horizontal with axes lengthwise or across.

6.5.1. Eye to sky

Lighter rolls can be stowed like drums. Place them close to each other and fill out gaps. Secure at the door with nets or planks. Steel coils should also be placed close to each other. For security, bind them together with steel straps or block them with wood. Heavy steel coils, which are shipped on skids or pallets, should be securely fastened down on a pallet and secured by lashings.

6.5.2. Eye horizontal, axes lengthwise

Distribute the coils over the full floor area, so that the centre of gravity is in the middle of the container lengthwise and across. Avoid pressure on side walls. Proper bedding, lashing and blocking sideward and to the door side is necessary.



Steel Coil loaded on axes lengthwise, blocked sideward, lengthwise and lashed by nylon belts.

6.5.3. Eye horizontal, axes across

With this stowage, the floor section will be stressed at the highest level due to a very short contact area. Therefore it is very important to put square timber or cradles lengthwise under each coil as bedding. Heavy steel coils have to be packed on heavy duty cradles of wood or steel. Use strong steel wire lashing to secure each roll individually to the cradle and to each other. Lash the rolls to the container through their centre holes. Reinforce the front end of the container with cross bars positioned at the height of the centre of the rolls. Chock empty spaces with wood.



Steel coils secured on a cradle from CoilTainer.

The company CoilTainer offer a very good steel cradle for transportation of steel coils in containers. Their steel cradles distribute the cargo weight over a certain length and to the outer edges of the container.

Lighter rolls of paper can be stowed on top of each other. Secure the bottom layers with wedges. Place suitable rubber mats as anti-slip material between each layer. Place filling material into the gaps at the side walls to avoid shifting. At the door chocking is necessary by a frame of square timber to all layers.

6.6. Vehicles

All types of vehicles, ranging from motor cars to road building machinery, can be transported by container vessels. In few countries vehicles may be classified as dangerous goods. There are official recommendations regarding the carriage of vehicles by sea in some other countries. Please ensure vehicles are prepared in accordance with the local instructions. We recommend that batteries should be disconnected and fuel drained prior to loading the vehicle into the container.

Motor cars and vans can normally be wheeled into a standard container without difficulty. Use a small ramp and leave space for the car driver to leave the car. Load the vehicles absolutely dry. Leave a gap open in windows to facilitate air circulation. Special span sets are available for lashing the cars at axes.

Larger and heavier trucks must be loaded on flat rack container. There, 50% of the wheels must rest on the flatracks floor or special wooden bedding below the chassis is required. Please refer also to chapter “7.2. Pre-lashed cargo”.



Van loaded in standard container, not yet lashed.

6.7. Glass sheets

Due to its dimensions and weight, glass is best loaded from the top into the container. Hapag-Lloyd provides open top containers with tarpaulin or hardtop. In addition to careful packaging of glass sheets in boxes, crates or A-frames, further cargo securing measures may be taken. Place the sheets, if possible lengthwise in the container. Provide a buffer zone between several A-frames if shipped in one container. Glass is extremely moisture sensitive. Therefore additional covering is necessary.

6.8. Bulk liquids

Bulk liquids can be transported in special tank containers. They must be filled at least 80% of volume to avoid dangerous surge movements during transport. The maximum

filling height is 95 % of the volume, to allow possible heat expansion of the liquid. Please observe the working limits affixed to the tank container. Hapag-Lloyd does not own any tank containers. Beside standard tank containers you can hire tank containers with heating or cooling aggregates.

Hapag-Lloyd does not recommend the transport of liquids in flexible inlets made of plastic. They give too much stress to the container and endanger the safe transport.

6.9. Bulk solids

Solid bulk can be transported by an inlet inside 20' standard or open top container. Bulk liner bags prevent the cargo against dirt and odour from the container and reduce the necessary time to clean the container after discharge. Only bulk cargo like powder, resin, corn or bulk without sharp edges can be transported in bulk liner bags. The cargo will be loaded into the liner bag by a conveyor belt through an opening above at the door or through openings of a special roof. The cargo has to be secured by a barrier at the door and is a strictly enforced mandatory requirement in many countries. Most liner bag manufacturers include a door securing system to the liner bag. Other bulk cargoes like scrap or stones can only shipped after approval by Hapag-Lloyd.

6.10. Long cargo

This section comprised long cargo which fits within the length of the standard containers. For longer cargo please refer to the chapter "7.2. Pre-lashed cargo". Useful for long cargo are open top, hard top and flatrack containers. Loading long items like pipes or logs into standard container from the door side can cause damages to the container floor, corrugated side walls and the cargo. Lengthy good must be secured in length-wise direction very well, therefore install chocking or lashing at front ends. Anti-slip material is to be used between each layer. Chocking can be done by a vertical wooden bulkhead, which is to be blocked against corner posts or is to be fixed by lashings. For securing the cargo against moving across the container, use loop lashings and/or chocking.

6.11. Livestock

Hapag-Lloyd does not recommend the transport of livestock on container vessels. Sometimes, if customer insists on the transportation and after clarifications many questions livestock can be transported. Then the transport boxes for animals can be loaded on flatracks or open top containers on deck for easy access at any time. Keepers have to accompany the animals during the voyage. Containers with food can be stowed close to the animals on deck. Familiarize yourself with the quarantine regulations of the country of destination and of the transit ports.

7. Oversized and heavy cargo

7.1. General

Out of gauge and heavy cargo can be loaded either pre-lashed or as break bulk. Pre-lashed means the cargo is placed and secured on the flatrack or in the open top container before being loaded onto the vessel.

If the weight or dimension of the cargo exceeds the limits for a pre-lashed move, they must be loaded as a break bulk move. This means that empty flatracks will be loaded as the foundation inside the vessel, bedding from wood or steel will be arranged and then the cargo will be loaded on top by a gantry or floating crane.

7.2. Pre-lashed cargo

Hapag-Lloyd provides open top containers, hard top containers and flatracks in 20' or 40' sizes for out of gauge cargo. It is important to know, that the floor construction of open top and hard top containers is the same as the standard containers. The weight distribution limits are the same as given in chapter 3.1. The flatracks however have two big longitudinal steel beams as floor construction. They can carry cargo with more concentrated weight. If heavy cargo is narrow and does not rest on these steel beams, bedding athwart the flatrack is required to ensure that the weight rests on them. When the container shows a certain payload, the allowable weight to load depends on the length of the cargo. As this calculation is not linear, please check with the Special Cargo Department for individual cargo.

The decision that is made to find out if cargo is out of gauge and what equipment should be used for transport depends on the dimensions i.e. length, width, height and weight. Furthermore one should pay attention to the commodity as well as the shape and structure of the bottom of the cargo. If one dimension exceeds the limits of a standard container special equipment must be used. Open top containers are suitable for extended height or long cargo. If the width is more than 220 cm or the cargo is heavy, the use of flatracks is compulsory.

Cargo with exceeding length can be loaded on platforms, which are flatracks with collapsible end walls. The following is to be observed, when loading cargo with extended length:

- The corner castings must be kept free in order to lift the platform.
- It is not permissible to lift a flatrack with one end wall down and the other up. Both end walls must be either up or down.
- Special care must be taken to secure the cargo against movement in lengthwise direction.
- Platforms can only be shipped on deck.

7.2.1. Cargo securing in open top container

Cargo securing is always a mix of lashing and chocking. Chocking protects the cargo against sliding. Square timbers are placed between cargo and the corner posts against lengthwise movement and on the bottom rail against sliding across.

Side and front walls are not constructed to take selective pressure. When chocking to the side or the front wall is necessary, a large contact area is to be ensured. Lashing is necessary for securing against tipping and to hold the cargo down.

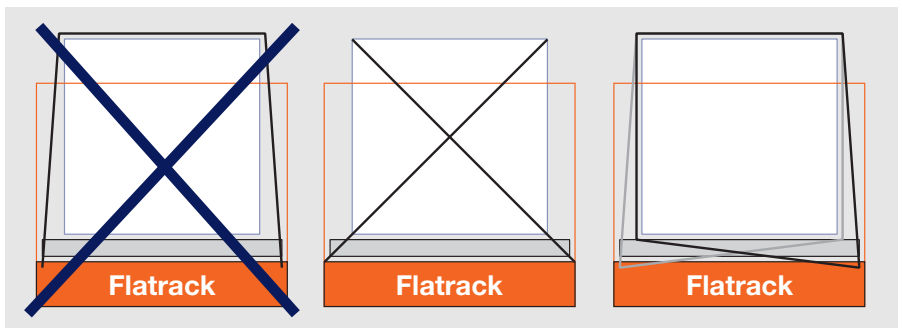
All open top containers are equipped with lashing devices along the bottom and top rail as well as at the corner posts. Each lashing eye has a Maximum Securing Load (MSL) of 2t.

7.2.2. Cargo secured on flatrack container

Similar to the open top container, securing the cargo on flatracks must be done with a mix of lashing and chocking. Furthermore, the cargo must be protected against environmental influences.

The Hapag-Lloyd flatracks have lashing devices on both sides and both front walls. All lashing points have a Maximum Securing Load (MSL) of 5t. The purpose of lashing is to secure against tipping and to hold down the cargo.

A preferred method for lashing is the use of cross lashing, if lashing eyes are available on the cargo. Otherwise, loop lashings are to be used. A single lashing over the cargo must not be used. The sketch below shows the different lashing methods.

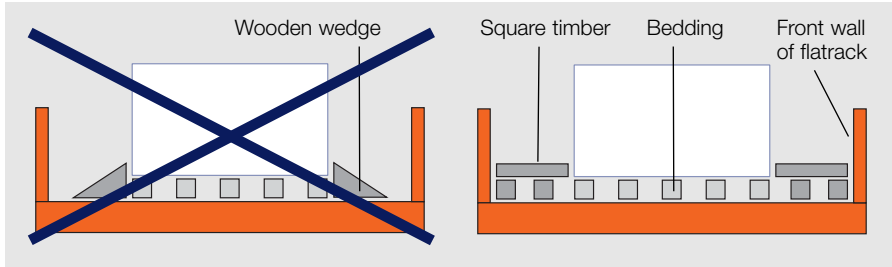


Single lashings over the cargo are NOT sufficient. The cargo can slide sideward.

Cross lashings are very useful if lashing eyes are available on the cargo.

Loop lashings are suitable for all cargoes without lashing eyes.

Corner posts can be used to chock the cargo. The use of wooden wedges, nailed on flatracks floor is not sufficient and will damage the floor.

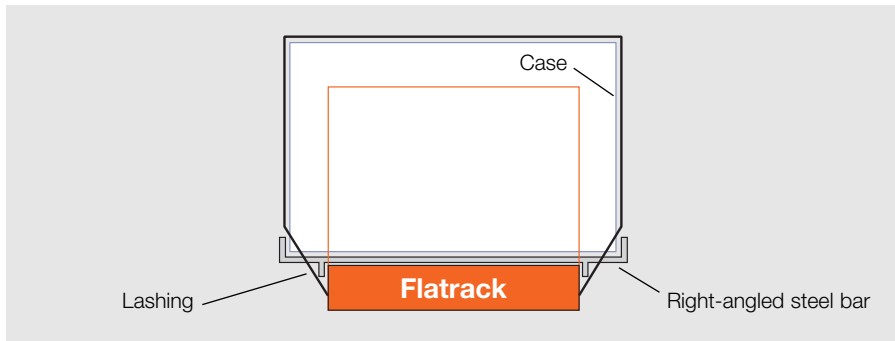


Wooden wedges only fixed by nails to block the cargo lengthwise are NOT sufficient.

Square timber placed horizontally as chock protection against the corner posts must be used.

All flatracks are equipped with holes for stanchions along the side. Ordinary steel beams, placed vertically into these holes can be used as chock protection against sliding sideward, for e.g. for lengthy cargo such as pipes.

A cargo with a width that exceeds the flatracks base is difficult to secure against sliding sideward. Light cases can be secured by toothed steel sheets. They look like serrated washers and can be laid down between the case and the wooden floor and are to be fixed by nails or by means of the weight of the cargo. This toothed steel sheet increases friction. It is important to mark the case with a label to ensure that the persons who check the lashing arrangement get notice of the securing material used. Keep in mind lashing the cargo is essential in addition to these toothed steel sheets.



Over-width cargo, secured by a right-angled steel bar against sliding sideward.

Furthermore, blocking sideward is possible by right-angled steel bars, which are locked to the flatrack. The single loop lashing in the sketch beside is only acceptable with the right-angled steel bar. If no chocking equipment is used, only cross lashings will be allowed to lash cargo with exceeding width.

The use of edge protection is important to avoid breaking the lashing on sharp edges. Furthermore, they protect soft wooden cases against breaking or being cut by the lashing. Securing without edge protection will loosen lashings at sea.

Cargo on flatracks is normally loaded under deck as protection against weather. Inside the hatches the vessels have a cell guide system to keep the containers in position. These cell guides reduce the maximum possible length of cargo with overwidth (more than 244 cm), although the cargo fits onto the flatrack. Therefore the maximum acceptable length for cargo with overwidth is 1160 cm for 40' flatracks and 550 cm for 20' flatracks; in other words, the cargo is to be stowed minimum 30 cm from each outer front side of the flatracks.

7.3. Break bulk cargo

All cargo which exceeds the limits of pre-lashed shipment must be moved as break bulk. These limits depend on many influencing factors.

In doubt please contact your Hapag-Lloyd agency. Every break bulk cargo requires special handling. Thus, every booking goes through a special procedure at Hapag-Lloyd. Many people are involved in break bulk shipment. Experts check the possibility to carry, develop stowage proposals and lashing plans. The agents at the loading and discharge port calculate the expected costs and organize all detailed questions regarding the handling of this cargo with the local port operating.

Hapag-Lloyd offers safe transportation for most large and heavy cargo.

Below are some examples of cargo that Hapag-Lloyd carried.



This press is tipped and laid down on two flatracks. Below the press strong square timbers are placed to distribute the weight and prevent damages of the cargo and flatracks. Nylon belts are used as lashing.



Loading of a large ships propeller of 80t. The propeller has a very small contact area to the base; therefore a strong bedding of timber is used. Additional wooden supports below each propeller blade will be added and steel wire to be used for lashing.



This transformer with an approximate weight of 160t is placed on steel beams and chains are used for lashing.

8. Further information and contact

Please visit our web site: www.hlcl.com

There you can find a lot of information such as addresses of sales offices, information about the vessels and containers used by Hapag-Lloyd, time schedules and how to book cargo online.

Our booklet "Container Specification" describes all container types operated by Hapag-Lloyd with their exact dimensions and specifications.

Under www.containerhandbuch.de further information about container packing can be found. This is a very detailed homepage issued by the German Insurance Association with a lot of information regarding packing, lashing, stowage, products and law regulations, available in English and German language.

The web site of the International Maritime Organisation www.imo.org provides a lot of information and regulation. Many publications can be ordered there.

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