Informal meeting on Code of Practice for Packing of Cargo Transport Units

at the request of the United Nations Economic Commission for Europe Working Party on Intermodal Transport and Logistics

Geneva and virtual, 29-30 September 2021 (second meeting)
Item 4 of the provisional agenda
Updates to the CTU Code

Bulk transport

Submitted by ETS Consulting

This document proposes change to existing text of Annex 7 conse

This text was not included during the GoE work on the original revision due to its late proposal. Therefore, these changes reflect the text that was proposed amalgamated with new information on false bulkheads and cargo and container protection.

Additional information has been submitted by Russian Federation which relates to liners used for bulk cargoes and this has been included in the introductory text to the new Appendix (see below).

The introduction of cargo protection is also related to the carriage of bulk cargoes.

Note: ***Figure references to be renumbered when text is agreed.***

Proposed changes
Existing clause 5.3 replaced by:

5.3 [Non-regulated] solid bulk cargoes

5.3.1 [Regulated and] Non-regulated solid bulk cargoes may be loaded into a CTU provided the boundaries of the cargo space are capable to withstand the static and dynamic forces of the bulk material under the foreseeable transport conditions (see Chapter 5 of this Code).

5.3.2 The most common container in the world is the 20ft general purpose dry freight container and it is these containers are most commonly used for carrying dry bulk cargoes. However, the design requirements of these containers are not always totally suitable for dry bulk cargoes, especially free flowing powders and granules. For instances extremely free flowing materials can damage the side (see Figure 7.53) and end walls due to stresses induced during intermodal transport where there is high sideway acceleration, such as turning a sharp corner on a road vehicle.

Figure 7.53 Bulging wall

5.3.3 Additionally the rear doors are the only means of access into the container and so need to be opened to load and remove the cargo. When transporting free flowing materials opening the rear doors may result in the cargo falling from the container with the associated injury to cargo handlers and loss of cargo. Therefore, in order to transport powders and granules in general purpose containers false walls, known as bulkheads, should be erected at the rear end to retain the cargo when one or both doors are opened.

5.3.4 Bulkheads

5.3.4.1 Cargoes categorised as a dangerous good in the IMDG Code (or similar) are required to be carried in accordance with packing instruction BK2 which requires that bulk containers is designed and tested in accordance with ISO 1496 -4:1991 "Series 1 Freight containers-Specification and testing - Part 4: Non pressurized containers for dry bulk". Unfortunately, there are a very limited supply of containers built to this standard, so the IMDG Code states "*Freight containers designed and tested in accordance with ISO 1496-1:1990 "Series 1 Freight containers - Specification and testing - Part 1: General cargo containers for general purposes" shall be equipped with operational equipment which is, including its connection to the freight container, designed to strengthen the end walls and to improve the longitudinal restraint as necessary to comply with the test requirements of ISO 1496-4:1991, as relevant*." This can normally be fulfilled by fitting a partial height false bulkhead against the front wall.

Figure 7.54 False bulkhead

5.3.4.2 The front false bulkhead could be constructed from 12 mm birch plywood (internal grade) with three full width 6 x 2in softwood timber cross beams. The false bulkhead is made from two pieces both full width and lower 1,200mm high (with two beams attached) and a half height (600mm) panel with one horizontal beam. The height of the front panel should be greater than the expected height of the cargo during packing.

5.3.4.3 At the door end, the IMDG Code requires that "*operational equipment of bulk containers designed to be emptied by tilting shall be capable of withstanding the total filling mass in the tilted orientation."* This means that the rear bulkhead should be sufficiently strong so as the retain the cargo with the door open.

5.3.4.4 ISO box containers are equipped with shoring slots in the door corner posts which are suitable to accommodate transverse steel bars of 60 mm square cross section. This arrangement is particularly designed to strengthen the container door end for taking a load of 0.6 P, as required for solid bulk cargoes. These bars should be properly inserted. The relevant transport capability of the CTU should be demonstrated by a case-related certificate issued by a recognised consultative body or by an independent cargo surveyor. This requirement applies to multi-purpose ISO box containers and to similar closed CTUs on road vehicles, which are not explicitly designed to carry bulk cargoes.

5.3.4.5 Timber beams may be used so long as they satisfy the strength requirements, however, the length of the beams should so long enough so as not to be able to slide out when moved horizontally (see Figure 23 and Figure 24).

Figure 1 Beam too short

Figure 2 Beams too short

5.3.5 Cargoes

5.3.5.1 When using box type CTUs it should be recognised that it will have been used to transport a variety of cargoes, some of which may constitute a contaminate to the powder or granule to be carried. While shipping companies and owners will endeavour to ensure that CTUs are clean before delivery to a shipper, it is the shippers' responsibility to ensure that the CTU is fit for use before loading. Likewise, after the shipment has been made, the consignee must clean the interior of the container to remove all traces of the cargo carried. Sift proof liners make the cleaning process easier, but they do not totally eliminate the need for pre and post laden cleaning.

5.3.5.2 Small and fine powders and grains if not contained within a liner may fall out through the doors during transport due to vibration. It is therefore recommended that all dry bulk cargoes are only carried within a suitable liner.

5.3.5.3 If crude or dirty material shall be transported, the CTU boundaries should be lined with plywood or chipboard for avoiding mechanical wastage of the CTU (see Figure 20. In all cases an appropriate door protection should be installed consisting of battens fitted into suitable recesses and complemented by a strong plywood liner.

5.3.5.4 Scrap and similar waste material to be carried in bulk in a CTU should be sufficiently dry to avoid leakage and subsequent contamination of the environment or other CTUs, if stacked ashore or transported in a vessel.

Figure 3: Lined container loaded with scrap

5.3.5.4 The CTU intended to carry a bulk cargo should be cleaned and prepared adequately as described under paragraph 5.2.5, in particular if a cargo-specific liner shall be used for accommodating bulk cargoes like grain, coffee beans or similar sensible materials.

5.3.6 Packing bulk cargoes

5.3.6.1 The CTU intended to carry a bulk cargo should be cleaned and prepared adequately to meet the consignee's requirements. In particular if a cargo-specific liner shall be used for accommodating bulk cargoes like grain, coffee beans or similar sensible materials.

5.3.6.2 Informative Material 3 – *Cargo Transport Units (CTU) types,* section 1.5 Non pressurised bulk container types describes the various designs of bulk container. These containers have an outward appearance of a general-purpose container but are fitted with loading and discharge hatches to the roof, front end or rear doors. Specialist bulk containers will generally have loading hatches in the roof which would allow gravity filling (Figure 4) or from ground level by means of an elevator (Figure 5). Bulk containers with a top loading hatch at the front of the container (Figure 6) can be packed using a gravity chute or a screw loaded (see Figure 7).

Figure 4: Top loading

Figure 5: Elevator

Figure 6: Front chute

5.3.6.3 Box type CTUs can only be loaded and discharged through the rear doors so typical processes can include a screw loading elevator (Figure 7), a belt thrower (Figure 8), a retractable belt (Figure 9) or a pneumatic blowing system (Figure 10).

Figure 7: Screw loading

Figure 8: Belt thrower

Figure 9: Retractable belt

Figure 10: Pneumatic

Figure 11: Pneumatic blower

5.3.6.4 Abrasive cargoes, such as sugar and some grains, can cause damage to the liner if the flow of the material is directed directly at the liner, particularly during gravity loading through the top hatches (floor) or thrown or pneumatic loading through the rear doors (roof or front wall).

5.3.6.5 These loading methods do have restrictions, and it requires the loading operators to understand the "flowability" of the product being loaded so that it is evenly distributed across the entire container by gradually withdrawing the conveyor / blow pipe. Powders and grains which have a high angle of repose may settle unevenly and cause the ecentricity of the bulk material in the CTU which could result in handling difficulties.

5.3.6.6 Depending on the internal friction and the angle of repose of the solid bulk cargo, the CTU may be inclined to a certain degree, to facilitate the loading or unloading operation. However, it should always be ensured that the walls of the CTU are not overstressed by the filling operation. It is not acceptable to turn a CTU by 90° to an upright position for filling, unless the CTU is especially approved for this method of handling.

5.3.7 Packing problems

5.3.7.1 It is frequently seen, that despite correct lining procedures, the packing method used may cause damage to the liner and thus defeating the objective of the liner. Damage can be caused by a number of ways:

- abrasion
- wear
- tearing

is defeated, resulting in additional costs for cleaning up onboard ship and in terminals wherefore correct stuffing supervision and spot checking of hide shipper's stuffing operations should be performed regularly.

5.3.8 Weighing

5.3.8.1 The international convention for Safety Of Life At Sea (SOLAS) requires that all containers are weighed prior to loading on board a ship, and that a verified gross mass certificate (VGM) is presented to the master.

The following is an extract from SOLAS:

4	In the case of cargo carried in a container, except for containers carried on a chassis or a trailer when such containers are driven on or off a ro-ro ship engaged in short international voyages as defined in regulation III/3, the gross mass according to paragraph 2.1 of this regulation shall be verified by the shipper, either by: .1 weighing the packed container using calibrated and certified equipment; or .2 weighing all packages and cargo items, including the mass of pallets, dunnage and other securing material to be packed in the container and adding the tare mass of the container to the sum of the single masses, using a certified method approved by the competent authority of the State in which packing of the container was completed.

5.3.8.2 Under the current terms of SOLAS, dry bulk cargoes can only have a VGM produced by method 1, therefore, on completion of packing and after the container has been sealed, whole container should be weighed on a calibrated weighing device.

5.3.8.3 A report produced by PEMA investigated the available technologies for weighing containers in ports and found that the reach stacker system was unreliable, suggesting serious unreliability because such weighing facilities are associated with overload, rather than accuracy. Therefore, following the packing of the container, the gross mass of the container should be obtained using a weighbridge or a spreader mounted weighing system.

5.3.9 Unpacking bulk containers

5.3.9.1 Unpacking containers is generally far easier than loading as gravity can greatly assist the process. All types of container apart from the vertical hopper type container can be tipped either on specialist tipping equipment or, as is becoming more popular, using tipping chassis /

trailers. During the tipping operation, extra care should be taken to ensure that the rear doors are not over stressed and, wherever possible, the rear false bulkhead should take all of the load caused by the tipped load. Specialist bulk containers, such as shown in Figure 12 are designed with discharge hatches and a front or rear structure that can withstand the forces associated with a tipped load.

5.3.9.2 Discharging a CTU generally is undertaken using a tundish system attached to the rear of the container, a piped discharge or a general discharge into a receiving hopper. As the following three pictures show the CTU will need to be tipped to a lesser or greater degree.

Figure 12: Tundish discharge

Figure 13: Grid discharge

Figure 14: Piped discharge

5.3.9.2 CTUs can be tipped in one of three ways, using the trailer chassis, a tipping platform or a tipping frame. Using the chassis or a platform means that CTU does not need to be lifted off the road vehicle, which in the case of some specialist bulk containers with a gross mass of 38 tonnes would require special handling equipment. A tipping frame may be able to lift the CTU directly off the trailer as shown in Figure 17 or may require handling equipment that positions the CTU with in the frame (see Figure 14).

Figure 15: 40ft Tipping trailer

Figure 16: 100t Tipping platform

Figure 17: 40ft Tipping frame

5.3.9.3 When handling CTUs, especially longer than 20ft, extra care is required to ensure that the stability of the CTU is maintained during the whole unpacking process. As the cargoes moves within the CTU during the operation, the centre of gravity will change, and if associated with potentially uneven ground or side winds, the stability may be compromised, resulting in the CTU falling.

Figure 18: locking twistlock

Figure 19: Backstop

5.3.9.4 When tipping a container on a trailer, it is important to ensure that the container is properly attached and there is no risk of the unit moving during the unpack process. Sudden movement of the cargo can place extraordinary loads on the twistlocks, therefore, it is essential that the correct attachment devices are used and properly tightened. Figure 18 shows a tightened screw-down twistlock which should be used at all four corners and Figure 19 shows a backstop, which prevents the container from slipping.

Consequential Changes

1. Add new definitions

Bulk materials	Materials that can move freely in a CTU or that are not otherwise secured in their position and for the purpose of this document includes liquids.
Siftproof	means impermeable to dry contents including fine solid materials produced during transport Where a liner is used to make the container sift proof it shall be made of a suitable material. The strength of the material used for, and the construction of, the liner shall be appropriate to the capacity of the container and its intended use. Joins enclosures of the liner shall withstand pressures and impacts liable to occur under normal conditions of handling and transport. For ventilated bulk containers any liner shall not impair the operation of ventilating devices Source: United Nations Recommendations on the Transport of Dangerous Goods Model Regulations

2. Add new appendix 2 and renumber subsequent appendices

Other changes

The following text has been supplied by the Russian Federation. Readers are requested consider if the appendix is required and if elements of the Russian Federation text should be incorporated.

Stowage and Fastening of Bulk Goods

1. Bulk goods in containers shall be carried with use of disposable liners.

A liner into a container shall be made of the two-ply fabric propylene with a density not less than 120 g/m2 (woven polypropylene of high strength, and polypropylene coating (lamination) on the inner side).

A liner shall, at its surface, have a marking that contains the following (for example):

- trademark (manufacturer’s name);
- name of product and its specifications;
- number of product;
- date of manufacture.

2. Containers for the stowage of liners with goods shall have a doorway groove for fastening the beams of the doorway shield.

The inner surfaces of the walls and floor of a container shall not have any mechanical damage and sharp edges, protruding or loose screws, welded seams, or marks indicating repairs that are made on the inner surface.

3. The following shall be installed for fastening the liner in a container:

- end shield;

- doorway safeguarding shield.

The height of shields shall exceed the height of loading not less than by 100 mm.

At the end wall, full width, a shield made of plywood sheet with a thickness not less than 8 mm, position 5. It is permitted to install an end shield composed of two plywood sheets, by width, and with an overlapping value not less than 200 mm in the middle part.

The liner installation shall be executed from the rear wall of a container to the doorway opening. Sequentially, beginning with the rear wall, the upper part of the liner shall be fixed to the upper bracing facilities of a container, using the strips sewn to the liner for this purpose. The lower part of the liner shall be fastened by the lower bracing facilities of a container, and the liner material's adjoining the container walls shall be provided by the tension of strips (Figure 23).

Figure 23

The container doorways shall be safeguarded by shields made of a sheet of plywood with a thickness not less than 8 mm, full width, and six steel beams with a section not less than 50x70 mm and thickness not less than 3 mm. The steel beams shall be installed in the grooves of corner posts of a container, equally spaced by the height of loading, and shall be fastened by straps that shall be tied in a double knot to the wire rods of the shoot of the container corner posts. It is permitted to install a sheet of plywood composed of two parts, by width, and with an overlapping value not less than 200 mm in the middle.

The steel beams shall be fastened to the safeguarding sheets by means of textile straps or plastic clamps.

If available, the liner unloading chute located below shall, prior to loading, be firmly tied by strings available (Figure 24).

Figure 24

4 Loading of bulk goods shall be executed through the loading opening of a liner or loading chute, which shall, after completion of loading, be buttoned or tied subject to the container's design.

Loading shall be performed in a smooth flowing manner in the container floor space (Figure 25). The maximum loading height shall not exceed the level by 100 mm lower than the upper edge of the doorway opening safeguard or end wall of a container.

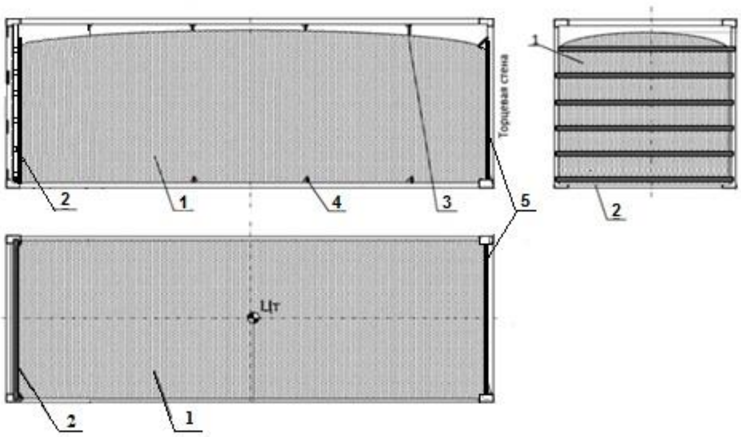


Figure 25 – Pattern of stowage and fastening of a liner with goods

1 – liner with goods;

2 – shield for safeguarding the doorway opening;

3 – strips for fastening a liner with upper bracing facilities of a container;

4 – strips for fastening a liner with lower bracing facilities of a container;

5 – shield made of a sheet of plywood

Appendix 2 CTU and cargo protection

Introduction

CTU and cargo owners both require that their asset needs to be protected from the other. Often this will be achieved by the wrapping of the cargo in some form of packaging, usually card or stretch wrap film. However, many cargoes carried in CTU are packed in bulk form and therefore impossible to wrap.

CTUs need to be protected from cargoes that may scratch or contaminate the interior surfaces:

- scrap steel
- old engine parts
- wet salted hides
- corrosive chemicals, such as sulphur.

Conversely cargoes may be contaminated by the internal condition of the CTU and corrosion, flaky surface coating or condensation may fall into the cargo:

- grains
- plastic granules
- certain food stuffs

CTUs may be lined with timber panelling, matting or film.

Solid liners and bulkheads

The simplest form of liner is a plywood or chipboard or similar facing (Figure 20) to the side and end walls, and this provides both protection and assists in reinforcing the walls. Dry scrap steel with sharp edges can seriously damage the internal surfaces during packing and unpacking and such bulk cargoes may cause bulging of the walls.

Figure 20 Lined 40' container

Cargoes carried in bulk present the CTU with particular problems. Liquids and solids that are suspectable to free flow can both destabilise the CTU during transport but my also damage the walls. Non-regulated liquid cargoes may be carried in a general purpose CTU within a flexitank (see Annex 7 sub section 5.2).

Dry bulk cargoes, whether regulated or not, may be carried in specialist bulk CTUs or in general purpose CTUs (see Annex 7 sub-section 5.3) subject to extra provisions:

- the CTU is sufficiently sift-proof to retain the cargo for the entire duration of the transport chain;
- the end and side walls of the CTU are strong enough to prevent any permanent deformation as a result of handling;
- adequate protection is provided if the CTU is to be tipped to unpack.

Cargoes categorised as a dangerous good in the IMDG Code (or similar) are required to be carried in accordance with packing instruction BK2 which requires that bulk containers is designed and tested in accordance with ISO 1496 -4:1991 "*Series 1 Freight containers- Specification and testing - Part 4: Non pressurized containers for dry bulk*". Unfortunately, there are a very limited supply of containers built to this standard, so the IMDG Code states

"*Freight containers designed and tested in accordance with ISO 1496-1:1990 "Series 1 Freight containers - Specification and testing - Part 1: General cargo containers for general purposes" shall be equipped with operational equipment which is, including its connection to the freight container, designed to strengthen the end walls and to improve the longitudinal restraint as necessary to comply with the test requirements of ISO 1496-4:1991, as relevant*."

This can normally be fulfilled by fitting a partial height false bulkhead against the front wall and a rear bulkhead using the shoring slots at the door end.

While there is no regulation to prevent the carriage of dry bulk cargoes in general purpose CTUs, it is highly recommended that the provisions required for dangerous goods are followed for non-regulated cargoes.

Figure 21 Preparing container

Figure 22 False bulkhead

The front false bulkhead could be constructed from 12 mm or thicker birch plywood (internal grade) with at least three full width 6 x 2in softwood timber cross beams. At the front (blind) end the beams must extend to either corner post so that the load is take mostly by the strong points of the CTU structure. The false bulkhead is made from two or more pieces of panel material, both full width. Each panel must be supported by two of the full width beams and the height of the front panel should be at least 100mm greater than the expected height of the cargo during packing.

The Packer must ensure that the combined front end wall strength and that of the false bulkhead achieve the strength required by the latest version of ISO 1496-4.

At the door end, the IMDG Code requires that "*operational equipment of bulk containers designed to be emptied by tilting shall be capable of withstanding the total filling mass in the tilted orientation.*" This means that the rear bulkhead should be sufficiently strong so as the retain the cargo with the door open.

ISO box containers are equipped with shoring slots in the door corner posts which are suitable to accommodate transverse steel bars of 60 mm square cross section. This arrangement is particularly designed to strengthen the container door end for taking a load of 0.6 P, as required for solid bulk cargoes. These bars should be properly inserted. The relevant transport capability of the CTU should be demonstrated by a case-related certificate issued by a recognised consultative body or by an independent cargo surveyor. This requirement applies to multi-purpose ISO box containers and to similar closed CTUs on road vehicles, which are not explicitly designed to carry bulk cargoes.

Timber beams may be used so long as they satisfy the strength requirements, however, the length of the beams should so long enough so as not to be able to slide out when moved horizontally (see Figure 23 and Figure 24).

Figure 23 Beam too short

Figure 24 Beams too short

Cargoes

When using box type CTUs it should be recognised that it will have been used to transport a variety of cargoes, some of which may constitute a contaminate to the powder or granule to be carried. While shipping companies and owners will endeavour to ensure that CTUs are clean before delivery to a shipper, it is the shippers' responsibility to ensure that the CTU is fit for use before loading. Likewise, after the shipment has been made, the consignee must clean the interior of the container to remove all traces of the cargo carried. Sift-proof liners make the cleaning process easier, but they do not totally eliminate the need for pre and post laden cleaning.

Small and fine powders and grains if not contained within a liner may fall out through the doors during transport due to vibration. It is therefore recommended that all dry bulk cargoes are only carried within a suitable liner.

If crude or dirty material shall be transported, the CTU boundaries should be lined with plywood or chipboard for avoiding mechanical wastage of the CTU (see Figure 20). In all cases an appropriate door protection should be installed consisting of battens fitted into suitable recesses and complemented by a strong plywood liner.

Figure 25: Lined container loaded with scrap

Scrap and similar waste material to be carried in bulk in a CTU should be sufficiently dry to avoid leakage and subsequent contamination of the environment or other CTUs, if stacked ashore or transported in a vessel.

Liners

Many cargo owners feel that the internal condition and cleanliness of containers is inconsistent therefore sought other methods to retain and protect the cargo. Likewise, container owners also sought methods their containers from cargoes, especially corrosive, or those requiring extensive cleaning after discharge.

Liners are best described as oblong sacks or envelopes whose size is equivalent to the inner space of a 20 foot or longer CTU. It is attached to hooks in the upper corners after which loose cargo is blown, or poured in, gradually filling the entire CTU with the cargo. CTU liners are used in the bulk shipment of dry free-flowing cargo such as coffee. They are quick and simple to install and enable bulk cargo to be shipped door to door with a minimum of handling, thereby minimizing cargo spillage and waste.

Liners are usually made from virgin polyethylene (film or woven polyolefins), allowing the cargo to be transported safely in an enclosed chamber, thus avoiding contamination from pollutants and salt sea air. The liner therefore protects the cargo from external influences such as moisture and, in case of condensation occurring on the CTU's inside walls, it ensures that this does not affect the cargo.

Container liners were originally developed for 30ft bulk containers with three or four top loading hatches. Delicate cargoes, mainly plastic granules, where contained within a liner to ensure that the material was not contaminated. More recently grain shipments are increasingly carried in bulk in containers and although originally carried without a liner, almost all shipments are now made with them fitted, partially to protect the cargo from the damp and partially to protect the container. Cargoes such as hides (wet or dry) may release corrosive liquids that will damage the container metal work and paint, therefore, these cargoes require containers that are partially lined to protect the cargo. Differing cargoes may release gases or moisture that may attack the structure or paintwork. In all of these cases, the shipper, consignee or the container operator may require that the container is lined internally.

Additionally, the IMDG Code states "*Bulk containers shall be sift-proof. Where a liner is used to make the container sift-proof, it shall be made of a suitable material. The strength of the material used for, and the construction of, the liner shall be appropriate to the capacity of the container and its intended use. Joins and closures of the liner shall withstand pressures and impacts liable to occur under normal conditions of handling and transport.*"

Figure 26: Open rear

Figure 27: Bulk (top load)

Figure 28: Open top

Figure 29: Top & bottom rear

Figure 30: Fluid liner

Figure 31: Open rear - thermal

Figure 32 Thermal blanket

Figure 26 to Figure 32 show typical liner designs to cater for different cargoes and packing processes.

Figure 33: Container with bulk material liner

Figure 34: Container with bulk material liner and integral bars

Figure 35: Half height liner

Figure 33 and Figure 34 show examples of bulk liners fitted to general purpose containers where the cargo is blown in through the opening or central circular access hole and then discharged through the flap at the bottom. Figure 35 shows an example of a half-height liner that would be used to retain liquids or heavy cargoes that does not require a sift-proof enclosure.

For the best integrity a welded construction is required, especially when carrying fine powders and dangerous goods.

Such Container liners are generally made from one of the following materials:

Low Density Polyethylene Film (LDPE)
This term is generally considered to include polyethylene's ranging in density from about 0.915 to 0.925 g/cm^3. In low density polyethylene's, the ethylene monomeric units are linked in random fashion, with the main chains having long and short side branches. This branching prevents the formation of a closely knit pattern, resulting in material that is relatively soft, flexible and tough, and which will withstand moderate heat.

LDPE is soft, low barrier, good clarity film. It is also the least expensive of all polymer packaging films.

Very flexible, natural milky color, translucent with high impact strength. Excellent for mild and strong buffers, good chemical resistance. Good water vapor and alcohol barrier properties. Poor gas barrier, sterilizable with EtO or gamma radiation. Good stress crack and impact resistance.

High Density Polyethylene Film (HDPE)
High density polyethylene or HDPE is a low cost, milky white, semi-translucent thermoplastic. It is flexible but more rigid and stronger than LDPE and has good impact strength and superior puncture resistance. Like LDPE, it also has good chemical resistance, good release properties, and good vapor but poor gas barrier and weathering properties. Other limitations or disadvantages include: subject to stress cracking, difficult to bond, flammable, and poor temperature capability.

Typically, high-density polyethylene is more linear and consequently more crystalline than LDPE. The higher crystallinity leads to a higher maximal service temperature up to about 130°C and results in somewhat better creep resistance. The lower service temperature is about -40°C.

HDPE tends to be stiffer than other polyethylene films, which is an important characteristic for packages that need to maintain their shape. HDPE is easy to process and can be blended with other polymers and/or additives, like (surface treated) fillers, other polyolefin (LDPE, LLDPE), and pigments to alter its basic properties.

Polypropylene Films
The density of (PP) is between 0.895 and 0.92 g/cm^3. Therefore, PP is the commodity plastic with the lowest density. With lower density, mouldings parts with lower weight and more parts of a certain

mass of plastic can be produced. Unlike polyethylene, crystalline and amorphous regions differ only slightly in their density. However, the density of polyethylene can significantly change with fillers.

Polypropylene is normally tough and flexible, especially when copolymerized with ethylene. This allows polypropylene to be used as an engineering plastic, competing with materials such as acrylonitrile butadiene styrene (ABS).

Polypropylene has good resistance to fatigue.

Figure 36: Woven PP Sheet

Figure 37: Stretched stitching

When used for liners, the sheets will be woven (see Figure 36) and therefore cannot be welded.

Overstressing the material can result in the stitching used to join sheets becomes stretched (see Figure 37) and may result in leakage of liquids, moisture or powder.

Thermal liners

Certain industries - including pharmaceuticals, food and beverage, and chemicals – must ensure that their commodities maintain a specific temperature range during the shipping process, whether that lasts hours or days. It is in these circumstances that thermal packaging and thermal CTUs and thermal liners are used to help protect valuable cargo from temperature spikes that would make it worthless upon arrival.

Even using refrigerated CTUs, thermal liners provides additional temperature protection throughout the transport chain. Thermal packaging protects the cargo from radiant heat exposure from the sun and moisture from precipitation before packing and after unpacking but additional termal linings provide “keep from freezing” protection for cargoes transported in general purpsoe CTUs. In addition to protecting from hot and cold spikes, thermal packaging and liners reduce the amount of temperature fluctuation that a cargo experiences, even with longer shipping times.

Figure 38 Thermal blanket

Figure 39 Thermal coverall

Figure 40 Thermal liner and coverall

Blankets similar to the thermal blanket shown in Figure 38 made from a woven material can also be used to protect the cargo packages from contamination or condensation falling from the roof.

Lining procedures

Hides and skins

To minimise the risk of damages to the CTU, protective liners made of good material with sufficient thickness to catch leakage must be used in addition to spreading and an effective absorbent medium over the floor, prior to the packing of cargo. Protection liners may vary in thickness and might be made of extremely lightweight material. Some of those liners appear to do very little to protect the product from leaking and are easily punctured and torn and do not withstand the rigours of vanning.

Before fitting the liner, the floor should be covered with 6 mm thick cardboard or corrugated plastic sheeting to ensure that imperfections in the flooring do not damage the liner. Make sure this fits neatly into all corners. A few pieces of tape will be required to stop cardboard from moving towards the centre of the CTU. Leave a flap of cardboard hanging out past the door end by about 1.5 metres (Figure 41).

Figure 41 Pre liner

Figure 42 Liner in place

Figure 43 Supporting the liner

A one-piece woven polythene liner of minimum 200/250-micron thickness or polyethylene woven liners (10x 10 mesh per square inch) of 850 denier, coated on both sides with polyethylene, having all seams welded (not sewn), with aluminium eyelets punched along the top of the liner edge that is reinforced with a cord to allow the liner to be hung securely, may also be utilised. The liner should be of sufficient size to cover the entire container to a height of 2.20m (floor, front wall and sidewalls), with a full width flap of 2.4 meters must be used. This is to form a full envelope around the cargo to capture any moisture that originates from the cargo and to prevent any leakage. Access skirts or base liners may be used for extra protection.

To establish a fixing point for the liner a bail lash or 4mm rope is run through the lashing points around the top of the CTU and tied off ensuring that the lash is tight. After threading plastic bungee clips through the lashing rings of the liner, beginning at the front wall, the liner is clipped onto the lashing (Figure 43). Using tape to support the liner is not recommended as the length of the voyage and the prevailing weather conditions, tape may tend to lose its adhesive quality due to the build-up of heat.

There must be minimal slackness in the liner on the walls and floor to reduce snagging and slipping and it should be pushed into the corners to avoid damage during packing.

During packing an additional 6 mm thick cardboard should be fitted to protect the liner bag from being damaged when driving in and out with a forklift and from rough handling of pallets. Once again make sure this fits neatly into all corners with a few pieces of tape to stop cardboard moving towards the centre of the container and leave a flap of cardboard hanging out past the door end by about 1.5 metres.

Figure 44 Bagged sawdust prior to laying

Finally place a sufficient amount of fine grade absorbent sawdust into the container, so that the floor is completely covered. Coarse sawdust or wood shavings are not suitable due to their bad absorbent qualities.

The CTU is now ready for packing the hides or skins.

Bulk powders and grains

Depending on the nature of the cargo any of the liners shown in Figure 26 to Figure 35 can be used. Fully enclosed (6-sided) liners should be used where the cargo should be protected from contamination or condensation or if the cargo presents a risk to the environment, such as one recorded as a dangerous good.

To establish a fixing point for the liner a bail lash or 4mm rope is run through the lashing points around the top of the CTU including across the doors and tied off ensuring that the lash is tight. After threading plastic bungee clips through the lashing rings of the liner, beginning at the front wall, the liner is clipped onto the lashing.

The inner polypropylene liner must fit snugly against the walls, roof and floor when full - improper placing of the inlet could cause tearing - and the load must be as evenly levelled as possible. The liner's roof must not sag but must be tight so at no time will the inlet or roof rest on the cargo after packing. Ideally, built-in reinforced straps in the liner's front panel (bulkhead) will prevent bulging when the CTU is full, thus allowing for easy closing of the doors. (strapping ropes can also be used.) There should not be any pressure on the doors when closed after packing. The liner must be properly fastened to the CTU's interior, also at the far end: at the point of discharge the CTU is tilted to enable the cargo to slide out of the liner, rather than the filled liner sliding out of the CTU.

Closing liners

For cargo packed as unit or unitized loads the liner will need to be closed after the completion of packing. It is essential that the following procedure is followed to ensure that the cargo cannot escape.

Ensure that all materials within the liner are folded into the cargo area before the liner itself is secured.

1. Take the end of the liner and secure it to the line across the door (arrowed in Figure 45) Ensure that there is no material trapped in the folds
2. Pull the liner to form a trapezoid and fold one point up to the other side of the CTU. Ensure that it is properly secured to the top lashing ring or to the 4 mm rope down the side. Do not secure it to the line across the door opening.
3. Fold the other point up to the opposite side and secure in the same way as 2 above.

The finished envelope should contain all the cargo and not permit any egress of material and the folded end should look like Figure 47

Figure 45 End folded up

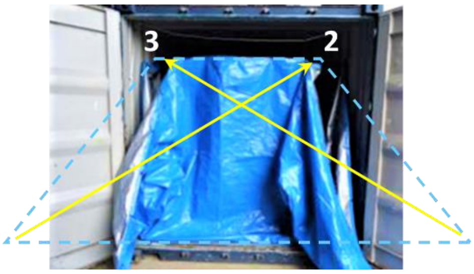


Figure 46 Folding steps

Figure 47 Sides folded in

Once full the liner is sealed and not opened again until discharge at destination, either into the reception system of the destination plant, or into a silo storage system, for example in a port.

For cargoes carried loose in bulk a suitable rear false bulkhead should be fitted prior to the completion of packing.

Figure 48 Partially filled

Figure 49 Use of shoring slots

Figure 50 Rear false bulkhead

When packing bulk materials manually fitting the rear bulkhead would normally be completed in two stages. The bulk cargo is packed until the pile within the CTU is approaching the rear end (see Figure 48). At this stage the bottom portion of the rear bulkhead is fitted with at least three horizontal beams being located into the shoring slot groove (see**Error! Reference source not found.**). The liner would be pulled up over the top of the false bulkhead whilst packing is completed. Packing continues to pack more or the bulk material through the space above the rear bulkhead. On completion the liner should be secured as described above and the top portion of the rear bulkhead is fitted (see Figure 50). Care must be taken that the fixings do not protrude into the cargo space and it is best practice for any fixing to be made from the interior, i.e. through the plywood bulkhead into the horizonal beam.

Note: The cargo shown in Figure 48 is bulk lump sulphur and the liner should fully enclose the cargo to form a sift-proof enclosure.

Specific cargoes carried in liners

Hides and skins

Transporting hides in containers can cause a variety of problems for terminals and ships if the wet hides are improperly treated or inappropriately stowed. The problem of wet hides or sheep skins carried in CTUs is predominately due to the run-off of excess brine. If this liquid leaks at any stage between origin and destination costs are incurred for cleaning this liquid which can have an offensive odour and could possibly be deemed a health hazard. Leakage of liquid from the hides can also result in damage and degradation of the CTU. When the leakage comes into contact with the interior of the CTU it can cause permanent damage through corrosion of metal surfaces and rubber seals and contamination of timber floors. In addition, leakages of brine from CTUs onboard a vessel may contaminate CTU stowed adjacent to or underneath and corrode the ship’s decks and fittings.

The risk of problems occurring when carrying hides are minimised when the CTU is properly prepared prior to packing and care exercised during the packing process. Prior to packing cargo preparation is essential and requires the container to be inspected, lined and an effective absorbent medium spread over the floor. By following the guidelines set out in this factsheet shippers/packers may be able to reduce their potential liability for damage.

The following are the common types of Hides/Skins being offered for transport:

Wet Salted hides:

Wet salted hides and skins are a raw product, only temporarily saturated in a brine solution of salt water. This concentrated salt solution ensures protein destroying organisms cannot function. This process takes about 12-18 hours to “cure” (salt) the hides. However, they are an unstable organic material that may slowly degrade activity which can be accelerated by increasing temperature especially when sealed inside a shipping container. The raw hides and skins are covered in hair or wool and of course fat and blood with a fair share of insects and bacteria feeding on this food source. By its very nature salted hides and skins will purge the salty brine continually as the product ages.

Figure 51 Wet salted hides

Wet Blue hides

These hides have already undergone vigorous cleaning processes which begin with the soaking of the hides in detergents, various chemical treatments and then several water cleaning treatments containing salts. All hair and fat and protein have been removed in the tanning process and the hides are chemically stable. Since any water is chemically bonded to the collagen proteins in the hides then during storage and transit this wet blue tanned leather does not deteriorate in quality and does not lose any moisture.

Figure 52 Wet blue hides

Dry Salted / Air Dried hides

In this process the flesh side of the hide is covered with salt. After some time, excess salt is removed, and hide is then dried in the air. Since product contains no water no leakage should be expected. However condensed water released due to climate change might result in brine leakage.

Air dried hides which are properly dried and devoid of any wetness or dripping, and have a maximum moisture content of 10-15% may be shrink-wrapped and carried without sawdust absorbent material and, with the CTU Operators permission, without a liner.

Shipment / storage / usage

Hides and skins are shipped in bales, bundles, casks, barrels, bags, loose or palletised in freight containers. Any animal hide or skin is of fibrous texture and from the moment of slaughter is liable to decomposition due to bacterial action. This decomposition is only completely stopped when the hide or skin is tanned but can be halted temporarily by salting and/or drying.

Hides are shipped as Wet-Salted (Brine-Cured), Dry-Salted and Dry. These methods of preservation are effective for fairly long periods, provided that the curing or drying has been satisfactorily carried out, and conditions of storage and transit have not caused the curing or drying to become ineffective. Climatic conditions at the time of preparation may have some bearing upon the condition and appearance at destination, e.g. , skins which have been salted and dried in the heat of the summer may tend to become somewhat overdried and although not damaged are liable to be broken or torn if roughly handled, more particularly in the case of a poor type of skin. Surveys should be called before the skins have been put to work and thereby lost their identity. The surveyor has a better opportunity of examining skins in the original bales and thus of ascertaining the cause and extent of the damage.

Salted skins once having been wetted will readily absorb moisture from the atmosphere. This may give rise to a wrong impression as to the length of time which has elapsed since wetting.

Heating

Wet-salted hides are liable to decompose through heating if not adequately salted or if exposed to high temperatures in stowage or to a fairly high temperature for an extended period. Hides may be lightly cured to preserve them for short periods, or more thoroughly cured when they need to be transported over long distances. Hides stored under salt for a long period have a stale appearance and if deterioration has started to set in, the first indication will be looseness of the hair or ‘hair slip’. In advanced cases this is accompanied by a smell of ammonia and obvious signs of decomposition. Hides already stale when shipped will lack resistance to adverse conditions during transit and may deteriorate when well-cured fresh hides would not be affected. ‘Hair slip’ may also arise in hides which have been subjected to heating, as the looseness of the hair is brought about by bacterial action. Red stains on the flesh side of the hides (‘red heat’) are also an indication of heating; in early stages this need not signify damage, but in more advanced stages will be accompanied by other signs of damage. When hides are seriously heated, the fibrous structure of the pelt will have been destroyed with serious results. ‘Red Heat’ may also be found in dry-salted hides and skins, but in this case the skins will usually have been wetted or have been damp at some time. It is the result of salt-loving bacteria which progressively break down the hide substance.

Wetting
Hides and skins of all descriptions can be seriously damaged if wetted by fresh or salt water. The effects are more rapid on dry hides and skins than on salted, but the latter will become severely damaged if wetting has been sufficient to remove much of the salt. Wetting allows bacteria to thrive to the detriment of the pelt, and decomposition will be accentuated if the wetting is accompanied by heating, which is particularly liable to occur in press-packed bales. Salted hides and skins may absorb a certain amount of moisture from the humidity of the atmosphere, but this does not constitute damage, and normally does not affect the skins. Dry hides and skins may absorb moisture to a limited extent if the atmosphere is very humid; a slight mould will form on the surface of the skin. This may not be harmful, but much will depend on the degree of moistening and the length of time the skins have been in this condition. Wetting prior to shipment or from sweat during the voyage may produce similar effects. If skins have been packed damp, a mildewed condition may exist, but this will clearly be of an internal character inside bales, as distinct from the effects produced by external wetting. Dry and dry-salted hides and skins are not liable to sweat from inherent causes.

Holing
Inferior quality hides are liable to develop holes due to a skin defect, and care should be taken not to attribute this holing to the use of hooks or other fortuitous cause. The skins concerned are usually those with a rough surface, and careful examination of the holes will make it comparatively easy to determine whether this has arisen through the use of hooks or other fortuity, or whether it is a defect in the kin itself. When the hole is due to a defect, the surface immediately surrounding the hole is not usually as smooth as the remainder of the hide or skin. The skin may also suffer from blemishes which may eventually result in further holes. These holes and blemishes are usually accepted in the trade as being defects of the hide or skin itself.

Hides and Skins in CTUs
Hides and skins may be carried palletised in freight containers. CTUs must be lined with plastic or other impervious material. Heating may occur if insufficient ventilation is provided. Packed CTUs should not be exposed to direct sunlight or heat as this will lead to heating and heavy damage. CTUs should be so stuffed as to allow adequate circulation of air.

Contact with metal - Contact with iron or copper can, if allied to moisture, lead to serious damage in a relatively short time.

Treatment - Where damage is not severe enough to warrant goods being classed as useless, damaged skins should be put into work immediately; discarded skins may be sold for glue manufacture. Unless water-damaged hides are dealt with promptly, damage will be considerably aggravated as the result of bales being left unopened or stored, decay in the skins advancing rapidly if air has no access to them.

Basils

(Australian tanned Sheep and Lambskins) - Usually satisfactory cargo. Liable to damage from wetting. Damp packing very rare.

Goatskins
Dry Salted – Mostly India. Usually well packed and prepared for shipment in press-packed bales. Most likely cause of damage is external wetting. May become mildewed internally if packed slightly damp under monsoon conditions.

Shade Dried – East and West African, etc. Usually well dried and prepared for shipment. Liable to heavy damage from wetting, slight wetting may cause considerable mildew. Mildew may also result from damp packing. Liable to worm damage.

Wet Salted – Mostly Indian – Packed in casks. Are liable to heavy damage from exposure to heat and heating. Similar troubles arise from improper salting before packing.

Lizard Skins
Susceptible to heating which 'cooks' skins. These tear easily, rendering them useless.

Pickled Pelts
Lamb and Sheep – Mostly shipped in casks. Liable to deterioration and damage if exposed to heat and water. Will also deteriorate if pickled unsatisfactory.

Rabbit Skins
Improper curing can cause mould damage which is easily mistaken for damage due to contact with water or sweating in transit.

Raw Calfskins
These are shipped dry, dry-salted and wet-salted. The same conditions apply as above, except that wet-salted skins are usually shipped in casks.

Raw Hides
Dry Salted - Usually carry well but can be damaged by wetting. Sometimes absorb moisture during very humid weather, but this dampness may not result in damage.

Shade Dried – African, Ethiopian, Indian, etc. – Can deteriorate quickly after wetting by fresh or sea water. Damping by rain before shipment may result in heavy mildew on bales or hides, not to be confused with similar mildew which may result from insufficient drying before packing. Liable to attack by worm or weevil (Dermestes vulpinus) which may be inherent or contracted in transit.

Sun Dried – Similar to above, usually more common types. May suffer from incorrect drying in too great heat. Wet Salted – Australian, New Zealand and South American – Freezer works and abattoir hides are usually well prepared for shipment. Can be damaged by wetting due to loss of salt content. Chief danger is from heating usually resulting from exposure to heat, faulty stowage, inadequate ventilation, or delays in transit. Damage may result from insufficient salting, but this is most unlikely with freezer works and abattoir hides.

Raw Sheepskins and Lambskins
Australian, New Zealand, South African, South American – These are usually shade dried in abattoir conditions and shipped in press-packed bales. The chief cause of damage is wetting, but they can become heated and badly mildewed, or attacked by black mould, through damp packing. These skins are also subject to attack by worm or weevil which may be inherent or contracted during transit.

Dry Salted – Indian – Usually well packed and prepared for shipment in pres-packed bales. Most likely cause of damage is external wetting. May become mildewed internally if packed slightly damp under monsoon conditions.

Dry Salted – Red Sea Area – Most likely cause of damage is wetting from external causes.

Dry Salted – Australian, New Zealand, South African, etc. – Usually well prepared for shipment in bales. Chiefly subject to damage by water, but liable to absorb moisture during very humid conditions, which may be harmless but may give rise to red heat or black mould.

Dry Raw Hair – Arabian, Ethiopian, etc. – These are usually well prepared for shipment in bales with naphthalene and gammexane as protection against worm. They will deteriorate rapidly if wetted.

Shade Dried – East and West African, etc. – Usually well dried and prepared for shipment. Liable to heavy damage from wetting. Slight damage cause considerable mildew. Mildew may also result from damp packing. Liable to worm damage

Wet Salted – Indian – Packed in casks. Are liable to heavy damage from exposure to heat and heating. Similar troubles can arise from improper salting before packing.

Sheepskins and Goatskins, East India Tanned Hides
Usually most satisfactory cargo but can be severely damaged by wetting and subsequent heating. May be packed damp during monsoon conditions, resulting in mildewed condition inside bales.

Sheepskins and Goatskins, Semi-Tanned Baghdad, Syrian etc. – As above but tend to deteriorate more rapidly after wetting. Contain salts used in manufacture which may attract moisture in very humid conditions.

More information on hides

Hides are normally only accepted in DRY CTU - The hides are only acceptable if they are shrink wrapped and the container is fitted with one of the approved hide Liner Bags and then only with ample use of absorbent sawdust on the floor. It is important that the liner is not cut in the container doorway to facilitate door opening/loading as once cut, the liner looses any liquid retaining ability when the container is handled/tilted. Shrink-wrapping is not sufficient.

Hide CTUs must not be stowed in the bays next to the accommodation, preferably they should be stowed in the foremost bays in rows close to outboard side but not over walkways.

All hide CTUs must be stowed on deck and must never be stowed on top of any reefer containers (live, NOR or empty). Hides may be stowed beside or under a live FROZEN REEFER or live CHILLED REEFER only with VENTS SHUT but may not be stowed beside or under a live CHILLED REEFER requiring ventilation.

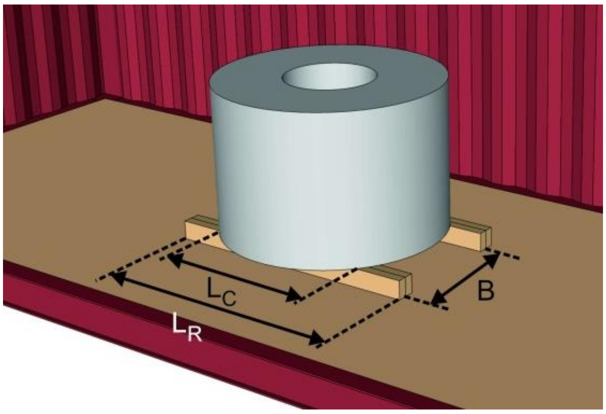
Vessel masters must be presented with stow positions of on board hide CTUs at time of loading to enable pinpointing of leakage.

Leaking CTUs are not allowed to be loaded at all and should be returned to the shore at once.

Minimum length

The table below gives the minimum required length of longitudinal bedding beams, L_R, based on the following factors:

- The cargo weight (in ton)
- The spacing of the beams, B (in meters)



Minimum required length of longitudinal bedding beams, L_R, [m]							
Spacing between beams, B [m]	**Cargo weight [ton]**						
	4	**8**	**12**	**16**	**20**	**24**	**28**
0.50	1.2	2.4	3.6	4.8	6.0	-	-
0.75	1.0	2.1	3.1	4.1	5.1	6.2	-
1.00	0.9	1.7	2.6	3.4	4.3	5.2	6.0
1.25	0.7	1.4	2.1	2.8	3.5	4.2	4.9
1.50	-	1.1	1.6	2.1	2.6	3.2	3.7
1.75	-	0.7	1.1	1.5	1.8	2.2	3.0
2.00	-	-	0.6	0.8	1.3	2.1	3.0

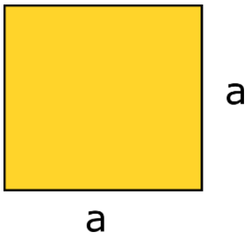
Minimum dimensions

When the minimum length of the bedding beams has been determined, the minimum cross section dimensions of the beams may be taken from the tables below, which is based on the following factors:

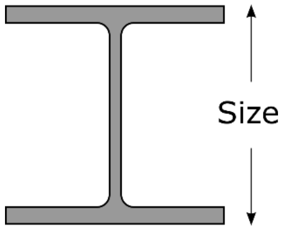
- The cargo weight (in ton)
- The minimum length of the beams, LR (in meters)
- The length of the footprint of the cargo on the beams, LC (in meters)

Minimum edge length, a × a, of a pair of square wooden beams with σ_p = 1.5 kN/cm^2 [mm]							
Free length L_R - L_C [m]	**Cargo weight [ton]**						
	4	**8**	**12**	**16**	**20**	**24**	**28**
0.5	79	99	114	125	135	143	151
1.0	99	125	143	158	170	181	190
1.5	114	143	164	181	194	207	218
2.0	125	158	181	199	214	227	239
2.5	135	170	194	214	231	245	258
3.0	143	181	207	227	245	260	274
3.5	151	190	218	239	258	274	289
4.0	158	199	227	250	270	287	302

Minimum size of a pair of HEB steel beams with σ_p = 15 kN/cm^2 [mm]							
Free length L_R - L_C [m]	**Cargo weight [ton]**						
	4	**8**	**12**	**16**	**20**	**24**	**28**
0.5	100	100	100	100	100	100	100
1.0	100	100	100	100	100	120	120
1.5	100	100	100	120	120	140	140
2.0	100	100	120	120	140	140	160
2.5	100	100	120	140	140	160	160
3.0	100	120	140	140	160	160	180
3.5	100	120	140	160	160	180	180
4.0	100	120	140	160	180	180	200



Definition of edge length, a × a, for wooden beams cross sections



Definition of size for HEB steel profiles

If multiple pairs of beams or beams with a different cross section are used, they shall have the same combined section modulus as the beams represented in the tables above. Furthermore, the required section modulus is proportional to the bending strengths, σ_p, given in each of the tables.