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, 12-13 July 2022

Blocking and bracing material and arrangements

Submitted by ETS Consulting and MariTerm AB

This document proposes changes to Annex 7, clause 2.3 on Blocking and bracing material and arrangements and clause 4 on Securing of cargo in CTUs.

The following comments were received from packing experts regarding the existing CTU Code wording:

- The principle of securing the load against the corner posts of the container to prevent longitudinal displacements, as shown in 2.3.4, figure 7.6, cannot be applied to the container structures currently used. Therefore, this clause should be reformulated.
- The example of securing a load to the corner posts of the container door opening shown in figure 7.32 is not correct, as the corner posts do not protrude beyond the side walls of the container.

Additionally, when reviewing the use of terms associated with blocking there were a number of terms used that were not properly defined and could cause confusion. The current edition of the CTU Code has been searched for those terms that have been used when associated with securing the load (excluding lashing) in some way or another. These are:

Shoring (12) / Shore (5)
Form locking (2) / locking (16)
Threshold (10)
Bracing (13) / Brace (1)
Blocking (38)
fencing (1) / fence (3)
Batten (19)
Scantling (3)
Cross beam (5)

The value in brackets is the number of times the word is used.

Much of clause 2.3 is based on blocking arrangements in containers only. It is proposed to insert some references of techniques and devices used in other types of CTUs as well. In particular, the clause could include a description of the term Blocking Capacity, BC, that is increasingly used to describe the strength of blocking devices, similar to the terms Maximum Securing Load, MSL, and Lashing Capacity, LC, that are used for lashing equipment

In view of the above points, text changes are proposed to clauses 2.3 and to 4.1 and 4.2 plus single amendments to the use of blocking terms (these are shown as tracked changes).

Additionally new definitions are proposed for Chapter 2

Proposed changes:

Preamble

The use of freight containers, swap bodies, vehicles or other cargo transport units substantially reduces the physical hazards to which cargoes are exposed. However, improper or careless packing of cargoes into/onto such units, or lack of proper blocking~~, bracing~~ and lashing, may be the cause of personal injury when they are handled or transported. In addition, serious and costly damage may occur to the cargo or to the equipment.

Chapter 6, clause 6.2.11

Flatracks and platforms have a bottom structure consisting of at least two strong longitudinal H-beam girders, connected by transverse stiffeners and lined by solid wooden boards. For securing of cargo units, strong anchor points ~~lashing brackets~~ are welded to the outer sides of the longitudinal bottom girders with an MSL of at least 30 kN according to the standard. In many cases the anchor points ~~lashing points~~ have an MSL of 50 kN. Cargo may also be secured in longitudinal direction by blocking against ~~shoring to~~ the end walls of flatracks. These end walls may be additionally equipped with lashing points of at least 10 kN MSL.

Chapter 6 clause 6.4.6

The curtain-sided swap body is designed similarly to a standard curtain side semi-trailer. It has an enclosed structure with rigid or removable roof and end walls and a floor. The sides consist of removable canvas or plastic material. The site boundary may be reinforced by ~~battens~~ removable stanchions.

Chapter 7 clause 7.2.5

Heavy items such as granite and marble blocks may also be packed into closed CTUs. However, this cargo cannot be simply stowed from wall to wall. ~~Bracing and blocking~~Blocking against the frame of the CTU and/or lashing to the securing points is necessary (see annex 7, section 4.3). As the lashing capacity of the securing points in general purpose freight containers is limited, such standard containers might not be appropriate for certain large and heavy cargo items. Instead, platforms or flatracks could be used.

Annex 2 clause 3.3.5

~~A b~~Bottom slings are~~is~~ used in connection with a cross beam spreader bar. The freight container ~~is~~ may be lifted from the side apertures of the four bottom corner fittings by means of ~~slings which are connected to the corner fittings~~lifting devices bearing on the bottom corner fittings only. ~~by means of locking devices.~~ Hooks are not suitable for this connection. This method can be used for all freight container sizes in an empty or packed state. Packed freight containers the angle between the sling and the horizontal should not be less than 30° for 40 ft freight containers, 45° for 20 ft freight containers and 60° for 10 ft freight containers.

Annex 4 clause 2.4

T_s Mass of the ~~securing and bracing~~ cargo securing materials

Annex 7 clause 2

clause 2.1.2

Timber planks or ~~scantlings~~ battens may also be used for creating gaps between parcels of cargo in order to facilitate natural ventilation, particularly in ventilated container is. Moreover, the use of such dunnage is indispensable, when packing reefer containers.

clause 2.3

Blocking ~~and bracing~~ material and arrangements

2.3.1 Blocking~~, bracing or shoring~~ is a securing method, where either the cargo is stowed directly against strong structural elements of the CTU or additional materials, e.g., timber beams and frames, empty pallets or dunnage bags are used to fill~~ed~~ ~~in the~~ gaps between the cargo and solid boundaries of the CTU or ~~into~~ gaps between different packages (see figure 7.3). Forces are transferred in this method by compression with minimal deformation. ~~Inclined bracing or shoring arrangements bear the risk of bursting open under load and should therefore be properly designed.~~ In CTUs with strong sides, and where ~~if~~ possible, packages should be stowed tightly to the boundaries of the CTU on both sides, leaving the remaining gap in the middle. This reduces the forces to the ~~bracing~~ blocking arrangement, because lateral g-forces from only one side will need to be transferred at a time.

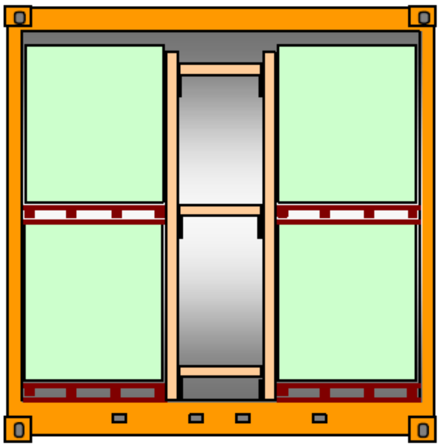


Figure 7.3 Centre gap with transverse ~~bracing~~ blocking

2.3.2 The restrictions on the use of blocking materials with regard to quarantine regulations, in particular for wood or timber, should be kept in mind (see sections 1.13 and 1.14 of this annex). ~~Road vehicles may be prepared to accept different types of demountable blocking devices, such as stanchions or blocking cross beams. Such devices may be marked with their Blocking Capacity (BC), indicating the maximum ability to take loading distributed over the device's full height and width during sustained use. Stanchions are exerted to a bending moment which depends on the height of the load. Blocking beams are typically restricted by the strength of the fittings on each side the CTU.~~

~~**Figure 7.4 Floor mounted stanchions**~~

~~**Figure 7.5 Blocking cross beams**~~

2.3.3 Temporary wooden structures used for blocking should be so designed that they primarily transfer the forces from the cargo to the boundaries of the CTU by means of compressions of the timber and not rely on their bending strength or the strength of the joints of the different components. Those forces ~~Forces being transferred by bracing or shoring~~ needs to be dispersed at the points of contact by suitable ~~cross beams~~, spreader beam unless a point of contact represents a strong structural member of the cargo or the CTU. Softwood timber ~~cross~~ spreader beams should be given sufficient overlaps at the shoring beame contact points. For the assessment of bedding and blocking arrangements the nominal strength of timber should be taken from the following table:

	Compressive strength normal to the grain	Compressive strength parallel to the grain	Bending strength
Low quality	0.3 kN/cm²	2.0 kN/cm²	2.4 kN/cm²
Medium quality	0.5 kN/cm²	2.0 kN/cm²	3.0 kN/cm²

2.3.4 A ~~bracing or shoring arrangement~~ temporary wooden structure should be designed and completed in such a way that it remains intact and in place, also if compression is temporarily lost. This requires suitable ~~uprights~~ supports or benches supporting the actual ~~shores~~blocking elements, a proper joining of the elements by nails or clamps and the stabilising of the arrangement by diagonal braces as appropriate (see figures 7.6 ~~and 7.5~~). Inclined blocking arrangements bear the risk of bursting open under load and should therefore be properly designed.

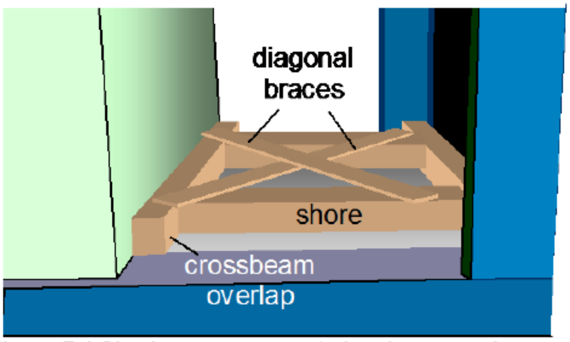


Figure 7.4 Shoring arrangement showing cross beam overlap and diagonal braces

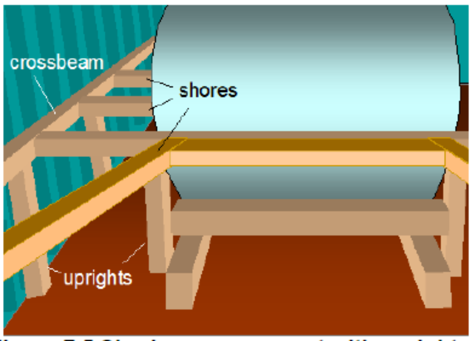


Figure 7.5 Shoring arrangement with uprights and crossbeam

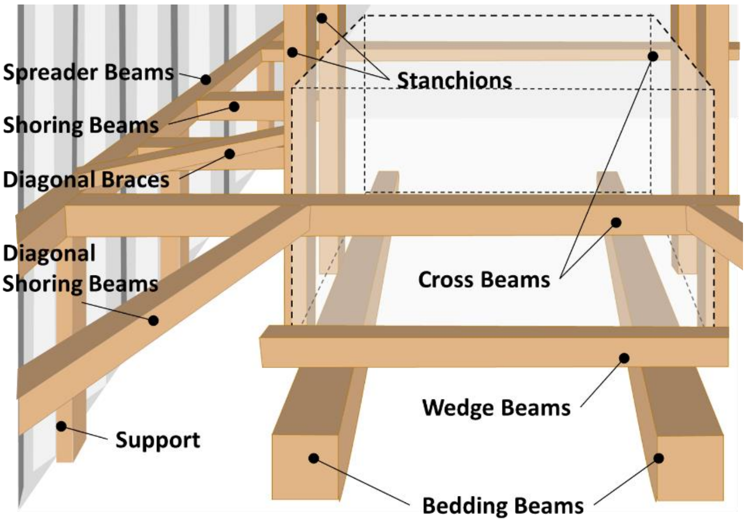
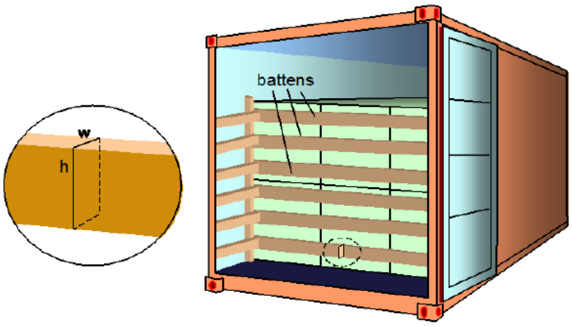


Figure 7.6. Components of a temporary wooden blocking arrangement

Guide to components:

Shoring beams are generally under compression
Spreader and bedding beams run longitudinally
Stanchions stand vertically
Cross beams and door shoring bars run transversally

~~2.3.4 Transverse battens in a CTU, intended to restrain a block of packages in front of the door or at intermediate positions within the CTU, should be sufficiently dimensioned in their cross section, in order to withstand the expected longitudinal forces from the cargo (see figure 7.6). The ends of such battens may be forced into solid corrugations of the side walls of the CTU. However, preference should be given to brace them against the frame structure, such as bottom or top rails or corner posts. Such battens act as beams, which are fixed at their ends and loaded homogeneously over their entire length of about 2.4 metres. Their bending strength is decisive for the force that can be resisted. The required number of such battens together with their dimensions may be identified by calculations, which is shown in appendix 4 to this annex.~~



~~**Figure 7.6 General layout of fence battens for door protection in a CTU**~~

2.3.5 Blocking ~~by nailed on scantlings~~ that is secured using mechanical fastenings on bedding or spreader beams should be used for minor securing demands only. The different types of fixing will provide a range of shear strength, depending on the type, configuration and size of the ~~nails~~ fastener used.

For example, ~~the shear strength of a blocking arrangement secured using nails may be estimated to take up a blocking force between 1 and 4 kN per nail. Nailed~~ nailed on wedges may be favourable for blocking round shapes like pipes. Care should be taken that wedges are cut in a way that the direction of grain supports the shear strength of the wedge. Any such timber beams or wedges should only be nailed to bedding beams or timbers placed under the cargo (see figure 7.7). Wooden floors of closed CTUs are generally not suitable for nailing. Nailing to the softwood flooring of flatracks or platforms and open CTUs may be acceptable with the consent of the CTU operator ~~(see figure 7.7)~~.

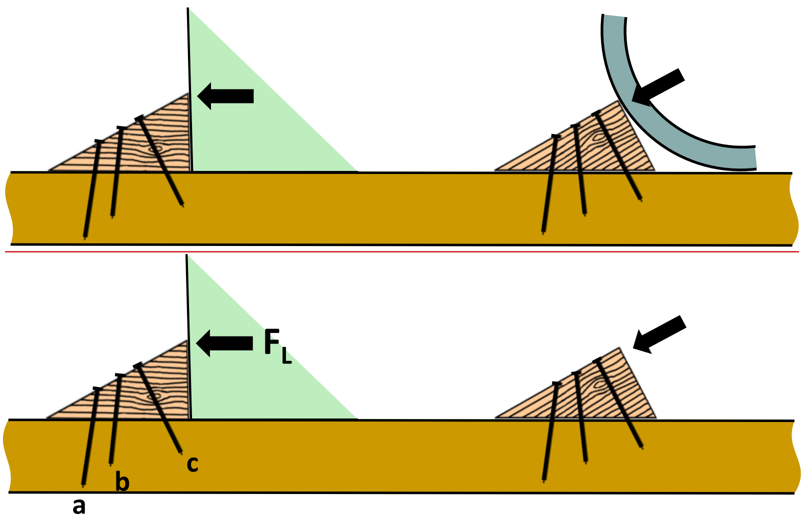


Figure 7.7 Properly cut and nailed wedges

2.3.6 Joints in blocking arrangements fail when the lateral load exceeds the strength of the mechanical fastener, often resulting in the blocking beam or wedge rotating and levering the fastening out. ~~In the left-hand example shown in figure 7.7 a lateral force as shown by the arrow F_L will force the wedge to the left. This displacement is resisted by the two left-hand fastenings (a and b). If the~~

~~fastening is not strong enough, they will bend, and the wedge rotate anticlockwise thus levering out all three fasteners.~~. To prevent this, ~~type or failure in the blocking arrangement~~ the correct type of mechanical fastenings must be selected and correctly inserted. ~~Fasteners can come in a number of formats, each has their own characteristics, and their use will depend on the nature, strength and integrity of the joint to be made.~~ The most common fastening used in fabrication packing framework is the nail due to its ease of availability and use. Nailed joints rely on three basic elements:

- The size and shape of the nail
- The penetration of the nail
- The timber used for blocking

2.3.6.1 The size of the nail is measured by its diameter and length. The most commonly used nail has a smooth shank and round in cross section. Other shapes and designs are available and may improve the effectiveness of the joint. When deciding on the size of the nail and its effectiveness the loads that the joint is subjected to and the effectiveness of the two timber elements need to be considered:

.1 Nails in use are subjected either to withdrawal loads or lateral loads (as shown in figures 7.8 and 7.9), or a combination of the two. Both withdrawal load and lateral load are affected by the wood, the nail, and the condition of use.

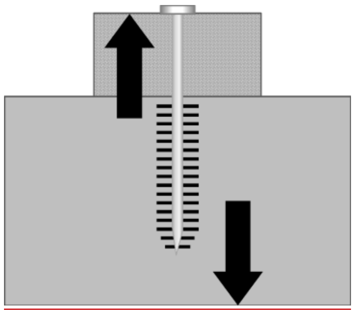


Figure 7.8 Withdrawal loads

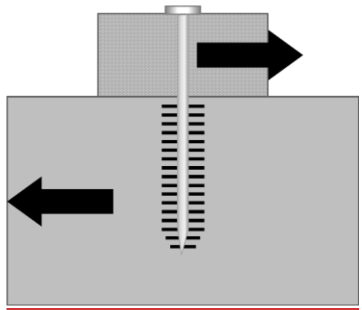


Figure 7.9 Lateral loads

.2 ~~.3~~ Any lateral load on a blocking element that is affixed using nails will result in the hole formed in the timber as the nail in driven in will distort and the blocking element rotates, thus levering out the nail (see figure 7.10). As shown in Figure 7.11, the force required to extract the nail diminishes significant already at relatively small displacements, but the effect is less prominent for ringed or spiral nails.~~The diameter of the nail dictates the resistance to lateral loads; a small displacement laterally will cause the nail to bend and the depth of penetration is of lesser importance. However, if there is a larger displacement, then the nail will be subjected to both lateral and withdrawal loads~~.

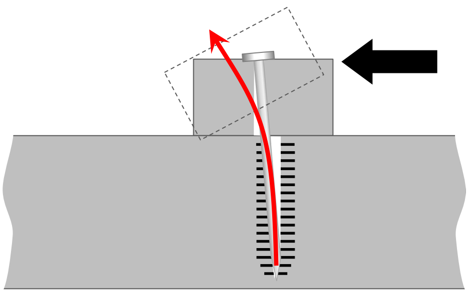


Figure 7.10 Lateral displacement and effect on nail

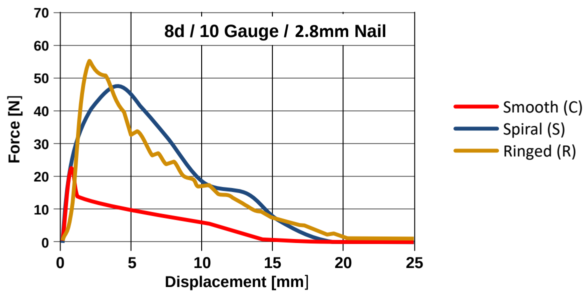


Figure 7.11 Extraction force vs displacement

.3 Blocking arrangements that rely on nailed joints should primarily be used for taking up lateral loads on the nails and be sufficiently strong to not allow any significant displacement of the wooden components. Table 7.1 gives the approximate blocking capacity for nails of various sizes with sufficient penetration.

Nail diameter [mm]	Approximate blocking capacity per nail [daN]
3	90
4	120
5	150

Table 7.1 Approximate lateral blocking capacity of nails with various diameters and sufficient penetration

2.3.6.2 Depth of penetration

.1 The lateral nail load is also related to the depth of penetration of the nail in the foundation member or member receiving the point. There are two general rules for the depth of penetration:

. (a) The depth of penetration generally recommended for plain-shank nails to develop full load varies but is about 14 times the nail diameter for the softer woods[1].

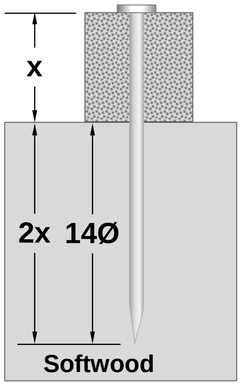


Figure 7.120 Depth of penetration

(b) The depth of penetration can also be calculated so that the shank penetrates to a depth of twice the thickness of the affixed member. Thus, the length of the nail should, if possible, be three times the thickness of the blocking element to be attached and that the nail is fully driven in.

.2 Clause 2.3.6.2 (b) allows packers can adopt a simple rule, the length of the nail should be three times the thickness of the blocking element to be attached and that the nail is fully driven in. Figure 7.13 shows the length of common smooth shank nails and the maximum penetration when adopting this rule of thumb.

.3 Figure 7.13 also shows the force required to withdraw each size of nail from four species[2] of timber often used in blocking arrangements. It should be noted that only a 150 mm long nail fixed into Western Larch provides more than 1kN of resistance, which means that multiple nails per joint would be required to ensure that there is sufficient strength in the joint.

.4 If the packer is not aware of the species of timber at all, then the resistive force of Scots Pine should be used. If the timber is wet the resistive force will be approximately halved as the timber dries out.

[1] The most common used timbers for blocking arrangements are softwoods such as Douglas Fir, Larch, Scots Pine and Spruce

[2] Two examples of Larch are shown, European and Western which have different densities and therefore the force required to withdraw them differs. If Packers are unaware of the exact species the lower value should be used.

Nail Length	Diameter	Maximum Penetration	Douglas Fir	European Larch	Western Larch	Scots Pine	Spruce
40	2.0	27	82.0	82.0	100.0	69.8	62.3
45	2.2	30	100.0	100.0	122.0	85.3	76.2
50	2.2	33	110.0	110.0	135.0	93.9	83.8
55	2.2	37	124.0	124.0	151.0	105.0	93.9
55	2.5	37	141.0	141.0	172.0	120.0	107.0
60	2.5	40	152.0	152.0	186.0	129.0	115.0
60	2.8	40	170.0	170.0	208.0	145.0	129.0
65	2.8	43	183.0	183.0	223.0	156.0	139.0
65	3.1	43	203.0	203.0	247.0	172.0	154.0
70	3.1	47	221.0	221.0	270.0	188.0	168.0
80	3.1	53	250.0	250.0	305.0	212.0	190.0
80	3.4	53	274.0	274.0	334.0	233.0	208.0
90	3.4	60	310.0	310.0	379.0	264.0	235.0
90	3.8	60	346.0	346.0	423.0	295.0	263.0
100	3.8	67	387.0	387.0	473.0	329.0	294.0
100	4.2	67	428.0	428.0	522.0	364.0	325.0
150	6.4	100	972.0	972.0	1,188.0	828.0	739.0

Figure 7.13 Maximum Withdrawal load (Newtons)

2.3.6.3

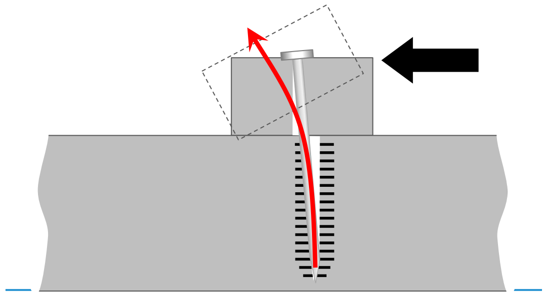


Figure 7.14

55also compares the force required to withdraw the nail for Spiral and ringed nail shanks.2.3.6.33 Finally the effectiveness of the nail will depend on the timber used and it should be properly seasoned:

- It should be clean, dry, and free from dry rot, knotholes, infestation, and splits which will affect its strength or interfere with proper nailing.
- Dry timber (at approximate moisture content 15 to 25 percent) is an excellent securing material. It is much lighter than wet or green timber. This is very important when weight limitations are to be considered.
- The use of green or wet timber should always be avoided.
  - Such timber quickly loses most of its strength and can contain 30 to 50 percent moisture depending upon the species.
  - Green and wet timber will emit a heavy concentration of moisture which may cause water or sweat damage, moulding, or cargo staining
  - Shrinkage of green timber in drying loosens the nails, and the movement of the container during transportation often causes nails to work out. This results in a reduction of cargo security in the container and eventual breakdown of the holding system.

2.3.6.44 It has been shown that the use of nails to provide resistance to lateral forces within a blocking arrangement is very limited and it is therefore recommended that nails are used to secure blocking elements in place, but where they are required to provide the lateral resistance the largest diameter of nail available should be used.

2.3.7 In the case of form lockingWhen cargo units are blocked against each other, void spaces should be filled and may be favourably stuffed by empty pallets inserted vertically and tightened by additional timber battens as necessary. Materials which may deform or shrink permanently, like rags of gunny cloth or solid foam of limited strength, should not be used for this purpose. Small gaps between unit loads and similar cargo items, which cannot be avoided and which are necessary for the smooth packing and unpacking of the goods, are acceptable and need not be filled. The sum of the void spaces in any horizontal direction should not exceed 15 cm. However, between dense and rigid cargo items, such as steel concrete or stone, void spaces should be further minimised, as far as possible.

2.3.8 Gaps between cargo that is stowed on and firmly secured to pallets (by lashings or by shrink foil), need not to be filled, if the pallets are stowed tightly into a CTU and are not liable to tipping (see figure 7.816). Securing of cargo to pallets by shrink foil wrapping is only sufficient if the strength of the foil is appropriate for above purpose, see appendix X (Transport Stability of Packages). It should be considered that in case of sea transport repetitive high loadings during bad weather may fatigue the strength of a shrink foil and thereby reduce the securing capacity.

Figure 7.8 165 Cargo firmly secured to pallets by textile lashings

2.3.9 If dunnage bags are used for filling gaps21, the manufacturer's instructions on filling pressure and the maximum gap should be accurately observed. Dunnage bags should not be used as a means of filling the space at the doorway, unless precautions are taken to ensure that they cannot cause the door to open violently when the doors are opened. If the surfaces in the gap are uneven with the risk of damage to the dunnage bags by chafing or piercing, suitable measures should be taken for smoothing the surfaces appropriately (see figures 7.–176 and 7.187). The blocking capacity of dunnage bags should be estimated by multiplying the nominal burst pressure with the contact area to one side of the blocking arrangement and with a safety factor of 0.75 for single use dunnage bags and 0.5 for reusable dunnage bags (see appendix 4 to this annex).

Figure 7.176 Gap filled with central dunnage bag

Figure 7.187 Irregular shaped packages blocked with dunnage bags

2.3.10 Road vehicles may be prepared to accept different types of demountable blocking devices, such as stanchions or blocking cross beams. Such devices may be marked with their Blocking Capacity (BC), indicating the maximum ability to take loading distributed over the device’s full height and width during sustained use. Stanchions are exerted to a bending moment which depends on the height of the load. Blocking beams are typically restricted by the strength of the fittings on each side the CTU.

Figure 7.418 Floor mounted stanchions

Figure 7.519 Blocking cross beams

~~The restrictions on the use of blocking and bracing materials with regard to quarantine regulations, in particular for wood or timber, should be kept in mind (see sections 1.13 and 1.14 of this annex).~~

Subsequent figures will require renumbering

Clause 3.2

3.2.5 Packages with a less defined shape like bags or bales may be stacked in an interlocking pattern, or so-called cross tie (see figure 7.~~26~~32[LW1]), thereby creating a solid pile that may be secured by blocking ~~or fencing~~. Round longish units like pipes may be stacked into the grooves of the layer below. However, care should be taken of the lateral forces produced by top players in the grooves of the bottom layers, which may locally overload the sidewalls of the CTU if the friction between the pipes is low.

3.2.7 Near to completion of packing a CTU, care should be taken to build a firm face of the cargo so as to prevent a "fall out" when the CTU is opened. If there is any doubt about the stability of the face, further steps should be taken such as strapping top layers of cargo back to securing points of building a timber ~~fence~~ bulkhead between the rear posts in a CTU (see subsection 2.3.4 of this annex). It should be borne in mind, that a freight container on a trailer usually inclines towards the doors after and that cargo may move against the doors due to vibration induced shifts or by jolts during transport.

Clause 4 on Securing of cargo in CTUs:

4.1.3 Practical securing of cargo may be approached by three distinguished principles, which may be used individually or combined as appropriate:

- Direct securing is effected by the immediate transfer of forces from the cargo to the CTU by means of blocking, lashings~~, shores~~ or locking devices (see 4.1.7). The securing capacity is proportional to the MSL of the securing devices;
- Friction securing is achieved by so-called tie-down or top-over lashings which, by their pre-tension, increase the apparent weight of the cargo and thereby the friction to the loading ground and also the tilting stability. The securing effect is proportional to the pretension of the lashings. Anti-slip material in the sliding surfaces considerably increases the effect of such lashings;
- Compacting cargo by bundling, strapping or wrapping is an auxiliary measure of securing that should always be combined with measures of direct securing or friction securing.

4.1.4 Lashings used for direct securing will inevitably elongate under external forces, thus permitting the package a degree of movement. To minimize this movement, (horizontal or lateral sliding, tipping or racking) it should be ensured that the:

- Lashing material has appropriate load-deformation characteristics (see section 2.4 of this annex);

- Length of the lashing is kept as short as practicable; and
- Direction of the lashing is as close as possible to the direction of the intended restraining effect.

A good pre-tension in lashing will also contribute to minimising cargo motions, but the pre-tension should never exceed 50% of the MSL of the lashing. Direct securing by stiff pressure elements (~~shores~~ shoring beams or stanchions) or by locking devices (locking cones or twist-locks) will not allow significant cargo motion and should therefore be preferred method of direct securing

4.1.7 Any cargo securing measures should be applied in a manner that does not affect, deform or impair the package or the CTU. Permanent securing equipment incorporated into a CTU should be used whenever possible or necessary. Where this is not possible the following should apply:

4.1.7.1 Blocking should be braced against structurally significant components of the CTU, which may be corner posts and bottom rails.

4.1.7.2 Additional shoring may be made against the boundary side and front walls so long as the forces are distributed by spreader beams as shown in Figure 7.35 and Figure 7.36.

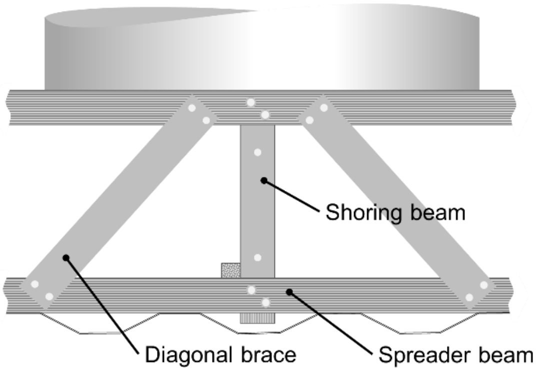


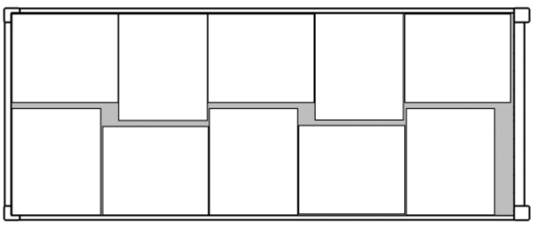
Figure 7.35 Boundary blocking arrangement

Figure 7.36 Boundary blocking arrangement

4.1.7.3 The CTU doors may be tested to withstand a force equivalent to a percentage of the CTU's payload, however, for cargoes that are liable to collapse, such as bulk materials (solids and liquids), small hand-packed packaged and pallets with low integral stability, the doors should not be used as the only mean to constrain the cargo as there is a risk of the cargo falling onto those who open the CTU for inspection or unpacking. In such cases the cargo should in addition be restrained by spring lashing (see Figure 7.~~43~~X), a modular lashing system (see Figure 7.~~20~~26) or using shoring bars / rear false bulkhead (see 5.3.4).

4.1.7.4 Cargo should never be secured by blocking or lashing against the CTU roof except for designs that permit this method of securing.

4.2.2 A tight stow of uniform or variable cargo items should be planned and arranged according to principles of good packing practice, in particular observing the advice given in section 3.2 of this annex. If coherence between items or tilting stability of items is poor, additional measures of compacting may be necessary like hooping or strapping batches of cargo items with steel or plastic tape or plastic sheeting. Gaps between cargo items or between cargo and CTU boundaries should be filled as necessary (see subsections 2.3.6 to 2.3.8 of this annex). Direct contact of cargo items with CTU boundaries may require an interlayer of protecting material (see section 2.1 of this annex).



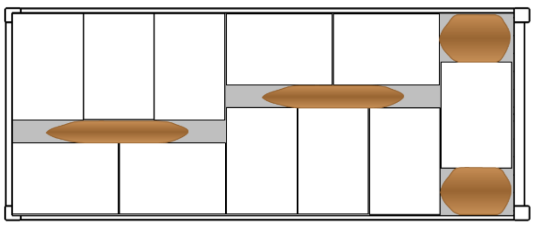


Figure 7.~~29~~ 37 Packing 1,000 x 1,200 mm unit loads into a 20-foot container

Figure 7.~~30~~ 38 Packing 800 x 1,200 mm unit loads into a 20-foot container

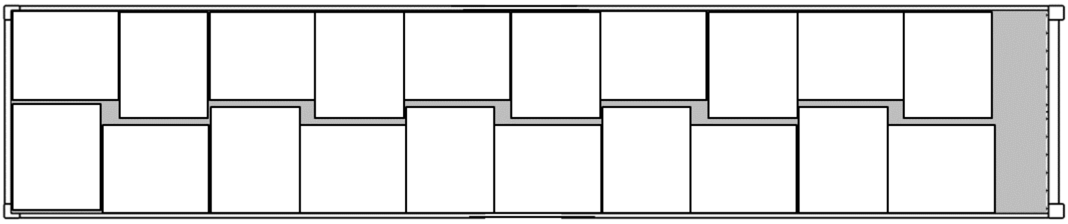
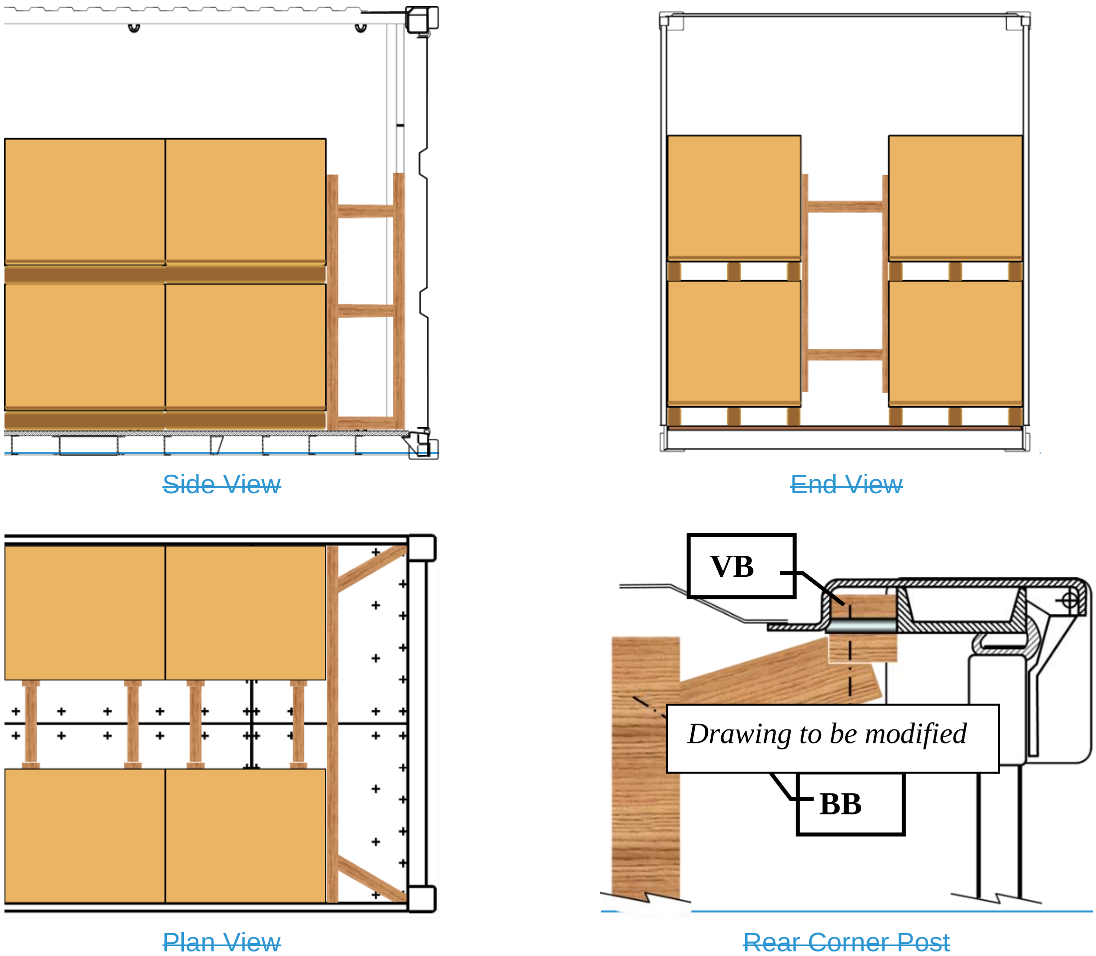


Figure 7.~~31~~ 39 Packing 1,000 x 1,200 mm unit loads into a 40-foot container

Note: The void areas (grey shaded) shown in figures 7.~~29~~ 37 to 7.~~31~~ 39 should be filled when necessary as shown in figure 7.38 (see subsection 2.3.6 of this annex)

4.2.4 Critical situations may arise, e.g., with a fully packed freight container in road transport, where longitudinal securing should be able to withstand an acceleration of 0.8 g. The longitudinal wall resistance factor of 0.4 should be combined with a friction factor of at least 0.4 for satisfying the securing balance. If a balance cannot be satisfied, the mass of cargo should be reduced, or the longitudinal forces transferred to the main structure of the container. The latter can be achieved by intermediate transverse ~~fences of~~false bulkheads of ~~timber battens~~cross beams (see subsection ~~2.3.4~~X of this annex) or by other suitable means, ~~(see figure 7.32).~~ When bracing against the rear corner frames, vertical timber battens (VB) should be inserted into the shoring slots between the slot bars and the bracing battens (BB) fitted against this. Where required nails or other fixings can be used to stabilise the bracing battens.



~~**Figure 7.32 Blocking in a strong boundary CTU**~~

4.2.7 Transverse cross beams in a CTU, intended to restrain a block of packages in front of the door (see figure 7.40) or at intermediate positions within the CTU, should be sufficiently dimensioned in their cross section, in order to withstand the expected longitudinal forces from the cargo (see figure 7.6). Such members act as beams, which are fixed at their ends and loaded homogeneously over their entire length of about 2.4 metres. Their bending strength is decisive for the force that can be resisted. The required number of such battens together with their dimensions may be identified by calculations, which is shown in appendix 4 to this annex. Wherever possible such battens should be braced against the solid frame structure, such as bottom or top rails or corner posts. While it is recognised that this type of blocking is not possible on all types of CTUs, any that has a shoring slot built into the rear frame can accommodate this blocking technique. -Alternative blocking can be achieved by forcing the battens into the solid corrugations of the side walls of the CTU (see figure 7.41). However, since these methods have limited strength, they should be used in combination with friction increasing material and/or limited cargo weight. The blocking capacity, BC, of a 75 x 100 mm beam inserted into the corrugation of a container is 500 daN if it is placed at half the height of the container and 750 daN if it is placed at the floor.

Figure 7.40 Shoring bars inserted in the shoring slots and supported by uprights placed against the doors

Figure 7.41 Cross beams inserted in the corrugations supported by shoring beams against the doors at the hinges

4.2.8 When a temporary wooden structure is used to block the cargo against the end walls of platform and flat rack type CTUs, this should be supported against the corner posts and the shoring beams should be placed as far out towards the sides as the cargo permits. Stanchions, produced from wooden beams with a cross section of 75x75 mm, may often be inserted into pockets along the sides of the platforms to prevent the cargo from sliding sideways.

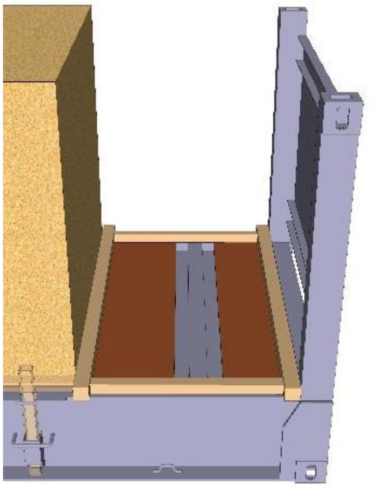


Figure 7.42 Wooden structure for blocking against the end wall of flat rack

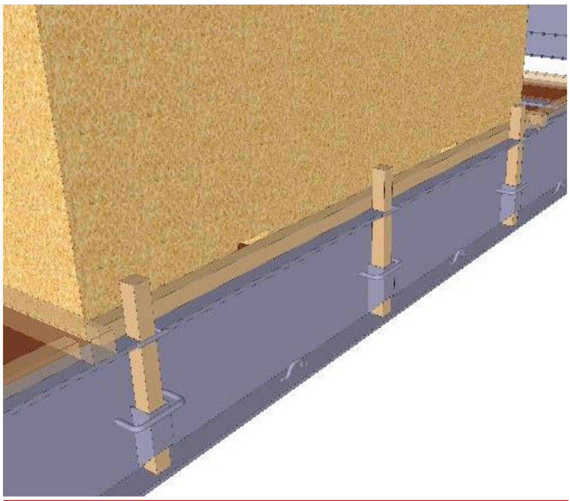


Figure 7.43 Stanchions preventing sideways sliding on platform CTUs

4.2.~~7~~9 CTUs with weak cargo space boundaries like certain road vehicles and swap bodies will regularly require additional securing measures against sliding and tipping of a block of tightly stowed cargo. These measures should also contribute to compacting the block of cargo. The favourite method in this situation is friction-securing by so-called top-over lashings. For obtaining a reasonable securing effect from friction lashings, the friction factor between cargo and stowage ground should be sufficient and the inherent elasticity of the lashings should be able to maintain the pre-tension throughout the course of transport. The following balance demonstrates the confinement of tightly stowed cargo within weak cargo space boundaries and an additional securing force against sliding:

$$c_{xy} \cdot m \cdot g \leq r_{xp} \cdot P \cdot g + \mu \cdot c_z \cdot m \cdot g + F_{sec} \; kN$$

Where:

F_{sec} = additonal securing force

If a wall resistant coefficient is not specified in the distinguished CTU, it should be set to zero. The additional securing (F_{sec}) may consist of blocking the base of the cargo against stronger footing of the otherwise weak cargo space boundary or ~~bracing the block of cargo~~ against stanchions of the cargo space boundary system. Such stanchions may be interconnected by pendants above the cargo for increasing their resistance potential. Alternatively, the addition securing force may be obtained by direct securing methods or top-over lashings. F_{sec} per top-over lashing is: $F_v \cdot \mu$, where F_v the is the total vertical force from the pretension. The vertical lashings F_v is 1.8 times the pretension of the lashing. The direct lashing arrangements μ should be set to 75% of the friction factor.

4.2.~~8~~10 On CTUs without boundaries the entire securing effect should be accomplished by securing measures like top-over lashings, friction increasing material and, if the CTU is a flatrack, by longitudinal blocking against the end-walls. The following balance demonstrates the securing of tightly stowed cargo on a CTU without cargo space boundaries:

$$c_{xy} \cdot m \cdot g \leq \mu \cdot c_z \cdot m \cdot g + F_{sec} \; kN$$

Where:

F_{sec} = additonal securing force

For F_{sec}, see subsection 4.2.~~7~~9. It should be noted that even in case of a friction factor that outnumbers the external acceleration coefficients, without cargo space boundaries a minimum number of top-over lashings is imperative for avoiding migration of the cargo due to shocks or vibration of the CTU during transport.

4.3.2 Individually secured packages and articles should preferably be secured by a direct securing method, i.e. by direct transfer of securing forces from the package to the CTU by means of lashings and / ~~, shores~~ or blocking.

4.3.3 Packages and articles without securing points should be either secured by ~~shoring or~~ blocking against solid structures of the CTU or by top-over, half-loop or spring lashings (see figures 7.40 to 7.43

4.3.4 CTUs with strong cargo space boundaries favour the method of blocking ~~or shoring~~ for securing a particular package or article. This method will minimise cargo mobility. Care should be taken that the restraining forces are transferred to the CTU boundaries in a way that excludes local overloading. Forces acting to CTU walls should be transferred by means of a ~~load~~ spreader~~ing~~ ~~cross~~ beams (see subsections 2.3.1 to 2.3.3 of this annex). Very heavy packages or articles, e.g. steel coils or blocks of marble, may require a combination of blocking and lashing, however with observation of the restrictions lined out in subsection 4.1.6 of this annex (see figure 7.45). Articles with sensitive surfaces may rule out the blocking method and be should be secured by lashings only.

4.3.5 Individual securing of packages or articles in CTUs with weak cargo space boundaries and in CTUs without boundaries requires predominantly the method of lashing. Where applicable, blocking ~~or shoring~~ may be additionally applied, but if used in parallel with lashings, the restrictions set out in subsection 4.1.6 of this annex should be observed. Although the provision of good friction in the bedding of a package or article is recommended in any case, the use of top-over lashings for sliding prevention is discouraged unless the cargo has limited mass. Top-over lashings may be suitable for tipping prevention. In particular over width packages or articles, often shipped of flatbed CTUs, should not be secured solely by top-over lashings (see figure 7.46). The use of half loops and/or spring lashings is strongly recommended (see figures 7.47 and 7.48).

4.4.2 The assessment of the securing potential includes the assumption of a friction factor, based on a combination of materials (see appendix 2 to this annex) and the character of the securing arrangement (subsection 2.2.2 of this annex), and, if applicable, the determination of the inherent tilting stability of the cargo (subsection 4.3.1 of this annex). Any other securing devices used for blocking~~, shoring~~ or lashing should be estimated by their strength in terms of MSL and relevant application parameters like securing angle and pre-tension. These figures are required for evaluating the securing arrangement.

Annex 10 section 7 2nd bullet

Blocking ~~and bracing~~arrangements

Consequential changes

1. Add new definitions

Blocking	Cargo securing method where the cargo is prevented from sliding and/or tipping by being stowed against sufficiently strong permanent structures or fixtures on the CTU. Wedges, dunnage, stanchions, inflatable dunnage bags, temporary wooden structures, removable components and other devices which are supported directly or indirectly by fixed blocking structures are also considered as blocking elements. *Source: CTU Code, Informative Material 5, §1.1.1* *Standard EN 12195-1:2010, §3.1.10*
Blocking capacity	The maximum ability of a structural member, arrangement, element or material to take loading distributed over its full height and width during sustained use.
Cargo securing method	Method for preventing cargo from sliding and/or tipping in forward, backward and sideways directions by blocking, lashing, locking or a combination of these basic methods, respectively providing a pushing force, pulling force or both. *Source: Standard ISO 23577:2021, §3.1.33* *EU Directive 2014/47, Annex 3, §I.4* *European Best Practice Guidelines on Cargo Stowage and Securing for Road Transport, §5.1*
Lashing	Cargo securing method where the cargo is prevented from sliding and/or tipping by the use of bendable devices, e.g. web- or chain lashings, steel straps, wire or ropes. Lashings can be attached by different techniques such as top-over-, half loop-, straight- or spring lashings. *Source: Standard ISO 23577:2021, §3.1.32* *Standard EN 12195-1:2010, §3.1.1*
Lashing capacity	Maximum force for use in straight pull that a web lashing is designed to sustain in use *Source: EN 12192-5 Part 2*
Locking	Cargo securing method where the cargo is prevented from sliding and tipping in all directions by mechanical devices, e.g. twist-locks, bolts or welds. *Source: Standard EN 12195-1:2010, §3.1.15*
Maximum securing load	A term used to define the allowable load capacity for a device used to secure cargo to a ship. Safe working load (SWL) may be substituted for MSL for securing purposes, provided this is equal to or exceeds the strength defined by MSL. *Source: Guidelines for the preparation of the Cargo Securing Manual, 2021, International Maritime Organization.*
Shoring slot system	Is designed to restrain the cargo from forcing the door open during sudden stops of tilts of the container during transportation. It also serves to restrain dislocated cargo to prevent it from spilling out of the container when the container's doors are opened. Shoring slot systems consist of shoring slots and one or more cargo securing bars. Source: Standard ISO 1496-1:2013 § D.1.1
Shoring slot	A permanent fixture into which cargo securing bars or boards can be inserted and which will prevent cargo from placing loads in excess of the container doors' design load on the doors during sudden motion. *Source: Standard ISO 1496-1:2013 § D.1.3* Note: Cargo shoring slots are optional features in all series 1 general purpose containers.

2. The following definitions are provided for information only

Local blocking	Blocking used to secure a package to prevent horizontal movement or tipping.
Global blocking	A method of cargo securing and means that the cargo is completely stowed against the boundaries of the CTU. The empty space between the cargo units and between the cargo and the boundaries should be minimised. The boundaries should be strong enough to absorb the normal forces that occur during transport
Threshold blocking	A specific type of blocking where packages / cargo units are raised either end of a partial second layer to prevent longitudinal movement.
Wedge blocking	A wedge-shaped type of blocking attached to bedding beams or transverse beams used to prevent cylindrical objects from moving either longitudinally or transversely.
Wedge bed	Pallet for coiled materials consisting of two wedge beams and braces to hold them apart to the correct distance.
Blocking bars	Bars mounted in CTUs, either vertically between the cargo platform and the roof, or horizontally, between both sidewalls.
Stanchions	Vertical posts that are: • fitted into pockets along the side of CTUs with no side walls or weak boundaries. • fitted into pockets in the cargo platform to prevent longitudinal and/or horizontal movement.
Bracing	Method of blocking mostly wooden structure, fixed to the load carrier to keep a load in one or more directions at its place *Source: EN 12195-1*
Securing	locking, blocking, lashing or combination of blocking and lashing to secure a load to all directions on the load carrier to prevent sliding and tilting *Source: Standard EN 12195-1*