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Group of Experts for the revision of the IMO/ILO/UNECE Guidelines for Packing of Cargo Transport Units

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Item 6 (a) of the provisional agenda
Proposals for amendments to the final draft of the CTU Code: Proposals for amendments

Proposed text for Annex 14, Appendix 5 (bedding arrangements)

Transmitted by the experts of Germany, Slovakia and Sweden

In Appendix 5 of Annex 14 of the draft CTU Code it is proposed to replace the current content of chapter 2, 3 and 4 of option 2 with the requirements for bedding arrangement found in Enclosure 1 of this joint proposal.

Examples on how to apply the proposed requirements are found in Enclosure 2 of this proposal.

The Group of Experts is also invited to consider the changes of editorial character proposed for Appendix 5 of Annex 14 chapters 5 (Longitudinal position of the centre of gravity of a CTU) and chapter 6 (Cargo securing with dunnage bags), which are found in the report of the DSC 18 Working Group, document DSC 18/WP.3.

Enclosure 1

Joint proposal regarding bedding arrangements

2 Beams for bedding of concentrated loads ~~in an ISO box-container~~

2.1 Bedding arrangements for concentrated loads in general purpose ISO series 1 freight containers, flatracks or platforms should be designed in consultation with the supplier or operator of the cargo transport unit. If no specific advice is available the provisions described in this section should be applied.

2.2 The centre of gravity of a concentrated load should be placed close to half the length of the ~~container~~ cargo transport unit. If more than one concentrated load shall be packed into ~~a container~~ or onto a cargo transport unit, the centres of gravity of the units should as far as possible be placed at distances in terms of ~~container~~ unit length as shown in the table below:

Number of concentrated loads	Suitable longitudinal stowage position
2	1/4 3/4
3	1/7 1/2 6/7
4	1/8 3/8 5/8 7/8

2.3 Short or narrow cargoes may overload the floor structure. This may be prevented either by using longitudinal support beams underneath the cargo to distribute the load over more transverse flooring beams, or by the use of transverse beams, to distribute the load towards the strong side structures of the cargo transport unit.

2.5 When longitudinal support beams are used, their minimum length should be calculated in accordance with sections 2.8 through 2.15 below and the material and the cross section dimensions of the beams should be chosen in accordance with sections 3.1 through 3.5 below. The beams should be placed as far apart as possible, near the edge of the cargo.

2.6 When four longitudinal support beams instead of two beams are used, these should be arranged as straddled twin-beams.

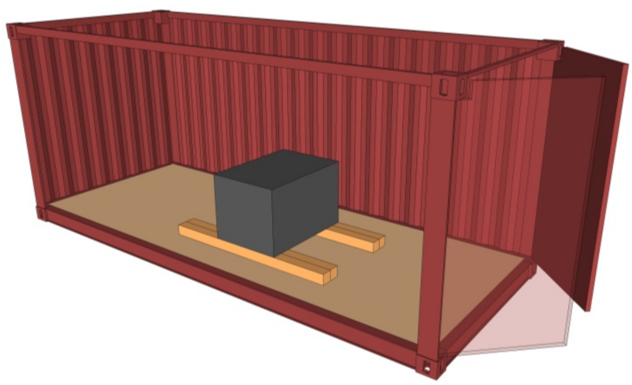


Figure 14.70 Straddle twin-beam arrangement

2.7 When transverse support beams are used, their length should equal the inner width of the container or the width of the platform in case of a flatrack. The material and the cross section dimensions of the beams should be chosen in accordance with sections 3.1 and 3.6 below.

Longitudinal strength of containers tested for concentrated cargo

2.8 The provisions in section 2.10 and 2.11 may be applied for cargoes in containers with side structure design identical to that of a design type series which have been tested for concentrated cargo according to 2.9. For cargoes in other containers the provisions of 2.12 through 2.14 should be applied.

2.9 To carry out a concentrated cargo test, a test load of 200% of the rated payload of the container is transmitted to the side beams and uniformly distributed over 50% length of the container. The container with the test load is supported on its corner fittings for five minutes. After removal of the load, the understructure of the container shall not exhibit any deformation.

2.10 The minimum length of a cargo which is resting on supports near the side beams of a general purpose ISO container is:

$$r = 2 \cdot L \cdot \left(\frac{m}{P} - 0.75 \right)$$ [m] *(Need only be calculated if **m** is greater than 75% of **P**)*

P = declared payload [t]
m = concentrated load [t]
L = full length of loading floor [m]
r = length of cargo foot print or bridging distance [m]

In all cases the minimum length of the concentrated cargo should be 20% of the container length L.

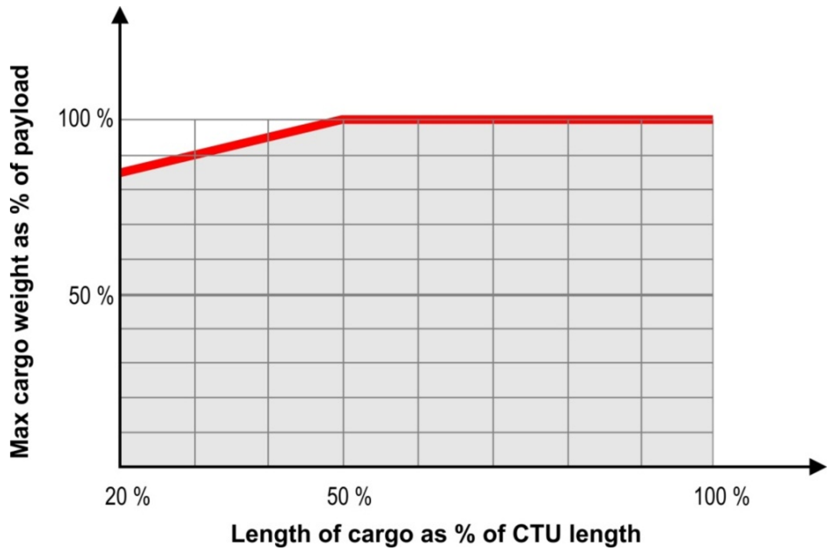


Figure 14.71 Load distribution for ISO containers tested for concentrated cargo.

2.11 If the length of the cargo is less than the required length according to the formula above, the cargo should be bedded with longitudinal beams designed in accordance with sections 3.1 through 3.5 below.

Longitudinal strength of flatracks and containers not tested for concentrated cargo

2.12 If a cargo unit is placed with its entire foot print over the length **r** on a flatrack, platform or container, the minimum length of the cargo is:

$$r = L \cdot \left(2 - \frac{2 \cdot P + T}{2 \cdot m} \right)$$ [m]

(A negative result indicates that the length of the cargo is sufficient and no bedding is required)

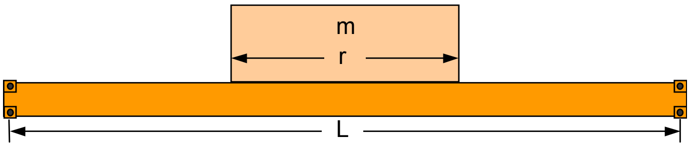


Figure 14.72 Concentrated load on an ISO platform

2.13 If the cargo unit is rigid and stowed on transverse beddings that bridge the distance **r** on the flatrack, platform or container, the minimum length of the cargo is:

$$r = L \cdot \left(1 - \frac{2 \cdot P + T}{4 \cdot m}\right) \text{ [m]}$$

(A negative result indicates that the length of the cargo is sufficient and no bedding is required)

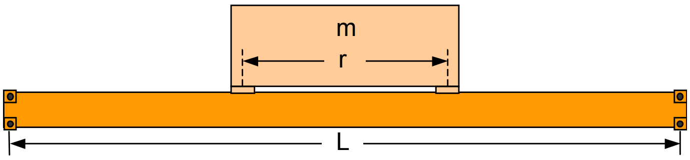


Figure 14.73 Concentrated load bridging the distance r

P = declared payload [t]
T = declared tare weight [t]
m = concentrated load [t]
L = full length of loading floor [m]
r = length of cargo foot print or bridging distance [m]

2.14 If the length of the cargo is less than the required length according to the formulas above, the cargo should be bedded with longitudinal beams designed in accordance with sections 3.1 through 3.5 below.

Transverse strength of container and flatrack flooring

2.15 In order not to overload the transverse structure of the floor, it should be checked that cargo in containers and flatracks which are approved in accordance with C.S.C. have at least the following length:

$$r = 0.2 \cdot m \cdot (2.3 - s) \text{ [m]}$$

2.16 For containers and flatracks which are built and tested in accordance with ISO 1496, the minimum length of the cargo can be calculated as:

$$r = 0.15 \cdot m \cdot (2.3 - s) \text{ [m]}$$

r = bottom length of the cargo unit in the container (footprint) [m]
s = width of cargo foot print [m]
m = mass of cargo unit [t]

2.17 If the length of the cargo is less than the required length according to the formulas above, the cargo should be placed on longitudinal or transverse bedding arrangements in accordance with sections 3.1 through 3.6 below.

3 Bending strength of beams

3.1 The permissible bending stress σ should be taken as 2.4 kN/cm² for timber beams and 22 kN/cm² for steel beams. The section modulus for a single beam should be obtained from supplier's documents. The following tables may serve as a quick reference:

timber: dimensions [cm]	10 x 10	12 x 12	15 x 15	20 x 20	25 x 25
section modulus [cm³]	152	260	508	1236	2450

Steel (HEB profiles): dimensions [cm]	12 x 12	14 x 14	16 x 16	18 x 18	20 x 20
section modulus [cm³]	144	216	311	426	570

Longitudinal support beams

3.2 The minimum length of longitudinal bedding beams **t** should be taken as the minimum required cargo length according to sections 2.8 through 2.15 above.

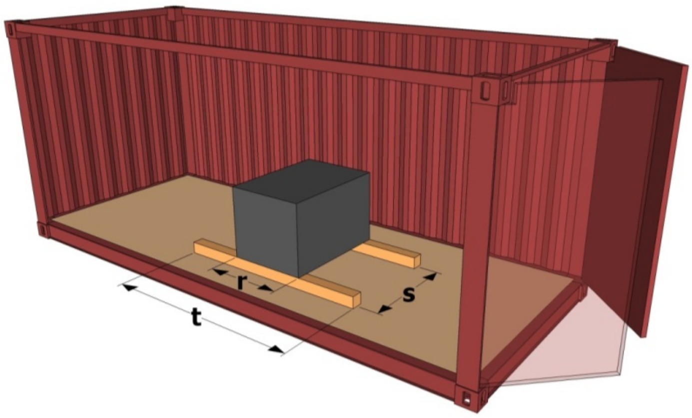


Figure 14.74 Narrow cargo placed on longitudinal support beams.

3.3 The required bending strength of beams should be determined by the formula:

$$n \cdot W = \frac{250 \cdot m \cdot K}{\sigma} \quad [\text{cm}^3]$$

W =	section modulus of one beam [cm³]
n =	number of parallel beams
m =	mass of package [t]
K =	Form factor of bedding beam as defined in section 3.4 and 3.5 below
σ=	permissible bending stress in beam [kN/cm²]

3.4 If the cargo unit is **flexible**, so that it will rest over its entire length on the bedding beams, the form factor **K** should be calculated according to below:

$$K = t - r \quad [\text{m}]$$

t =	length of the beam [m]
r =	loaded length of beam (footprint) or bridging distance [m]

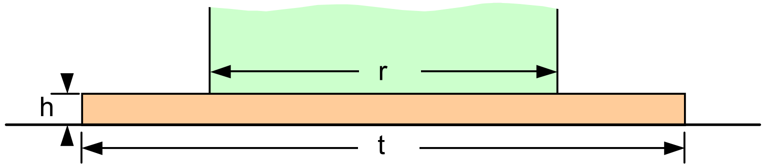


Figure 14.75 Beam for load spreading under a flexible package

3.5 If the package is **rigid** so that it will bridge a distance on the bedding beams, the form factor **K** should be calculated according to below:

$$K = \frac{(t-r)^2}{t} \quad [\text{m}] \quad \text{if } t > 1.7 \cdot r$$

$$K = 2 \cdot r - t \quad [\text{m}] \quad \text{if } t \leq 1.7 \cdot r$$

t =	length of the beam [m]
r =	loaded length of beam (footprint) or bridging distance [m]

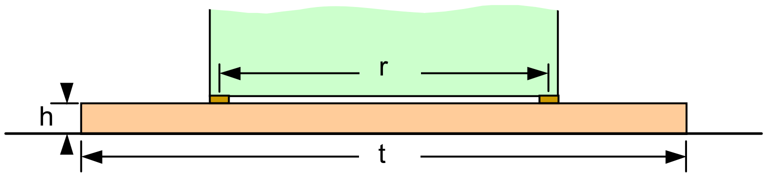


Figure 14.76 Beam for load spreading under rigid package

Transverse support beams

3.6 The required bending strength of transverse bedding beams should be determined by the following formulas:

Rigid cargo: $n \cdot W = \frac{600 \cdot m \cdot (2.8 - s) - 3300 \cdot l_e}{\sigma}$

Flexible cargo: $n \cdot W = \frac{220 \cdot m \cdot (4.6 - s) - 2300 \cdot l_e}{\sigma}$

W = *Section modulus of support beams [cm^3]*
n = *Number of support beams*
m = *Cargo weight [ton]*
s = *Width of cargo foot print [m]*
σ = *Permissible stress in support beams [kN/cm^2]*
l_e = *Contributing length of container floor [m], taken as the ~~minimum~~ lower value of*
~~*Beams spaced **more** than 0.84 m apart:*~~ $l_e = 0.84 \cdot n$
~~*Beams spaced **less** than 0.84 m apart:*~~ $l_e = r$
r = *Distance between outer edges of transverse beams [m]*

(A negative result indicates that due to the number of bedding beams, the cargo weight is sufficiently spread over the container floor and no bending strength of the bedding beams is required)

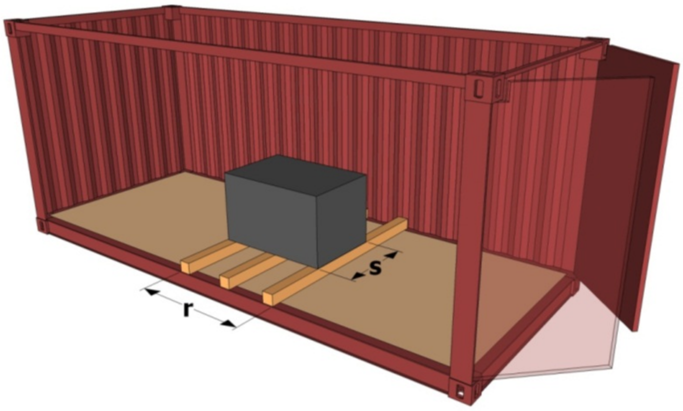


Figure 14.76 Narrow cargo placed on transverse support beams.

Enclosure 2

Examples of bedding arrangements according to the proposal in enclosure 1

These examples are given to illustrate the bedding arrangements resulting from the proposed requirements. They may or may not be included in the Code of Practice.

Example 1 – 8.5 tons coil

Coil

Weight:	8.5 ton
Diameter:	1.3 m
Width:	1.2 m

Required length – ISO 20' container

For cargo in a container which has been tested in accordance with standard ISO 1496, the minimum length of the cargo due to transverse strength of the floor is calculated according to section 2.16:

$$r_{req.} = 0.15 \cdot m \cdot (2.3 - s) = 0.15 \cdot 8.5 \cdot (2.3 - 1.2) = 1.4\ m$$

Since the longitudinal distance between the support points is shorter than 1.4 m, a bedding arrangement with either longitudinal or transverse beams is needed.

Longitudinal bedding beams – 2 pcs

r = 1.0 m (Distance between support points of cargo)

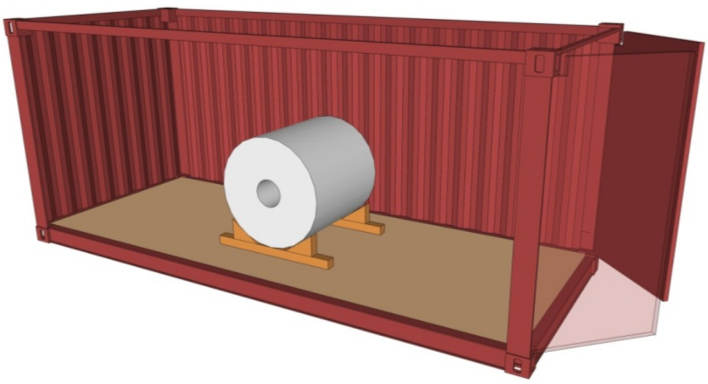
The length of the bedding beams is taken as the minimum cargo length calculated above:

$$t = r_{req.} = 1.4\ m$$

The required bending strength for longitudinal bedding beams is calculated in accordance with section 3.3, with the form factor K taken for rigid cargo where $t \leq 1.7 \cdot r$:

$$K = 2 \cdot r - t = 2 \cdot 1.0 - 1.4 = 0.6\ m$$

$$W = \frac{250 \cdot m \cdot K}{n \cdot \sigma} = \frac{250 \cdot 8.5 \cdot 0.6}{2 \cdot 2.4} = 266\ cm^3$$ (at least 12x12 cm cross section)



Transverse bedding beams – 2 pcs

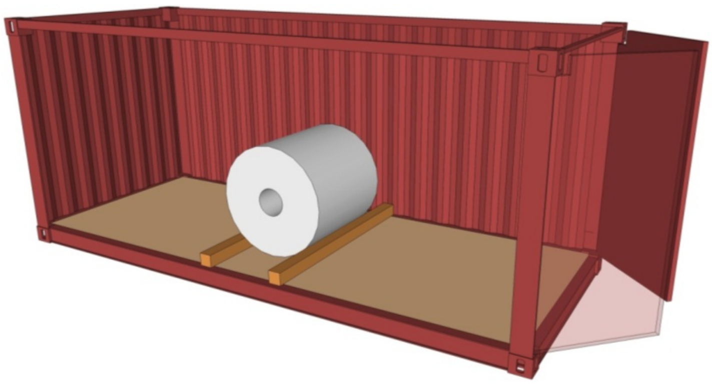
r = 1.0 m (Distance between outer edges of transverse beams)

The required bending strength for transverse bedding beams is calculated in accordance with section 3.6:

l_e = minimum of
r = 1.0 m
0.84·n =0.84·2=1.68 m
l_e = 1.0 m

$$W = \frac{600 \cdot m \cdot (2.3 - s) - 3300 \cdot l_e}{n \cdot \sigma} = \frac{600 \cdot 8.5 \cdot (2.3 - 1.2) - 3300 \cdot 1.0}{2 \cdot 2.4} = 481\ cm^3$$

(at least 14x14 cm cross section)



Example 2 – Marble block

Weight:	24 ton
Length:	r = 2.0 m
Width:	s = 1.4 m

Required length – ISO 20' container – concentrated cargo

For cargo in a container of a design type series which has been tested for concentrated cargo, the minimum length of the cargo due to longitudinal strength of the container is calculated according to section 2.10:

$$r_{req.} = 2 \cdot L \cdot \left(\frac{m}{P} - 0.75\right) = 2 \cdot 6 \cdot \left(\frac{24}{28} - 0.75\right) = 1.3\ m$$

For cargo in a container which has been tested in accordance with standard ISO 1496, the minimum length of the cargo due to transverse strength of the floor is calculated according to section 2.16:

$$r_{req.} = 0.15 \cdot m \cdot (2.3 - s) = 0.15 \cdot 24 \cdot (2.3 - 1.4) = 3.24\ m$$

Since the length of the cargo is shorter than 3.24 m, a bedding arrangement with either longitudinal or transverse beams is needed.

Longitudinal bedding beams – 2 pcs

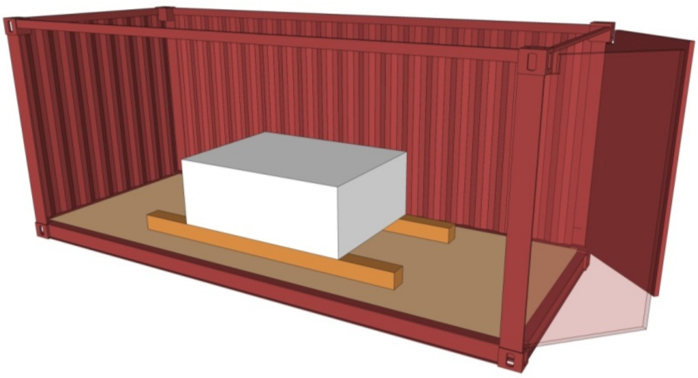
The length of the bedding beams is taken as the minimum cargo length calculated above:

$$t = r_{req.} = 3.24\ m$$

The required bending strength for longitudinal bedding beams is calculated in accordance with section 3.3, with the form factor K taken for rigid cargo where $t \leq 1.7 \cdot r$:

$$K = 2 \cdot r - t = 2 \cdot 2 - 3.24 = 0.76\ m$$

$$W = \frac{250 \cdot m \cdot K}{n \cdot \sigma} = \frac{250 \cdot 24 \cdot 0.76}{2 \cdot 2.4} = 950\ cm^3$$ (at least 18x18 cm cross section)



Transverse bedding beams – 3 pcs

The required bending strength for transverse bedding beams is calculated in accordance with section 3.6:

l_e = minimum of

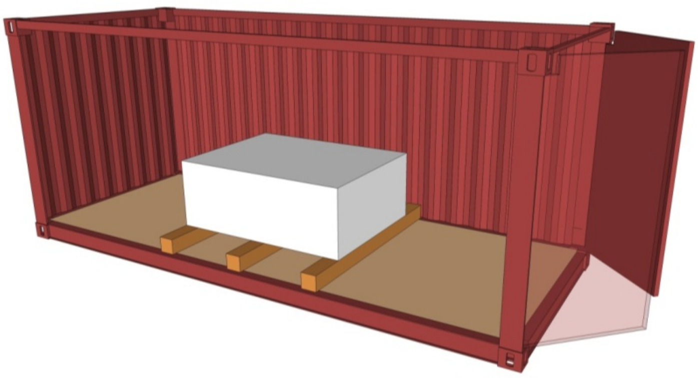
r = 2.0 m

$0.84 \cdot n = 0.84 \cdot 3 = 2.52$ m

l_e = 2.0 m

$$W = \frac{600 \cdot m \cdot (2.3 - s) - 3300 \cdot l_e}{n \cdot \sigma} = \frac{600 \cdot 24 \cdot (2.3 - 1.4) - 3300 \cdot 2.0}{3 \cdot 2.4} = 883\ cm^3$$

(at least 18x18 cm cross section)



Example 3 – 20 ton rods in bundles

Rods in bundles

Weight:	20 ton
Length:	9.5 m
Diameter:	15 cm
Width, total:	1.6 m

Required length – CSC 20' container

For cargo in a container for which has been tested in accordance with the CSC Code, the minimum length of the cargo due to transverse strength of the floor is calculated according to section 2.15:

$$r_{req.} = 0.2 \cdot m \cdot (2.3 - s) = 0.2 \cdot 20 \cdot (2.3 - 1.6) = 2.8\ m$$

No bedding arrangement is needed due to container strength. However, transverse beams are often used to facilitate the handling of rods. The suitable strength of such beams are calculated below.

Transverse bedding beams – 6 pcs

l_e = minimum of

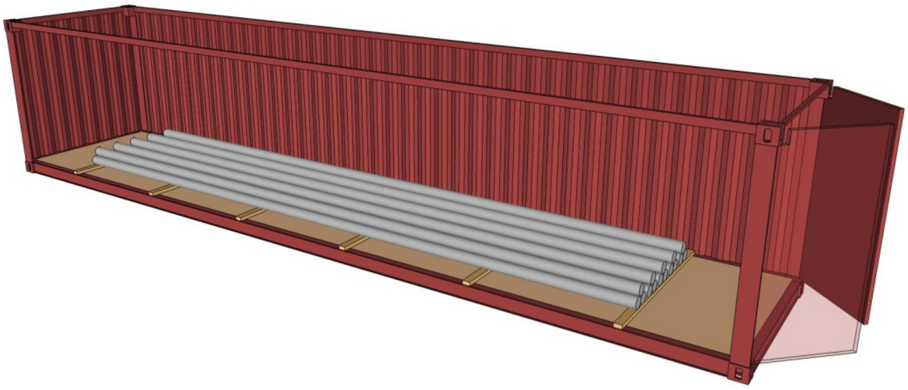
r = 9.5 m

0.84·n=0.84·6 =5.04 m

l_e = 5.04 m

$$W = \frac{220 \cdot m \cdot (2.3 - s) - 2500 \cdot l_e}{n \cdot \sigma} = \frac{220 \cdot 20 \cdot (4.6 - 1.6) - 2500 \cdot 5.04}{6 \cdot 2.4} = 42\ cm^3$$

(at least 5x10 cm cross section)



Example 4 – Steel plates

Weight:	20 ton	Payload:	P = 26 ton
Length:	r = 6.0 m	Tare:	T = 3.5 ton
Width:	s = 1.2 m	Length:	L = 12 m

Required length – ISO 40' container – not tested for concentrated load

For flexible cargo in a container of a design type series which has not been tested for concentrated cargo, the minimum length of the cargo due to longitudinal strength of the container is calculated according to section 2.12:

$$r_{req.} = L \cdot \left(2 - \frac{2 \cdot P + T}{2 \cdot m}\right) = 12 \cdot \left(2 - \frac{2 \cdot 26 + 3.5}{2 \cdot 20}\right) = 7.35m$$

Since the length of the cargo is shorter than 7.35 m, a bedding arrangement with longitudinal beams is needed.

Longitudinal bedding beams – 4 pcs

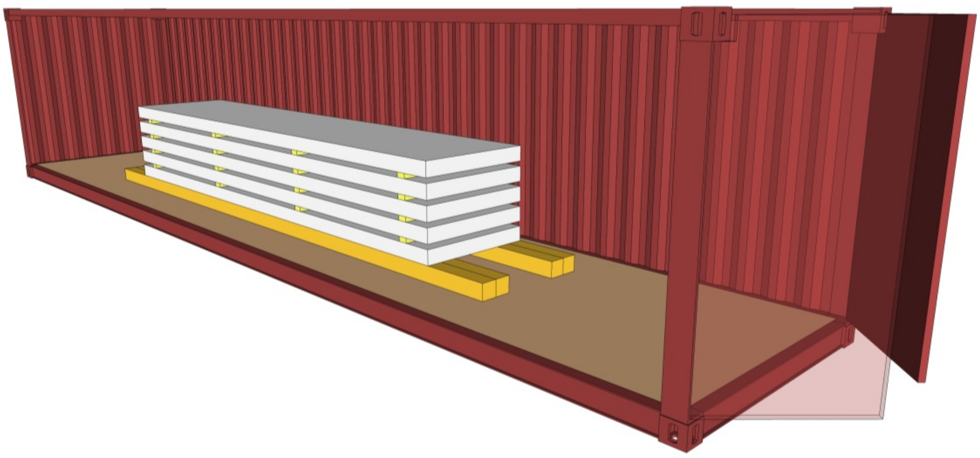
The length of the bedding beams is taken as the minimum cargo length calculated above:

$$t = r_{req.} = 7.35 \ m$$

The required bending strength for longitudinal bedding beams is calculated in accordance with section 3.3, with the form factor K taken for flexible cargo:

$$K = t - r = 7.35 - 6 = 1.35 \ m$$

$$W = \frac{250 \cdot m \cdot K}{n \cdot \sigma} = \frac{250 \cdot 20 \cdot 1.35}{4 \cdot 2.4} = 703 \ cm^3$$ (at least 16x16 cm cross section)



Example 5 – 38 ton stone crusher on flatrack

Stone crusher

Weight:	38 ton
Length:	3.3 m
Width:	2.4 m

Flak rack

Max payload:	40 ton
Tare:	5 ton

Required length –40' flatrack

For rigid cargo, the minimum length of the cargo due to the longitudinal strength of the flatrack is calculated according to section 2.13:

$$r_{req.} = L \cdot \left(1 - \frac{2 \cdot P + T}{4 \cdot m}\right) = 12 \cdot \left(1 - \frac{2 \cdot 40 + 5}{4 \cdot 38}\right) = 5.3\ m$$

Since the length of the cargo is shorter than 5.3 m, a bedding arrangement with longitudinal beams is needed.

Longitudinal bedding beams – 6 pcs

The length of the bedding beams is taken as the minimum cargo length calculated above:

$$t = r_{req.} = 5.3\ m$$

The required bending strength for longitudinal bedding beams is calculated in accordance with section 3.3, with the form factor K taken for rigid cargo where $t \leq 1.7 \cdot r$:

$$K = 2 \cdot r - t = 2 \cdot 3.3 - 5.3 = 1.3\ m$$

$$W = \frac{250 \cdot m \cdot K}{n \cdot \sigma} = \frac{250 \cdot 38 \cdot 1.3}{6 \cdot 2.4} = 858\ cm^3$$ (at least 17x17 cm cross section)