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Item 7 of the provisional agenda
Code of Practice for Packing of Cargo Transport Units

Code of Practice for Packing Cargo Transport Units – text prioritized in updates: transport stability level, bedding arrangements, load distribution, stabilizers and other changes

Note by the secretariat

I. Introduction

1. The United Nations Economic Commission for Europe (ECE) Working Party on Intermodal Transport and Logistics (WP.24) at its sixty-fourth session (Geneva, 20–22 October 2021) prolonged the informal pre-work on CTU Code for one more year to continue: (i) assess which areas of the CTU Code need to be prioritized in the updates, and (ii) consider text usage of the CTU Code in the mobile application.

2. Experts participating in the informal pre-work in the process of the assessment of the areas of the CTU Code where updates would be needed, among others, discussed issues such as: package stability, bedding arrangements, load distribution, stabilizers for dangerous substances and other related changes and considered possible new text developed on these issues to supplement the existing information in the Code.

3. This document presents changes for prioritization for updates on the issues referred above. In particular:

- Annex I presents a proposal for new section 4.2 of Annex 7 of the CTU Code with clauses on package stability, and more specifically introduction and explanation of the term of transport stability level (TSL). This section also proposes changes to Appendix 5 on practical inclination test for determination of the efficiency of cargo securing arrangements.
- Annex II shows a proposal for changes to clauses 3.1.1 to 3.1.3 of Annex 7 of the CTU Code to incorporate guidance for bedding arrangements in the CTU Code. It also shows proposed modifications to section 2 of Appendix 4 of Annex 7 with background and detailed calculations for the design of bedding arrangements.

- Annex III presents a proposal for modifications to section 3 of the Annex 7 of the CTU Code, clauses 3.1.4 to 3.1.8 to provide guidance for correct placement of cargo in terms of load positioning.
- Annex IV displays a proposal to add new section 10.4 on stabilizers to be considered for addition to Chapter 10 of the CTU Code.
- Annex V demonstrates updates to correct unit of measurements in the CTU Code if they did not follow the Metric System of Measurements and proposes changes to table on acceleration coefficients for rail transport (combined transport) available in chapter 5 under clause 5.3 of the CTU Code.

4. Proposed additions to the exiting text of the CTU Code are marked as bold text, while text proposed for deletion is marked as strikethrough.

5. WP.24 is invited to review the proposals presented in annexes I to V and provide its feedback and guidance.

Annex I

Transport Stability level

Proposal for a new section 4.2 of Annex 7:

4.2 ~~Tightly arranged cargoes~~**Transport Stability Level, TSL**

4.2.1 Importance of package stability

The term "package" is used to refer to any goods that are enclosed within one or more layers of packaging or secured on, or to, a packaging accessory.

Consignors should ensure that formed packages are capable of withstanding the hazards of environmental exposure, storage, handling and transport. Packages in the form of overpacks should retain their integrity during transport, failure to do so increases the risk of the cargo being damaged or the CTU stability being adversely affected.

To assist Packers in their role, the transport stability of the packages may be determined by practical tests, in which the packages capability of withstanding horizontal forces without substantial deformation is verified. Upon completion of such tests, the package may be marked with its corresponding Transport Stability Level (TSL), as given in table 7.8.

Transport Stability Level TSL	Horizontal acceleration a
TSL 1	$a \geq 1{,}0\ g^{a}$
TSL 2	$0{,}8\ g \leq a < 1{,}0\ g$
TSL 3	$0{,}5\ g \leq a < 0{,}8\ g$
TSL 4	$0{,}35\ g \leq a < 0{,}5\ g$
TSL 5	$0{,}18\ g \leq a < 0{,}35\ g$
[a] g = gravity acceleration 9,81 m/s^2 Note: Below 0.18 g no TSL marking allowed	

Table 7.8 – Transport Stability Level

The TSL when associated with the CTUs boundary strength can indicate the need for additional securing of the cargo and should be determined in each specific case.

4.2.2 Determine the TSL

The TSL of a package can be determined through practical tests by exposing the package to the horizontal acceleration corresponding to the sought TSL level according to table 1, for example by inclination tests as described in Appendix 5, with the addition that the maximum inclination angle shall be retained for at least 5 seconds and that the required inclination angle, to simulate the desired horizontal acceleration, shall be determined based on the internal friction of the goods in the package.

During the tests, the package should be prevented from sliding on the test platform by a measure that does not influence the package stability.

The package shall be tested 3 times in the lengthwise as well as in the sideways direction respectively. Asymmetrical cargo shall be tested in the most unstable directions. A separate test sample may be used in each test direction. No correction of the test samples may be done during the test.

After the test sequence, the permanent deformation of any part of the test sample from the primary location shall not exceed 60 mm in any direction. The maximum deformation may be measured on the front or back side of the test sample based on the primary vertical projection.

Furthermore, the test sample may not tip up or fall over during the tests.

No signs of visible leakage from the test sample are allowed after the test.

4.2.3 Marking of TSL

All packages which have a tested TSL should be marked with this, either on a separate label or incorporated with other markings on the units.

The TSL marking should:

a) be marked on at least one side of each package,

b) use letters or numbers of at least 12 mm height,

c) be visible and readable,

d) be displayed on a background of contrasting colour on the external surface of the package,

It is possible that test results for TSL differ in different directions depending on the shape of the package and therefore the lowest value for length and width directions should be displayed as per examples below (see figures 7.35 and 7.36).

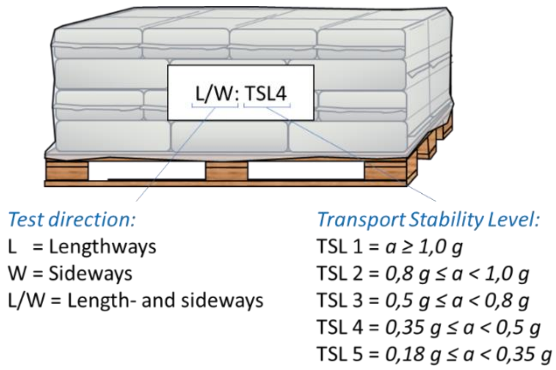

Figure 7.35: Marking of Transport Stability Level 4 in both length (L) and width (W) directions.

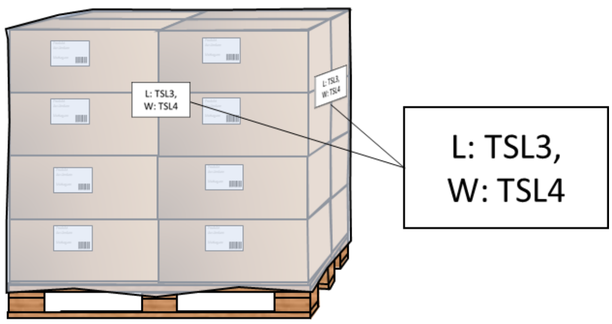

Figure 7.36: Marking of Transport Stability Level 3 in length (L) and 4 in width (W) directions

4.2.4 Practical applications for packages with known TSL

4.2.4.1 Bottom blocking

If the value of the directional TSL for a package (see table 7.8) is equal to or exceeds the directional acceleration coefficients (see chapter 5) for the intended transport mode, bottom blocking should be sufficient to prevent the cargo from sliding. When using bottom blocking only, table 7.9 below indicates the lowest required TSL to secure cargo in different directions and different modes of transport (see figure 7.37).

The lowest required TSL for securing the cargo using bottom blocking only			
Mode of transport	**Sideways**	**Forward**	**Backward**
Road	TSL3	TSL2	TSL3
Rail	TSL3	TSL3	TSL3
Sea Area A	TSL3	TSL2	TSL2
Sea Area B	TSL2	TSL1	TSL1
Sea Area C	TSL2	*Not advised*	*Not advised*

Table 7.9 – Required TSL for bottom blocking as the sole cargo securing method

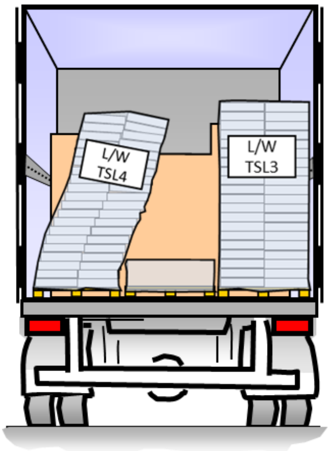

Figure 7.37: A package marked with TSL 3 or better may be bottom blocked sideways during road transport, while a package marked with TSL 4 risk collapsing in this situation.

4.2.4.2 Blocking against the side of the CTU

The TSL of the package indicates if the strength of the boundaries of the CTU is sufficient for blocking the packages or if additional securing methods are required by other means, e.g. lashings, in order not to overstress the CTU's boundary walls (see table 7.10 and figure 7.38).The lowest required TSL to block the cargo against the boundary walls of the CTU (evenly distributed cargo)						
Standard	**EN 12642:2016**				**EN 283**	**ISO 1496**
CTU	**L-vehicle**			**XL-vehicle**	**Swap-body**	**Container**
Mode of transport	**Box**	**Drop-sides**	**Curtain-sider**	**Box/Dropside/ Curtainsider**		
Road	TSL5	TSL5	TSL4	TSL5	TSL5	TSL5
Rail	TSL5	TSL5	TSL4	TSL5	TSL5	TSL5
Sea Area A	TSL5	TSL5	TSL4	TSL5	TSL5	TSL5
Sea Area B	TSL3	TSL3	TSL3	TSL4	TSL3	TSL5
Sea Area C	TSL3	TSL3	TSL2	TSL3	TSL3	TSL5

Table 7.10 – Required TSL for blocking only against the sides of CTUs

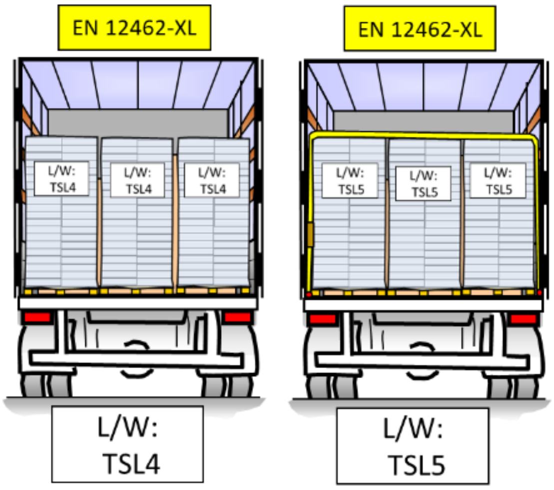

Figure 7.38: During transport in a road vehicle complying with standard EN 12642-XL, packages marked with TSL 4 or better may be secured by blocking against the CTU's sides only, whilst packages marked with TSL 5 needs additional securing measures, e.g. top-over lashings.

4.2.4.3 TSL in combination with the Quick Lashing Guides

The lashing tables in the Quick Lashing Guides (QLG) in Informative material IM5 are based on rigid packages and the assumption that sliding occurs between the bottom of the package or package accessory and the CTU floor. However, this is not the case for packages with low transport stability, which may tip earlier than indicated by their shape and structure indicates due to substantial deformation or sliding may occur within the package.

When using the Quick Lashing Guide (QLG) to identify the number of lashings required to prevent a package, with a given cargo mass, from sliding the maximum friction factor for a declared TSL can be identified in table 7.11 below.

Transport Stability Level TSL	**Maximum friction factor for deciding μ**
TSL 1	*1.0*
TSL 2	*0.80*
TSL 3	*0.50*
TSL 4	*0.35*
TSL 5	*0.15*

Table 7.11 – Maximum friction factors to use in the QLG for different TSLs

4.2.4.4 Selecting packaging to minimize breakage

If frequent breakage occurs during transport, the packaging may need improving. In such case, testing of TSL may be used as a tool for investigating the cause of the breakage, deciding on additional measures or new methods for packaging and verifying that these new measures provide a better transport stability.

Furthermore, a consignor or consignee may implement requirements of a minimum TSL for their packages, for themselves or for contracted partners, to minimize the risk of breakage and to make the cargo securing more efficient and safer.

~~4.2~~**4.3 Tightly arranged cargoes (**Subsequent clauses need to be renumbered)

Proposal for changes to Appendix 5 of Annex 7:

Appendix 5. Practical inclination test for determination of the efficiency of cargo securing arrangements

1 The efficiency of a securing arrangement **or the transport stability level (TSL) of a package** can be tested by a practical inclining test in accordance with the following description.

2 The cargo (alternatively one section of the cargo) is placed on a road vehicle platform or similar and secured in the way intended to be tested.

3 To obtain the same loads in the securing arrangement **or package** in the inclining test as in calculations, the securing arrangement **or package** should be tested by gradually increasing the inclination of the platform to an angle, α, in accordance with the diagram**s** below.

4 The inclination angle that should be used in the test is a function of the horizontal acceleration $c_{x,y}$ for the intended direction (forward, sideways or backward) and the vertical acceleration c_z.

(a) To test the efficiency of the securing arrangement in the lateral direction, the greatest of the following test angles should be used:

- The angle determined by the friction factor μ (for the sliding effect), or
- The angle determined by the ratio of $\frac{B}{n \cdot H}$ (for the tilting effect).

(b) To test the efficiency of the securing arrangement in the longitudinal direction, the greatest of following test angles should be used:

- The angle determined by the friction factor μ (for the sliding effect), or
- The angle determined by the ratio of $\frac{L}{H}$ (for the tilting effect).

(c) To test the TSL of a package in any direction the following test angles should be used:

- The angle determined by the internal friction factor μ on package without any package accessory.

5. Test of cargo securing arrangements

5.**1** The lowest friction factor, between the cargo and the platform bed or between packages if over-stowed should be used. The definition of *H*, *B*, *L* and *n* is according to the sketches in figures 7.~~61~~**96** and 7.~~62~~**97**.

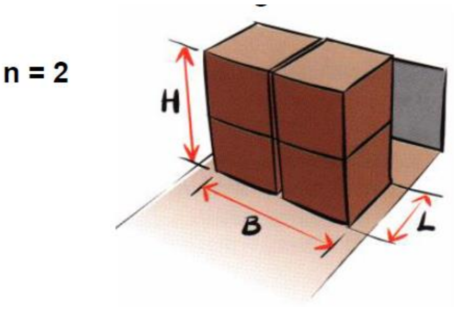

Figure 7.~~61~~**96**

Package or section with the centre of gravity close to its geometrical centre (L/2, B/2, H/2).

The number of loaded rows, n, in above section is 2.

L is always the length of one section also when several sections are placed behind each other.

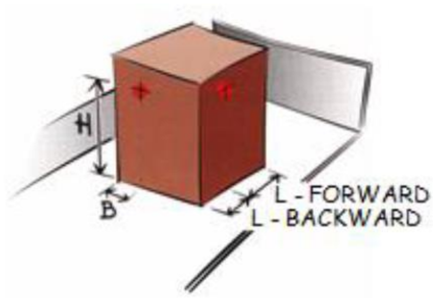

Figure 7.~~62~~**97**

Package with the centre of gravity away from its geometrical centre.

The required test angle α as function of $c_{x,y}$ (0.8 g, 0.7 g and 0.5 g) as well as μ, $\frac{B}{n \cdot H}$ and $\frac{L}{H}$ when c_z is 1.0 g is taken from the diagram shown in figure 7.~~63~~**98** or from the table **7.15** below.

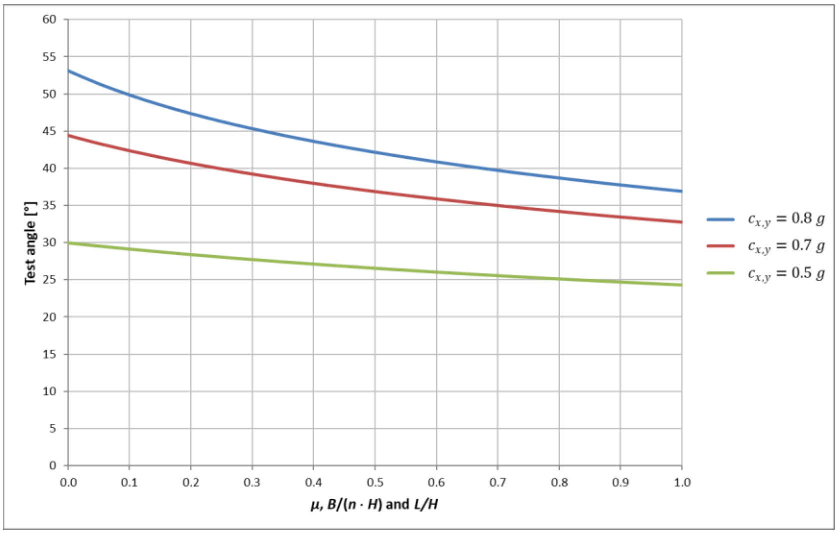

Figure 7.~~63~~**98**

Example:

If μ and $\frac{B}{n-H}$ is 0.3 ~~at~~ **for sideways** accelerations ~~sideways at~~**in** transport in sea area B (c_y = 0.7g) the cargo securing arrangement should be able to be inclined to approximately 39°, according to ~~the diagram~~**figure 7.98 and table 7.15**

In the table **7.15** below the inclination α is calculated for different γ factors at the horizontal accelerations ($c_{x,y} = 0.8$ g, *0.7* g and *0.5* g and $c_z = 1.0$ g).

The γ factor is defined as follows:

μ, *B/(n · H)* and *L/H*, as required in section 4 of this appendix.

$c_{x,y}$ / ϒ factor	0.8g	0.7g	0.5g
ϒ factor	Required test angle α in degrees		
0.00	53.1	44.4	30.0
0.05	51.4	43.3	29.6
0.10	49.9	42.4	29.2
0.15	48.5	41.5	28.8
0.20	47.3	40.7	28.4
0.25	46.3	39.9	28.1
0.30	45.3	39.2	27.7
0.35	44.4	38.6	27.4
0.40	43.6	38.0	27.1
0.45	42.8	37.4	26.8
0.50	42.1	36.9	26.6
0.55	41.5	36.4	26.3
0.60	40.8	35.9	26.0
0.65	40.2	35.4	25.8
0.70	39.7	35.0	25.6
0.75	39.2	34.6	25.3
0.80	38.7	34.2	25.1
0.85	38.2	33.8	24.9
0.90	37.7	33.4	24.7
0.95	37.3	33.1	24.5
1.00	36.9	32.8	24.3

Table 7.15

~~6~~**5.2** The securing arrangement is regarded as complying with the requirements if the cargo is kept in position with limited movements when inclined to the prescribed inclination α.

~~7~~**5.3** The test method will subject the securing arrangement to stresses and great care should be taken to prevent the cargo from falling off the platform during the test. If large masses are to be tested the entire platform should be prevented from tipping as well.

~~8~~**5.4** Figure 7.~~64~~**99** and figure 7.~~65~~**100** show tests to confirm the securing arrangements of a large package for acceleration forces in longitudinal and transverse directions.

Figure 7.~~64~~**99**

Figure 7.~~65~~**100**

6 Test of Transport Stability Level (TSL)

6.1 The required test angle α as a function of chosen TSL (1 – 5) is taken from the diagram shown in figure 7.101 or from the table 7.16 below.

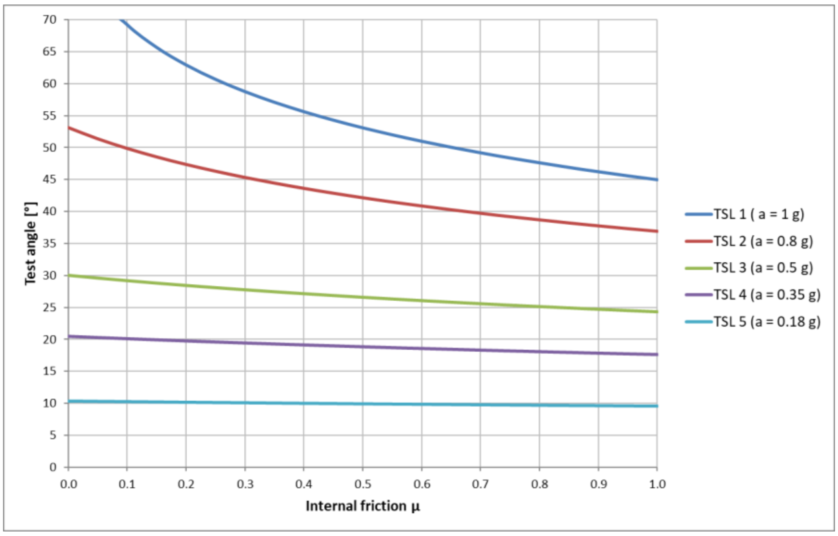

Figure 7.101

Example:

If the internal friction of a package is determined to µ = 0.40 and transport stability level chosen to be tested is TSL 3 the package should be able to be inclined to approximately 27°, according to the diagram

In table 7.16 the inclination *α* is calculated for different internal friction of a package at different TSL (1-5).

	TSL 1	TSL2	TSL3	TSL4	TSL5
Internal friction µ	Required test angle in degrees				
0.00	90.0	53.1	30.0	20.5	10.4
0.05	74.5	51.4	29.6	20.3	10.3
0.10	69.3	49.9	29.2	20.1	10.3
0.15	65.7	48.5	28.8	19.9	10.2
0.20	63.0	47.3	28.4	19.8	10.2
0.25	60.7	46.3	28.1	19.6	10.1
0.30	58.8	45.3	27.7	19.4	10.1
0.35	57.1	44.4	27.4	19.3	10.1

0.40	55.6	43.6	27.1	19.1	10.0
0.45	54.3	42.8	26.8	19.0	10.0
0.50	53.1	42.1	26.6	18.9	9.9
0.55	52.0	41.5	26.3	18.7	9.9
0.60	51.0	40.8	26.0	18.6	9.9
0.65	50.1	40.2	25.8	18.5	9.8
0.70	49.2	39.7	25.6	18.3	9.8
0.75	48.4	39.2	25.3	18.2	9.7
0.80	47.6	38.7	25.1	18.1	9.7
0.85	46.9	38.2	24.9	18.0	9.7
0.90	46.2	37.7	24.7	17.9	9.6
0.95	45.6	37.3	24.5	17.7	9.6
1.00	45.0	36.9	24.3	17.6	9.6

Table 7.16

6.2 Figure 7.102 shows inclining tests to confirm the TSL of a packages and figure 7.103 shows measuring of the permanent deflection after three tests with the same specimen in one direction.

Figure 7.102

Figure 7.103

Annex II

Bedding arrangements

Proposal for changes to clauses 3.1.1 to 3.1.3 of Annex 7:

3. Principles of packing

3.1 ~~Load distribution~~**Bedding arrangements in freight containers**

3.1.1 Freight containers~~, flatracks and platforms~~ are designed according to ISO standards, amongst others, in such a way that the permissible payload P, if homogeneously distributed over the entire loading floor, can safely be transferred to the four corner posts under all conditions of carriage. This includes a safety margin for temporary weight increase due to vertical accelerations during a sea passage. When the payload is not homogeneously distributed over the loading floor, the limitations for concentrated loads should be considered. It may be necessary to transfer the weight to the corner posts by supporting the cargo on strong timber or steel beams as appropriate (see figure 7.2~~1~~**6**).

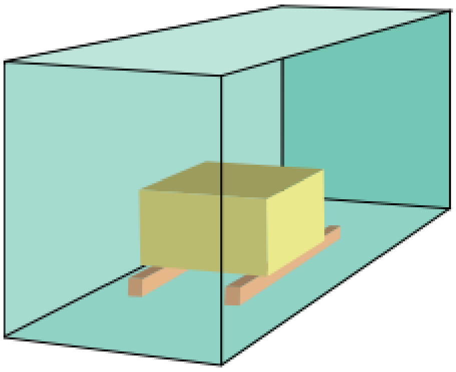

Figure 7.2~~1~~**6** Load transfer beams

3.1.2 ~~The bending strength of the beams should be sufficient for the purpose of load transfer of concentrated loads. The arrangement, the required number and the strength of timber beams or steel beams should be designed in consultation with the CTU operator.~~**The necessary length (L_R) of these beams depends on the cargo weight mass and their mutual distance (B). It is important to make the distance B of the longitudinal beams as large as possible in order to minimise the stress onto the cross-members of the container floor. The beams must have sufficient strength for effectively spreading the load. Their necessary dimensions should be determined by the cargo mass and the intended spreading effect, expressed by their "free length". This simple arrangement complies with the principles of structural engineering. There is no benefit of flooring the area under the cargo item with beams of lesser strength.**

3.1.2.1 Step 1 - Minimum length

1. **The bedding beams must be long enough to cover the distance of the container's floor so that load from the cargo will not overstress the floor.**
2. **The minimum length depends on the following factors (see figure 7.27):**
   - **The cargo mass (in tonnes)**
   - **The spacing of the beams, B (in meters)**

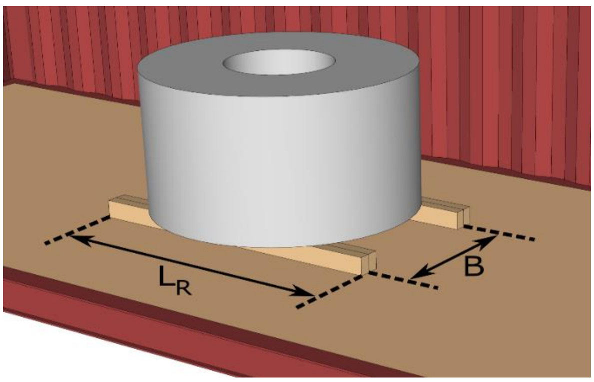

Figure 7.27 Minimum length

3. **The table 7.5 below gives the minimum required length, L_R, of longitudinal bedding beams based on these two factors.**

Minimum required length of longitudinal bedding beams, L_R, [m]							
Spacing between beams, B [m]	**Cargo mass [tonne] 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

Table 7.5

3.1.2.2 Step 2 - Minimum dimensions

1. **The proper size of the bedding beams depends on the bending resistance (section modulus) that is required of the beams for them to successfully transfer the load from the cargo over the required floor length. The required section modulus depends on the following factors (see figure 7.28):**
   - **The cargo mass (in tonnes)**
   - **The minimum length of the beams, L_R (in meters), as given by table below**
   - **The length of the footprint of the cargo on the beams, L_C (in meters)**
   - **The strength of the material of the bending beams**

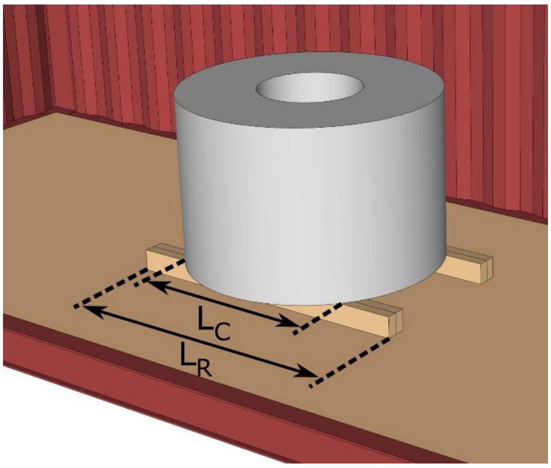

Figure 7.28 Minimum dimensions

2. **When wooden beams are used, the section modulus is calculated by the cross section. It is recommended that square sections are used to ensure the beams stability with a height and width of "a" measured in mm (see figure 7.29).**

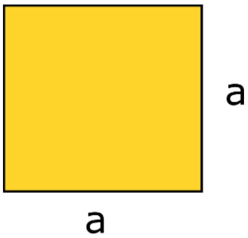

Figure 7.29 Definition of height and width, "a" for wooden beams with a square cross section

3. **The table 7.6 below shows the minimum value of "a" based on the cargo mass and the free length of the beams.**

4. **Free length is defined as:**

$$\frac{L_R - L_C}{2}$$

Minimum height and width, "a" ~~a × a~~, of a pair of square wooden beams with σ_p = 1.5 kN/cm^2 [mm]							
Free length (L_R – L_C) / 2 [m]	**Cargo mass [tonnes]**						
	4	**8**	**12**	**16**	**20**	**24**	**28**
0.25	79	99	114	125	135	143	151
0.50	99	125	143	158	170	181	190
0.75	114	143	164	181	194	207	218
1.00	125	158	181	199	214	227	239
1.25	135	170	194	214	231	245	258
1.50	143	181	207	227	245	260	274
1.75	151	190	218	239	258	274	289
2.00	158	199	227	250	270	287	302

Table 7.6

5. When steel beams are used, the section modulus depends on which type of profile is used. The table 7.7 below gives the minimum size (in mm) to use for standard HEB profiles based on the cargo mass and the free length of the beams (see figure 7.30).

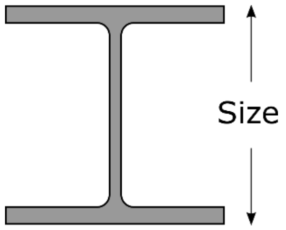

Figure 7.30 Definition of size for HEB steel profiles

Minimum size of a pair of HEB steel beams with σ_p = 15 kN/cm^2 [mm]							
Free length (L_R - L_C) / 2 [m]	**Cargo mass [tonnes]**						
	4	**8**	**12**	**16**	**20**	**24**	**28**
0.25	100	100	100	100	100	100	100
0.50	100	100	100	100	100	120	120
0.75	100	100	100	120	120	140	140
1.00	100	100	120	120	140	140	160
1.25	100	100	120	140	140	160	160
1.50	100	120	140	140	160	160	180
1.75	100	120	140	160	160	180	180
2.00	100	120	140	160	180	180	200

Table 7.7

6. 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 above.

3.2 Bedding arrangements on flatracks and platform containers and in road vehicles

3.2.1 CTUs with longitudinal structural beams do not require the bedding arrangements described in 3.1 but still do require beams to be placed under heavy cargo items to ensure that there are no areas where forces are concentrated and to ensure that the forces are transmitted to the longitudinal structural beams.

3.2.2 The bedding arrangement for these types of CTU should be placed transversally so that they land on the longitudinal structural beams.

3.2.3 The bedding arrangement should also support the cargo item so that no part of the cargo items is landed on the cargo deck. This is particularly true when transporting

coiled materials and the bedding arrangement can incorporate wedge beams to prevent the coil (eye to the side) from rolling.

3.2.4~~3.1.3~~ **If bedding beams cannot be used for concentrated loads on flatracks or platform containers and road trailers, the load may have to be reduced against the maximum payload.** ~~Concentrated loads on platforms or flatracks should be similarly expanded by bedding on longitudinal beams or the load should be reduced against the maximum payload.~~ The permissible load should be designed in consultation with the CTU operator.

(Subsequent clauses need to be renumbered)

Proposal for modifications to section 2 of Appendix 4 of Annex 7:

2. Bedding a concentrated load in a general purpose freight container ~~or on a flatrack~~

2.1 Introduction

2.1.1 Bedding arrangements for concentrated loads in general purpose freight containers ~~and on flatracks~~ should be designed in consultation with the CTU operator.

2.1.2 The minimum length and bending resistance (section modulus) of bedding beams should be taken from the tables in Section 3.1 of this annex or by the formulas presented below.

2.2 Minimum length

2.2.1 The minimum length of bedding beams, L_R, can be calculated by following formula:

$$L_R = 0.165 \cdot m \cdot (2.3 - B)$$

Where:
L_R = Minimum length of bedding beams (m)
m = mass of cargo (t)
B = Spacing of bedding beams (m)

2.2.2 In addition, where the cargo mass is greater than 50% of the Payload, the length of bedding beams, L_R, should also not be less than:

$$L_R = \left(\frac{m}{P} - 0.5\right) \cdot L_{CTU}$$

Where:
L_R = Minimum length of bedding beams (m)
m = mass of cargo (t)
P = Payload of CTU (t)
L_{CTU} = Length of CTU (m)

2.3 Minimum section modulus

2.3.1 The minimum section modulus, W, for bedding beams can be calculated by the following formula:

$$W = \frac{125 \cdot m \cdot g \cdot (L_R - L_C)}{n \cdot \sigma_p}$$

Where:
W = Minimum section modulus of bedding beams (cm^3)
m = mass of cargo (t)
L_R = Minimum length of bedding beams as given in section 2.2 (m)
L_C = Length of cargo footprint on bedding beams (m)
n = number of bedding beams
σ_p = Permissible bending stress of material in beams (N/mm^2)

Annex III

Load distribution

Proposal for changes to clauses 3.1.4 to 3.1.8 of Annex 7:

3.3 Load distribution

3.3.1 In order to enable safe handling and transport of CTUs, all relevant limitations that restricts the allowable eccentricity of the centre of gravity for combined mass of the cargo, securing equipment and bedding arrangement must be considered. The allowable mass of cargo and securing materials based on the position of the centre of gravity may be visualized through a Load Distribution Diagram, in which a limiting curve is plotted based on all applicable restrictions (see figures 7.31 and 7.33 below). ~~(3.1.4)~~The precise longitudinal position of the centre of gravity of the cargo may be determined by calculation (see Appendix 4 to this Annex).

3.3.2~~3.1.4~~ Where freight containers, including flatracks or platforms, will be lifted and handled in a level state during transport, the cargo should be so arranged and secured in the freight container that its joint centre of gravity is close to the mid-length and mid-width of the freight container. The eccentricity of the centre of gravity of the ~~cargo~~ **container's gross** ~~weight~~ **mass** should not exceed ±5% in general. As a rule of thumb this can be taken as 60% of the cargo's total mass in 50% of the freight container's length. ~~Under particular circumstances an eccentricity of up to ±10% could be accepted, as advanced spreaders for handling freight containers are capable of adjusting for such eccentricity. The precise longitudinal position of the centre of gravity of the cargo may be determined by calculation (see appendix 4 to this annex).~~

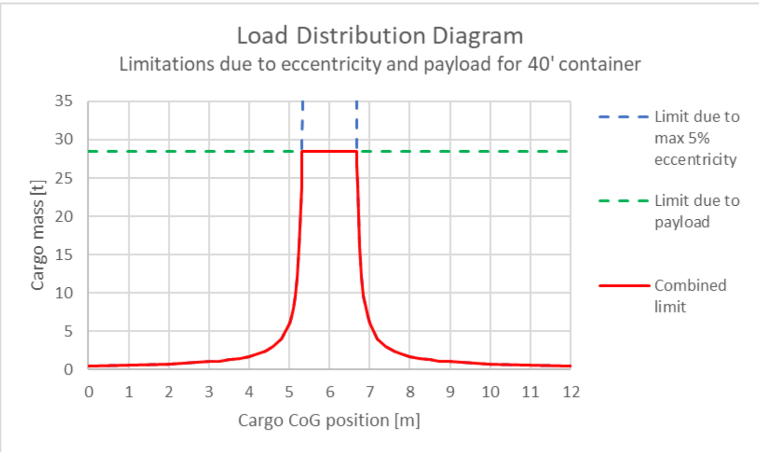

Figure 7.31 An example of a load distribution diagram for the safe loading and handling of a 40-foot container, based on the following parameters:

- **Tare mass of container: 4000 kg**
- **Max payload: 28 500 kg**
- **Maximum eccentricity: ±5% of the container's length**

3.3.3~~3.1.5~~ Roll trailers have structural properties similar to platforms, but are less sensitive to concentrated loads due to the usual wheel support at about 3/4 of their length from the gooseneck tunnel end. As they are generally handled without lifting, the longitudinal position of the cargo centre of gravity is also not as critical **but may further be restricted by the allowable deck and ramp capacities of the vessel**.

3.3.4~~3.1.6~~ Swap bodies have structural properties similar to freight containers, but in most cases ~~less tare weight~~**have a smaller tare mass** and less overall strength. They are normally not stackable. The loading instructions given under subsection 3.1.2 and ~~3.1.5~~**3.3.3** should be applied to swap bodies as appropriate.

3.3.5~~3.1.7~~ Road trucks and road trailers are in particular sensitive regarding the position of the centre of gravity of the cargo packed in them, due to **the manufacturer's** specified axle loads for maintaining steering and braking ability **as well as the infrastructure's**

restrictions for vehicle gross mass as well as axle and bogie loads. In case of semi-trailers, the maximum king pin load, resulting from the towing trucks restrictions, must also be considered. ~~Such~~ **Individual** vehicles may be equipped with specific load distribution diagrams~~, which show the permissible cargo mass as a function of the longitudinal position of its centre of gravity~~. Generally, the maximum ~~cargo mass~~**payload** may be ~~used~~ **utilized** only when the centre of gravity (CoG) is positioned within narrow boundaries about half the length of the loading space (see figure~~s 7.22 and~~ 7.**3**2~~3~~).

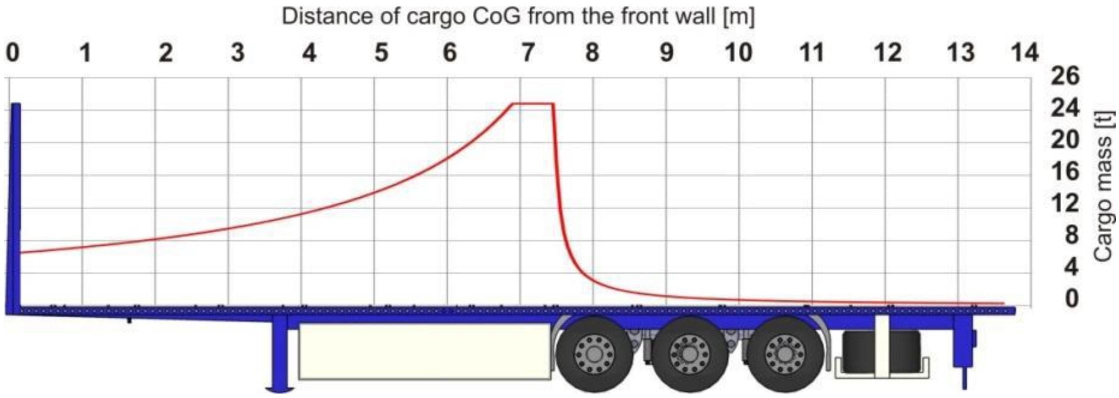

Figure 7.**3**2~~37~~ An example of a load distribution diagram for a semi-trailer

3.3.6~~3.1.8~~ Railway routes are generally classified into line categories, by which permissible **gross masses for wagons**, axle loads and loads per metre length of cargo space are allocated to each railway wagon. The applicable figures should be observed in view of the intended route of the wagon. Tolerable concentrated loads are graded depending on their bedding length. The appropriate load figures are marked on the wagons. The transverse and longitudinal ~~deviation~~**eccentricity** of cargo centre of gravity from wagon ~~centre lines~~ **centrelines** is limited by defined relations of transverse wheel loads and longitudinal axle/bogie loads. The proper loading of railway wagons should be supervised by specifically trained persons.

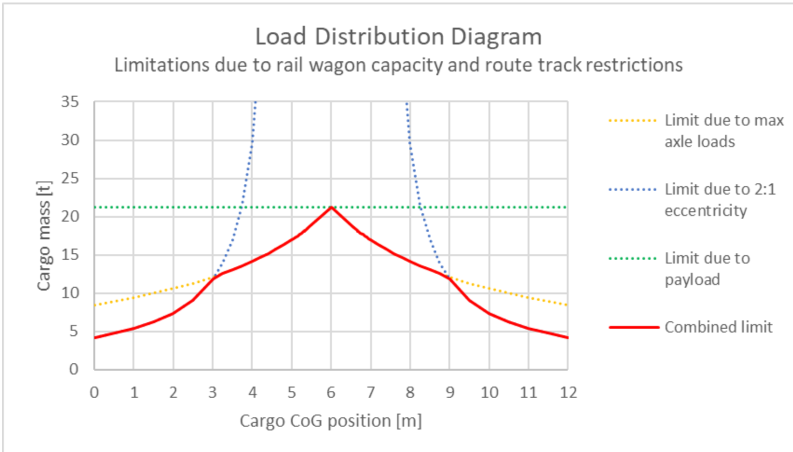

Figure 7.33 An example of a load distribution diagram for a 40-foot container on a two-axle rail wagon, based on the following parameters:

- **Maximum gross mass for wagon: 36 000 kg**
- **Tare mass of wagon: 10 800 kg**
- **Tare mass of container: 4000 kg**
- **Max cargo mass (payload): 21 200 kg**
- **Maximum axle load: 18 000 kg**
- **Distance between axles: 8 m**
- **Maximum difference between weight on axles: 2:1 (i.e. no axle may carry more than twice the weight of the other).**

3.3.7 Load Distribution Diagrams for different modes of transport may be superimposed to show the combined limiting curve for the whole intended voyage, as illustrated in the example in figure 7.34.

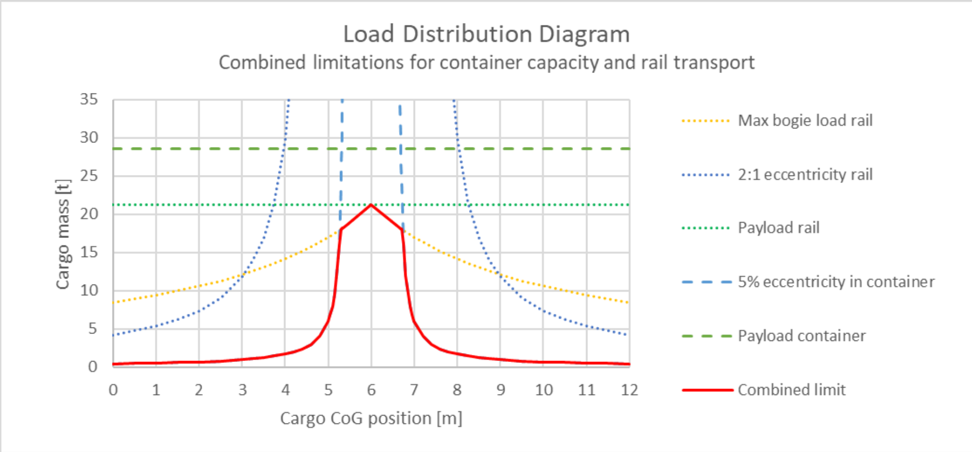

Figure 7.34 An example of a combined load distribution diagram for the handling and capacity of a 40-foot container as well as transport on a two-axle rail wagon

3.4~~3.2~~ General stowage/packing techniques **(**Subsequent clauses need to be renumbered)

Annex IV

Stabilizers

Proposal for addition of section 10.4 Stabilizers to chapter 10:

10.4 Stabilizers

10.4.1 The shipper should advise the carrier of critical information which pertains to controls implemented to ensure stabilization for an inhibited polymerizing substance. Such information is essential to safe carriage of goods in particular in situations of significant delays in supply chain. Such information should include the Self-accelerating decomposition temperature (SADT) or Self-accelerating polymerization temperature (SAPT), any temperature control measures applied, including operations controls considered and/or imposed, together with the duration of effectiveness of chemical inhibitors.

10.4.2 Carriers are encouraged to use the SADT/SAPT to validate that the corresponding regulatory requirements are met as a condition of acceptance. Similarly, if operational controls are used as a means to stabilize a substance, carriers would need this information to ensure that the operational controls are properly implemented and that mitigation actions can be considered when delays occur.

10.4.3 Carries are also encouraged to use the SADT/SAPT and anticipated duration for the effectiveness of inhibitors to anticipate contingencies and/or prepare for imminent dangers in the event of delays. Furthermore, carriers are encouraged to share this information with their service providers.

Annex V

Other changes

This annex presents updates to correct unit of measurements in the CTU Code and proposes changes to table on acceleration coefficients for rail transport (combined transport) available in chapter 5 under clause 5.3 of the CTU Code.

The following corrections to unit of measurements are proposed:

Chapter 5

5.2 During transport various forces will act on the cargo. The force acting on the cargo is the mass of the cargo (m) which is measured in kg or ~~ton~~**tonne**, multiplied by the acceleration (a) which is measured in m/s²:

Chapter 6

Clause 6.4.1:

Class A: 12.2 to 13.6 m long (maximum gross mass 34 ~~tons~~**tonnes**);

Class B: 30ft (9.125 m long);

Class C: 7.15, 7.45 or 7.82 m long (maximum gross mass 16 ~~tons~~**tonnes**).

Chapter 6

6.4.5 Floors of swap bodies are built to withstand corresponding axle loads of 4,400 kg and wheel loads of 2,200 kg (reference: EN 283). Such axle loads are typical for forklift trucks with a lifting capacity of 2.5 ~~tons~~**tonnes**.

Chapter 7

7.2.7 Heavy cargo items lifted by a forklift truck may result in a front axle load exceeding the maximum permissible concentrated load inside a CTU. For example, modern freight containers are designed to withstand a force of 0.5 kN/cm² which may limit package masses to approximately 3 to 3.5 ~~tons~~**tonnes** depending on the type of forklift truck used. For heavy cargo, open top, open side or platform CTUs should be used so that the cargo can be loaded from the top or from the side without a need to drive into the CTU with the forklift truck. ~~For load distribution, see annex 7, section 3.1.~~

Chapter 7

7.3.1 Freight containers, including swap bodies and regional containers designed for stacking and approved under the CSC are basically suitable for all modes of transport. However, **some designs of** freight containers **may be built with reduced stacking capacity (less than 192,000kg superimposed load) or built and tested with a lower allowable stacking load than is required in the latest version of ISO 1496 shall be marked in accordance with the latest edition of ISO 6346 and** ~~having an allowable stacking mass of less than 192,000 kg marked on the approval plate (see annex 4, section 1)~~ **may** require special stowage on board a ship, where the superimposed stacking mass will not exceed the permitted limits as marked on the plate. Furthermore, some freight containers and swap bodies may have a gross mass of 34 ~~tons~~**tonnes** or higher for which some road chassis and railcars will not be capable of carrying such heavy units. Therefore, especially for heavy massed containers, it is of utmost importance to arrange for an appropriate chassis and tractor vehicle or railcar, as applicable.

Chapter 7, first row in table in clause 7.3.4.2

Gross vehicle mass (GVM (~~tons~~**tonnes**))

The following changes to the acceleration coefficients for rail transport (combined transport) available in chapter 5 are proposed:

Rail transport (combined transport)				
Securing in	Acceleration coefficients			
	Longitudinally (c_x)		Transversely (c_y)	Minimum vertically down (c_z)
	forward	rearward		
Longitudinal direction	0.5 (1.0/**1.2**)†	0.5 (1.0/**1.2**)†	-	1.0 (0.7)†
Transverse direction	-	-	0.5	1.0 (0.7)†
†The values in brackets apply to shock loads only with short impacts of 150 milliseconds or shorter, and may be used, for example, for the design of packaging. **Shippers should contact their carriers for the applicable shock loads acceleration coefficient values.**				