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MSC/Circ.1026
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AMENDMENTS TO THE CODE OF SAFE PRACTICE FOR CARGO STOWAGE AND SECURING (CSS CODE)

1 The Maritime Safety Committee, at its seventy-fifth session (15 to 24 May 2002), approved the annexed amendments to the Code of Safe Practice for Cargo Stowage and Securing (CSS Code).

2 Member Governments are invited to bring the amendment to the attention of shipowners, ship operators, shipmasters and crews and all others concerned.

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ANNEX

AMENDMENTS TO THE CODE OF SAFE PRACTICE FOR CARGO STOWAGE AND SECURING (CSS CODE)

ANNEX 13

Methods to assess the efficiency of securing arrangements for non-standardized cargo

1 SCOPE OF APPLICATION

1 In paragraph 1, after the second sentence a new sentence is added as follows:

"All lashing assemblies used in the application of the methods described in this annex must be attached to fixed securing points or strong supporting structures marked on the cargo unit or advised as being suitable, or taken as a loop around the unit with both ends secured to the same side as shown in Annex 5, Figure 2 of the Code. Lashings going over the top of the cargo unit, which have no defined securing direction but only act to increase friction by their pre-tension, cannot be credited in the evaluation of securing arrangements under this annex."

4 STRENGTH OF SECURING EQUIPMENT

2 In paragraph 4.2, the second sentence in the first sub-paragraph is replaced by the following text:

"Safe Working Load (SWL) may be substituted for MSL for securing purposes, provided this is equal to or exceeds the strength defined by MSL."

3 In Table 1 (as amended by MSC/Circ. 812), "70% of breaking strength" on the line regarding web lashing is replaced by "50% of breaking strength".

5 SAFETY FACTOR

4 Existing paragraph 5 is replaced by the following text and re-numbered as paragraph 6:

"When using balance calculation methods for assessing the strength of the securing devices, a safety factor is used to take account of the possibility of uneven distribution of forces among the devices or reduced capability due to the improper assembly of the devices or other reasons. This safety factor is used in the formula to derive the calculated strength (CS) from the MSL and shown in the relevant method used.

$$CS = MSL/\text{safety factor}$$

Notwithstanding the introduction of such a safety factor, care should be taken to use securing elements of similar material and length in order to provide a uniform elastic behaviour within the arrangement."

6 RULE-OF-THUMB METHOD

5 Existing paragraph 6 is re-numbered as paragraph 5. Existing sub-paragraphs 6.1, 6.2 and 6.3 are re-numbered as 5.1, 5.2 and 5.3 accordingly.

7 ADVANCED CALCULATION METHOD

6 After Table 3 the following text and formula are added:

"For length/speed combinations not directly tabulated, the following formula may be used to obtain the correction factor with v = speed in knots and L = length between perpendiculars in metres:

$$\text{correction factor} = (0.345 \cdot v / \sqrt{L}) + (58.62 \cdot L - 1034.5)/L^2$$

This formula shall not be used for ship lengths less than 50 m or more than 300 m."

7 Under the existing paragraph 7.2, the following text and a new table are added:

"Friction contributes towards prevention of sliding. The following friction coefficients (μ) should be applied.

Table 5 – Friction coefficients

Materials in contact	Friction coefficient, (μ)
timber-timber, wet or dry	0.4
steel-timber or steel-rubber	0.3
steel-steel, dry	0.1
steel-steel, wet	0.0

"

8 In paragraph 7.2.1, the text from (μ = 0.3 for steel-timber or steel-rubber) to (μ = 0.0 for steel-steel, wet) is deleted; "table 5" in the definition of *f* is replaced by "table 6"; and a formula is added under the definition of CS as follows:

$$CS = \frac{MSL}{1.5}$$

9 Existing Table 5 is re-numbered as Table 6.

10 Under the re-numbered Table 6, the following text is added:

"As an alternative to using Table 6 to determine the forces in a securing arrangement, the method outlined in paragraph 7.3 can be used to take account of transverse and longitudinal components of lashing forces."

11 In paragraph 7.2.3, under the definition of CS a formula is added:

"$$CS = \frac{MSL}{1.5}$$ "

12 A new paragraph 7.2.4 is added as follows:

"**7.2.4** *Calculated example*

A calculated example for this method is shown in Appendix 1."

13 A new paragraph 7.3 is added as follows:

"7.3 Balance of forces – alternative method

The balance of forces described in paragraph 7.2.1 and 7.2.3 will normally furnish a sufficiently accurate determination of the adequacy of the securing arrangement. However, this alternative method allows a more precise consideration of horizontal securing angles.

Securing devices usually do not have a pure longitudinal or transverse direction in practice but have an angle β in the horizontal plane. This horizontal securing angle β is defined in this annex as the angle of deviation from the transverse direction. The angle β is to be scaled in the quadrantal mode, i.e. between 0 and 90°.

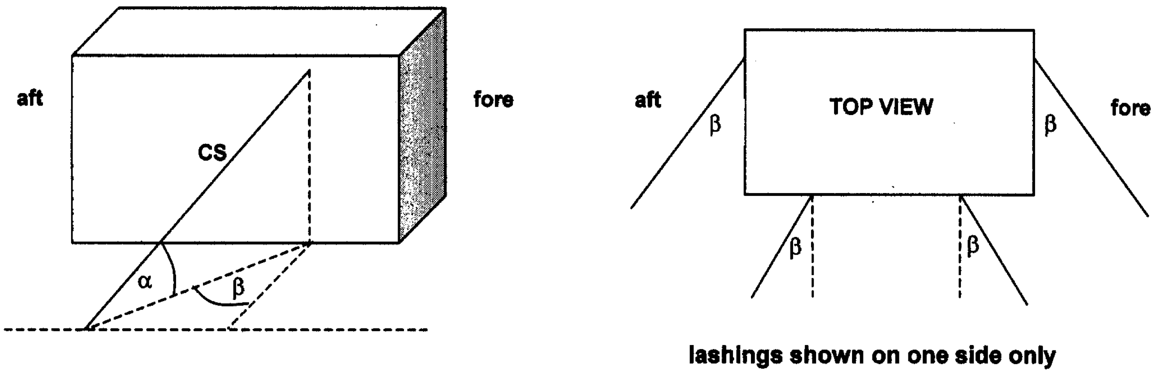


Figure 3 – *Definition of the vertical and horizontal securing angles α and β*

A securing device with an angle β develops securing effects both in longitudinal and transverse direction, which can be expressed by multiplying the calculated strength CS with the appropriate values of fx or fy. The values of fx and fy can be obtained from Table 7.

Table 7 consists of five sets of figures, one each for the friction coefficients μ = 0.4, 0.3, 0.2, 0.1 and 0. Each set of figures is obtained by using the vertical angle α and horizontal angle β. The value of fx is obtained when entering the table with β from the right while fy is obtained when entering with β from the left, using the nearest tabular value for α and β. Interpolation is not required but may be used.

The balance calculations are made in accordance with the following formulae:

Transverse sliding : $\mathbf{Fy \leq \mu \cdot m \cdot g + fy_1 \cdot CS_1 + ... + fy_n \cdot CS_n}$
Longitudinal sliding : $\mathbf{Fx \leq \mu(m \cdot g - Fz) + fx_1 \cdot CS_1 + ... + fx_n \cdot CS_n}$
Transverse tipping : $\mathbf{Fy \cdot a \leq b \cdot m \cdot g + 0.9(CS_1 \cdot c_1 + CS_2 \cdot c_2 + ... + CS_n \cdot c_n)}$

Caution:

Securing devices, which have a vertical angle α of less than 45º in combination with horizontal angle β greater than 45º, should not be used in the balance of transverse tipping in the above formula.

All symbols used in these formulae have the same meaning as defined in paragraph 7.2 except fy and fx, obtained from Table 7, and CS is as follows:

$$CS = \frac{MSL}{1.35}$$

A calculated example for this method is shown in Appendix 1.

Table 7 – fx-values and fy-values as a function of α, β and μ

Table 7.1 for μ = 0.4

β for fy	α -30	-20	-10	0	10	20	30	40	45	50	60	70	80	90	β for fx
0	0.67	0.80	0.92	1.00	1.05	1.08	1.07	1.02	0.99	0.95	0.85	0.72	0.57	0.40	**90**
10	0.65	0.79	0.90	0.98	1.04	1.06	1.05	1.01	0.98	0.94	0.84	0.71	0.56	0.40	**80**
20	0.61	0.75	0.86	0.94	0.99	1.02	1.01	0.98	0.95	0.91	0.82	0.70	0.56	0.40	**70**
30	0.55	0.68	0.78	0.87	0.92	0.95	0.95	0.92	0.90	0.86	0.78	0.67	0.54	0.40	**60**
40	0.46	0.58	0.68	0.77	0.82	0.86	0.86	0.84	0.82	0.80	0.73	0.64	0.53	0.40	**50**
50	0.36	0.47	0.56	0.64	0.70	0.74	0.76	0.75	0.74	0.72	0.67	0.60	0.51	0.40	**40**
60	0.23	0.33	0.42	0.50	0.56	0.61	0.63	0.64	0.64	0.63	0.60	0.55	0.48	0.40	**30**
70	0.10	0.18	0.27	0.34	0.41	0.46	0.50	0.52	0.52	0.53	0.52	0.49	0.45	0.40	**20**
80	-0.05	0.03	0.10	0.17	0.24	0.30	0.35	0.39	0.41	0.42	0.43	0.44	0.42	0.40	**10**
90	-0.20	-0.14	-0.07	0.00	0.07	0.14	0.20	0.26	0.28	0.31	0.35	0.38	0.39	0.40	**0**

Table 7.2 for μ = 0.3

β for fy	α -30	-20	-10	0	10	20	30	40	45	50	60	70	80	90	β for fx
0	0.72	0.84	0.93	1.00	1.04	1.04	1.02	0.96	0.92	0.87	0.76	0.62	0.47	0.30	**90**
10	0.70	0.82	0.92	0.98	1.02	1.03	1.00	0.95	0.91	0.86	0.75	0.62	0.47	0.30	**80**
20	0.66	0.78	0.87	0.94	0.98	0.99	0.96	0.91	0.88	0.83	0.73	0.60	0.46	0.30	**70**
30	0.60	0.71	0.80	0.87	0.90	0.92	0.90	0.86	0.82	0.79	0.69	0.58	0.45	0.30	**60**
40	0.51	0.62	0.70	0.77	0.81	0.82	0.81	0.78	0.75	0.72	0.64	0.54	0.43	0.30	**50**
50	0.41	0.50	0.58	0.64	0.69	0.71	0.71	0.69	0.67	0.64	0.58	0.50	0.41	0.30	**40**
60	0.28	0.37	0.44	0.50	0.54	0.57	0.58	0.58	0.57	0.55	0.51	0.45	0.38	0.30	**30**
70	0.15	0.22	0.28	0.34	0.39	0.42	0.45	0.45	0.45	0.45	0.43	0.40	0.35	0.30	**20**
80	0.00	0.06	0.12	0.17	0.22	0.27	0.30	0.33	0.33	0.34	0.35	0.34	0.33	0.30	**10**
90	-0.15	-0.10	-0.05	0.00	0.05	0.10	0.15	0.19	0.21	0.23	0.26	0.28	0.30	0.30	**0**

Table 7.3 for μ = 0.2

β for fy	α													β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.77	0.87	0.95	1.00	1.02	1.01	0.97	0.89	0.85	0.80	0.67	0.53	0.37	0.20	**90**
10	0.75	0.86	0.94	0.98	1.00	0.99	0.95	0.88	0.84	0.79	0.67	0.52	0.37	0.20	**80**
20	0.71	0.81	0.89	0.94	0.96	0.95	0.91	0.85	0.81	0.76	0.64	0.51	0.36	0.20	**70**
30	0.65	0.75	0.82	0.87	0.89	0.88	0.85	0.79	0.75	0.71	0.61	0.48	0.35	0.20	**60**
40	0.56	0.65	0.72	0.77	0.79	0.79	0.76	0.72	0.68	0.65	0.56	0.45	0.33	0.20	**50**
50	0.46	0.54	0.60	0.64	0.67	0.67	0.66	0.62	0.60	0.57	0.49	0.41	0.31	0.20	**40**
60	0.33	0.40	0.46	0.50	0.53	0.54	0.53	0.51	0.49	0.47	0.42	0.36	0.28	0.20	**30**
70	0.20	0.25	0.30	0.34	0.37	0.39	0.40	0.39	0.38	0.37	0.34	0.30	0.26	0.20	**20**
80	0.05	0.09	0.14	0.17	0.21	0.23	0.25	0.26	0.26	0.26	0.26	0.25	0.23	0.20	**10**
90	-0.10	-0.07	-0.03	0.00	0.03	0.07	0.10	0.13	0.14	0.15	0.17	0.19	0.20	0.20	**0**

Table 7.4 for μ = 0.1

β for fy	α													β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.82	0.91	0.97	1.00	1.00	0.97	0.92	0.83	0.78	0.72	0.59	0.44	0.27	0.10	**90**
10	0.80	0.89	0.95	0.98	0.99	0.96	0.90	0.82	0.77	0.71	0.58	0.43	0.27	0.10	**80**
20	0.76	0.85	0.91	0.94	0.94	0.92	0.86	0.78	0.74	0.68	0.56	0.42	0.26	0.10	**70**
30	0.70	0.78	0.84	0.87	0.87	0.85	0.80	0.73	0.68	0.63	0.52	0.39	0.25	0.10	**60**
40	0.61	0.69	0.74	0.77	0.77	0.75	0.71	0.65	0.61	0.57	0.47	0.36	0.23	0.10	**50**
50	0.51	0.57	0.62	0.64	0.65	0.64	0.61	0.56	0.53	0.49	0.41	0.31	0.21	0.10	**40**
60	0.38	0.44	0.48	0.50	0.51	0.50	0.48	0.45	0.42	0.40	0.34	0.26	0.19	0.10	**30**
70	0.25	0.29	0.32	0.34	0.35	0.36	0.35	0.33	0.31	0.30	0.26	0.21	0.16	0.10	**20**
80	0.10	0.13	0.15	0.17	0.19	0.20	0.20	0.20	0.19	0.19	0.17	0.15	0.13	0.10	**10**
90	-0.05	-0.03	-0.02	0.00	0.02	0.03	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.10	**0**

Table 7.5 for μ = 0.0

β for fy	α													β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.87	0.94	0.98	1.00	0.98	0.94	0.87	0.77	0.71	0.64	0.50	0.34	0.17	0.00	**90**
10	0.85	0.93	0.97	0.98	0.97	0.93	0.85	0.75	0.70	0.63	0.49	0.34	0.17	0.00	**80**
20	0.81	0.88	0.93	0.94	0.93	0.88	0.81	0.72	0.66	0.60	0.47	0.32	0.16	0.00	**70**
30	0.75	0.81	0.85	0.87	0.85	0.81	0.75	0.66	0.61	0.56	0.43	0.30	0.15	0.00	**60**
40	0.66	0.72	0.75	0.77	0.75	0.72	0.66	0.59	0.54	0.49	0.38	0.26	0.13	0.00	**50**
50	0.56	0.60	0.63	0.64	0.63	0.60	0.56	0.49	0.45	0.41	0.32	0.22	0.11	0.00	**40**
60	0.43	0.47	0.49	0.50	0.49	0.47	0.43	0.38	0.35	0.32	0.25	0.17	0.09	0.00	**30**
70	0.30	0.32	0.34	0.34	0.34	0.32	0.30	0.26	0.24	0.22	0.17	0.12	0.06	0.00	**20**
80	0.15	0.16	0.17	0.17	0.17	0.16	0.15	0.13	0.12	0.11	0.09	0.06	0.03	0.00	**10**
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**

Remark: $fx = \cos\alpha \cdot \sin\beta + \mu \cdot \sin\alpha$ $fy = \cos\alpha \cdot \cos\beta + \mu \cdot \sin\alpha$

14 The existing text under the heading "Advanced calculation method: calculated example" with the heading are deleted from section 7 and added in as new Appendix 1 to the Annex with modifications as following paragraphs 15 and 16.

15 In new Appendix 1, the words "Advanced calculation method: calculated example" are replaced by the follows:

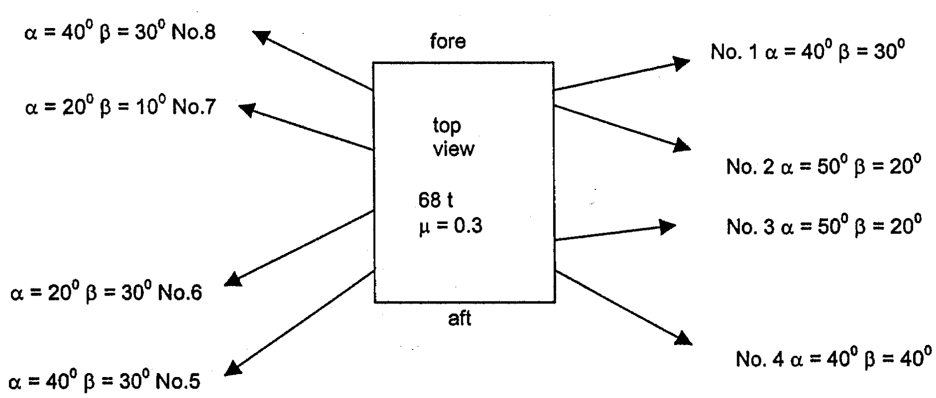
"Calculated example 1
(refer to paragraph 7.2, Balance of forces and moments)"

16 In new Appendix 1, calculated example 2 is added after calculated example 1 as follows:

"Calculated example 2
(refer to paragraph 7.3, Balance of forces – alternative method)

A cargo unit of 68 t mass is stowed on timber (μ = 0.3) in the 'tween deck at 0.7 L of a vessel. L = 160m, B = 24 m, v = 18 kn and GM = 1.5 m. Dimensions of the cargo unit are height = 2.4 m and width = 1.8 m. The external forces are: Fx = 112 kN, Fy = 312 kN, Fz = 346 kN.

The top view shows the overall securing arrangement with eight lashings.



Calculation of balance of forces:

No.	MSL (KN)	CS (KN)	α	β	fy	Cs* fy	fx	Cs* fx
1	108	80	40° stbd	30° fwd	0.86	68.8 stbd	0.58	46.4 fwd
2	90	67	50° stbd	20° aft	0.83	55.6 stdb	0.45	30.2 aft
3	90	67	50° stbd	20° fwd	0.83	55.6 stdb	0.45	30.2 fwd
4	108	80	40° stbd	40° aft	0.78	62.4 stdb	0.69	55.2 aft
5	108	80	40° port	30° aft	0.86	68.8 port	0.58	46.4 aft
6	90	67	20° port	30° aft	0.99	66.3 port	0.57	38.2 aft
7	90	67	20° port	10° fwd	1.03	69.0 port	0.27	18.1 fwd
8	108	80	40° port	30° fwd	0.86	68.8 port	0.58	46.4 fwd

Transverse balance of forces (STBD arrangement) Nos. 1, 2, 3 and 4:

312 < 0.3*68*9.81 + 68.8 + 55.6 + 55.6 + 62.4
312 < 443 this is OK !

Transverse balance of forces (PORT arrangement) Nos. 5, 6, 7 and 8:

312 < 0.3*68*9.81 + 68.8 + 66.3 + 69.0 + 68.8
312 < 473 this is OK!

Longitudinal balance of forces (FWD arrangement) Nos. 1, 3, 7, 8:

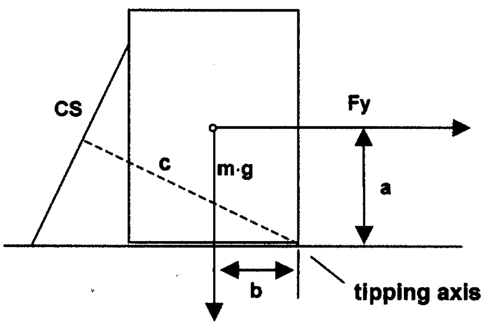
112 < 0.3 (68*9.81 – 346) +) + 46.4 + 30.2 + 18.1 + 46.4
112 < 237 this is OK !

Longitude balance of forces (AFT arrangement) Nos. 2, 4, 5, 6:

112 < 0.3 (68*9.81 – 346) + 30.2 + 55.2 + 46.4 + 38.2
112 <266 this is OK!

Transverse Tipping

Unless specific information is provided, the vertical center of gravity of the cargo unit can be assumed to be at one half the height and the transverse center of gravity at one half the width. Also, if the lashing is connected as shown in the sketch, instead of measuring c, the length of the lever from the tipping axis to the lashing CS, it is conservative to assume that it is equal to the width of the cargo unit.



$$Fy \cdot a \leq b \cdot m \cdot g + 0.9 \cdot (CS_1 \cdot c_1 + CS_2 \cdot c_2 + CS_3 \cdot c_3 + CS_4 \cdot c_4)$$
$$312 \cdot 2.4/2 < 1.8/2 \cdot 68 \cdot 9.81 + 0.9 \cdot 1.8 \cdot (80 + 67 + 67 + 80)$$
$$374 < 600 + 476$$
$$374 < 1076 \quad \text{this is OK !}$$

17 The existing text under the heading "Explanation and interpretation of "Methods of assess the efficiency of securing arrangements for non-standardized cargo" with the heading are deleted from section 7 and added in as new Appendix 2 to the Annex.

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