RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CS Hull Construction and Equipment of Small Ships

Rules for the Survey and Construction of Steel Ships
Part CS 2011 AMENDMENT NO.2
Guidance for the Survey and Construction of Steel Ships
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Rule No.82 / Notice No.90 1st November 2011
Resolved by Technical Committee on 7th July 2011
Approved by Board of Directors on 27th September 2011

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RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part CS Hull Construction and Equipment of Small Ships

2011 AMENDMENT NO.2

Rule No.82 1st November 2011
Resolved by Technical Committee on 7th July 2011
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Rule No.82 1st November 2011
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part CS HULL CONSTRUCTION AND EQUIPMENT OF SMALL SHIPS

Amendment 2-1

Chapter 3 RUDDERS

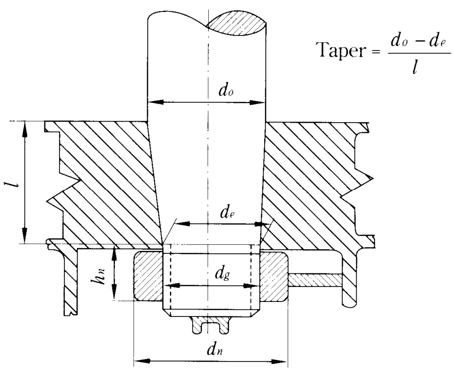
3.8 Couplings between Rudder Stocks and Main Pieces

Paragraph 3.8.2 has been amended as follows.

3.8.2 Cone couplings

1 Cone couplings that are mounted or dismounted without hydraulic arrangements (e.g. oil injection and hydraulic nut) are to be tapered 1:8 ~ 1:12 of the diameter. (*See* **Fig. CS3.4**)

Fig. CS3.4 Cone coupling



The taper length l of rudder stocks fitted into the rudder plate and secured by the slugging nut is generally not to be less than 1.5 *times* the rudder stock diameter d_0 at the top of the rudder. In this case, for couplings between stock and rudder, a key is to be provided. The scantling of the key is to be to the discretion of the Society.

2 The dimensions of the slugging nut as specified in **-1** are to be as follows (*See* **Fig. CS3.4**):

External thread diameter: $d_g \geq 0.65 d_0$ (*mm*)

Length of nut: $h_n \geq 0.6 d_g$ (*mm*)

Outside diameter of nut: $d_n \geq 1.2 d_e$ or $1.5 d_g$ (*mm*), whichever is greater

3 Notwithstanding the provisions in **-1** above, where a key is fitted to couplings between stocks and rudders, and it is considered that rudder torque is transmitted by friction at the couplings, the scantlings of the key as well as push-up force and push-up length are to be at the discretion of the Society .

~~3~~**4** Cone couplings that are mounted or dismounted with hydraulic arrangements (e.g. oil injection and hydraulic nut) are to have a taper on the diameter of 1:12 ~ 1:20 (*See* **Fig. CS3.4**).

The push-up force and the push-up length are to be to the discretion of the Society.

~~4~~**5** The nuts fixing the rudder stocks are to be provided with efficient locking devices.

~~5~~**6** Couplings of rudder stocks are to be properly protected from corrosion.

EFFECTIVE DATE AND APPLICATION(Amendment 2-1)

1. The effective date of the amendments is 1 November 2011.

Amendment 2-2

Chapter 23 EQUIPMENT

23.1 Anchors, Chain Cables and Ropes

Paragraph 23.1.6 has been amended as follow.

23.1.6 Chain Lockers

1 Chain lockers including spurling pipes are to be watertight up to the weather deck and to be provided with a means for drainage.
2 Chain lockers are to be subdivided by centre line screen walls.
3 Where a means of access is provided, it is to be closed by a substantial cover and secured by closely spaced bolts.
4 Where a means of access to spurling pipes or cable lockers is located below the weather deck, the access cover and its securing arrangements are to be to the satisfaction of the Society. Butterfly nuts and/or hinged bolts are prohibited as the securing mechanism for the access cover.
~~4~~5 Spurling pipes through which anchor cables are led are to be provided with permanently attached closing appliances to minimize water ingress.

EFFECTIVE DATE AND APPLICATION (Amendment 2-2)

1. The effective date of the amendments is 1 January 2012.
2. Notwithstanding the amendments to the Rules, the current requirements may apply to ships for which the date of contract for construction* is before the effective date.
   *"contract for construction" is defined in the latest version of IACS Procedural Requirement(PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.
2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
   For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
   (1) such alterations do not affect matters related to classification, or
   (2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
   The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.
3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.
4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Notes:
This Procedural Requirement applies from 1 July 2009.

Amendment 2-3

Chapter 1 GENERAL

1.3 Materials, Scantlings, Welding and End Connections

1.3.2 Scantlings

Sub-paragraph -5 has been added as follows.

1 Section moduli specified by the Rules include the steel plates with an effective breadth of $0.1l$ on either side of the members, unless specified otherwise. However, the $0.1l$ steel plates are not to exceed one-half of the distance to the next member. l is the length of the member specified in the relevant Chapters.

2 Where flat bars, angles or flanged plates are welded to form beams, frames or stiffeners for which section moduli are specified, they are to be of suitable depth and thickness in proportion to the section modulus specified in these Rules.

3 The inside radius of flanged plates is not to be less than twice but not more than three times the thickness of steel plates.

4 The thickness of face plates composing girders and transverses is not to be less than that of web plates and the full width is not to be less than that obtained from the following formula:

$$85.4\sqrt{d_0 l} \quad (mm)$$

d_0 : Depth (m) of girders and transverses specified in the relevant Chapter

l : Distance (m) between supports of girders and transverses specified in the relevant Chapters
However, where effective tripping brackets are provided, they may be taken as supports.

5 Scantlings of stiffeners based on requirements in this Part may be decided based on the concept of grouping designated sequentially placed stiffeners of equal scantlings. The scantling of the group is to be taken as the greater of the values obtained from the following requirements **(1)** and **(2)**. However, this requirement is not applicable to fatigue requirements.

(1) the average of the required scantling of all stiffeners within a group

(2) 90% of the maximum scantling required for any one stiffener within the group.

EFFECTIVE DATE AND APPLICATION (Amendment 2-3)

1. The effective date of the amendments is 1 May 2012.
2. Notwithstanding the amendments to the Rules, the current requirements may apply to ships for which the date of contract for construction is before the effective date.
3. Notwithstanding the provision of preceding **2.**, the amendments to the Rules may apply to ships for which the application is submitted to the Society before the effective date upon request by the owner.

Amendment 2-4

Chapter 1 GENERAL

1.3 Materials, Scantlings, Welding and End Connections

1.3.1 Materials

Table CS1.1 has been amended as follows.

Table CS1.1 Application of Mild Steels for Various Structural Members

Structural member	Application	Thickness of plate : t(*mm*)					
		t≦15	15 <t ≦20	20<t ≦25	25<t ≦30	30<t ≦40	40<t ≦50
(Omitted)							
Cargo Hatch							
Face plate and web of cargo hatch coaming longitudinally extended on the strength deck over 0.15L	within 0.4L amidship	*A*		*B*	*D*		*E*
Hatch cover	—	*A*				*B*	*D*
(Omitted)							

Table CS1.2 has been amended as follows.

Table CS1.2 Application of High Tensile Steels for Various Structural Members

Structural member	Application	Thickness of plate : t(*mm*)					
		t≦15	15 <t ≦20	20<t ≦25	25<t ≦30	30<t ≦40	40<t ≦50
(Omitted)							
Cargo Hatch							
Face plate and web of cargo hatch coaming longitudinally extended on the strength deck over 0.15L	within 0.4L amidship	*AH*			*DH*		*EH*
Hatch cover	—	*AH*					*DH*
(Omitted)							

(Notes)
(Omitted)

Chapter 19 HATCHWAYS, MACHINERY SPACE OPENINGS AND OTHER DECK OPENINGS

19.1 General

Paragraph 19.1.3 has been amended as follows.

19.1.3 Renewal Thickness for Ship in Operation

The structural drawings for hatch covers and hatch coamings complying with the requirements of **19.2** are to indicate the renewal thickness ($t_{renewal}$) for each structural element given by the following formula in addition to the as built thickness ($t_{as\text{-}built}$). If the thickness for voluntary addition is included in the as built thicknesses, the value may be at the discretion of the Society.

$t_{renewal}=t_{as\text{-}built} - t_c + 0.5$ (mm)

t_c: Corrosion additions specified in **Table CS19.1~~ and 19.2.3-1~~**

Where corrosion addition t_c is 1.0 (mm), renewal thickness may be given by the formula

$t_{renewal} = t_{as\text{-}built} - t_c$ (mm)

Section 19.2 has been amended as follows.

19.2 Hatchways

~~19.2.1 Application~~

~~(omitted)~~

~~19.2.2 Height of Hatchway Coamings~~

~~(omitted)~~

~~19.2.3 Construction of Hatchway Coamings~~

~~(omitted)~~

~~19.2.4 Portable Beams, Hatchway Covers, Steel Pontoon Covers and Steel Weathertight Covers~~

~~(omitted)~~

~~19.2.5 Additional Requirements for Steel Hatch Covers Carrying Cargoes~~

~~(omitted)~~

~~19.2.6 Special Requirements for Portable Beams, Hatchway Covers, Steel Pontoon Covers and Steel Weathertight Covers~~

~~(omitted)~~

~~19.2.7 Tarpaulins and Securing Arrangements for Hatchways Closed by Portable Covers~~

~~(omitted)~~

~~19.2.8 Steel Hatchway Covers of Deep Tanks~~

~~(omitted)~~

~~19.2.9 Additional Requirement for Small Hatches Fitted on Exposed Fore Deck~~
~~(omitted)~~

19.2.1 Application

1 The construction and the means for closing of cargo and other hatchways are to comply with the requirements in **19.2**.
2 Notwithstanding the provisions in this paragraph, the construction and means for closing of cargo and other hatchways of bulk carriers defined in **1.3.1(13), Part B of the Rules** and ships intended to be registered as "bulk carriers" are to be at the discretion of the Society.
3 When the loading condition or the type of construction differs from that specified in this section, the calculation method used is to be as deemed appropriate by the Society.

19.2.2 General Requirement

1 Primary supporting members and secondary stiffeners of hatch covers are to be continuous over the breadth and length of hatch covers. When this is impractical, appropriate arrangements are to be adopted to ensure sufficient load carrying capacity and sniped end connections are not to be allowed.
2 The spacing of primary supporting members parallel to the direction of secondary stiffeners is not to exceed 1/3 of the span of the primary supporting members.
3 Secondary stiffeners of hatch coamings are to be continuous over the breadth and length of said hatch coamings.

19.2.3 Net Scantling Approach

1 Unless otherwise specified, the structural scantlings specified in this section are to be net scantlings which do not include any corrosion additions.
2 "Net scantlings" are the scantlings necessary to obtain the minimum net scantlings required by **19.2.5** and **19.2.9**.
3 Required gross scantlings are not to be less than the scantlings obtained from adding the corrosion addition t_c specified in **-4** below to the net scantlings obtained from the requirements in this section.
4 The corrosion addition t_c is to be taken as specified in **Table CS19.1** according to ship type, the type of structure and structural members of steel hatchway covers, steel pontoon covers and steel weathertight covers (hereinafter referred to as "steel hatch covers").
5 Strength calculations using beam theory, grillage analysis or FEM are to be performed with net scantlings.

Table CS19.1 Corrosion Additions

Type of ship	Type of structural member		Corrosion addition t_c (mm)
Container carriers and car carriers	Steel hatch covers		1.0
	Hatchway coamings		1.5
Ships other than those specified above and subject to the application of this section	Single plating type hatch cover		2.0
	Double plating type hatch cover	Top, side and bottom plating	1.5
		Internal structures	1.0
	Hatchway coamings		1.5

19.2.4 Design Load for Steel Hatch Covers, Portable Beams and Hatchway Coamings

The design loads for steel hatchway covers, steel pontoon covers, steel weathertight covers, portable beams and hatchway coamings applying the requirements in **19.2** are specified in following **(1)** to **(5)**:

(1) Design vertical wave load P_V (kN/m^2) is not to be less than that obtained from **Table CS19.2**. Design vertical wave loads need not to be combined with cargo loads according to **(3)** and **(4)** simultaneously.

Table CS19.2 Design Vertical Wave Load P_V (*1) (*2) (kN/m^2)

		P_V (kN/m^2)
Position I	For 0.25 L_f forward	$\frac{9.81}{76}\left\{(4.28L_f+28)\frac{x}{L_f}-1.71L_f+95\right\}$ (*3)
	Elsewhere	$\frac{9.81}{76}(1.5L_f+116)$
Position II		$\frac{9.81}{76}(1.1L_f+87.6)$

Notes:

(*1) L_f: length of ship for freeboard defined in **2.1.3**, **Part A** of the Rules (m)

x : distance of the mid length of the hatch cover under examination from the aft end of L_f (m)

(*2) For exposed hatchways in positions other than Position I or II, the value of each design wave load will be specially considered.

(*3) Where a Position I hatchway is located at least one superstructure standard height higher than the freeboard deck, P_V may be taken as $\frac{9.81}{76}(1.5L_f+116)$ (kN/m^2).

(2) Design horizontal wave load P_H (kN/m^2) is not to be less than that obtained from the following formulae. However, P_H is not to be taken less than the minimum values given in **Table CS19.3**.

$$P_H = ac(bC_1 - y)$$

a: As given by the following:

$20+\frac{L'}{12}$ for unprotected front coamings and hatch cover skirt plates

$10+\frac{L'}{12}$ for unprotected front coamings and hatch cover skirt plates, where the distance from the actual freeboard deck to the summer load line exceeds the minimum non-corrected tabular freeboard according to the ILCC by at least one superstructure standard height

$5+\frac{L'}{15}$ for side and protected front coamings and hatch cover skirt plates

$7+\frac{L'}{100}-8\frac{x}{L_1}$ for aft ends of coamings and aft hatch cover skirt plates abaft amidships

$5+\frac{L'}{100}-4\frac{x}{L_1}$ for aft ends of coamings and aft hatch cover skirt plates forward of amidships

L': Length of ship L_1 (m)

L_1: Length of ship specified in **2.1.2, Part A** of the Rules (m). However, L_1 need not to be greater than 97% of the total length on the summer load waterline.

C_1: As given by the following formula:

$$C_1 = 10.75 - \left(\frac{300 - L_1}{100}\right)^{1.5}$$

c_L: Coefficient to be taken as 1.0

b: As given by the following formulae:

$$1.0 + \left(\frac{0.45 - \frac{x}{L_1}}{C_{b1} + 0.2}\right)^2 \quad \text{for } \frac{x}{L_1} < 0.45$$

$$1.0 + 1.5\left(\frac{\frac{x}{L_1} - 0.45}{C_{b1} + 0.2}\right)^2 \quad \text{for } \frac{x}{L_1} \geq 0.45$$

x: Distance (m) from the hatchway coamings or hatch cover skirt plates to after perpendicular, or distance from mid-point of the side hatchway coaming or hatch cover skirt plates to after perpendicular. However, where the length of the side hatchway coaming or hatch cover skirt plates exceeds $0.15L_1$, the side hatchway coaming or hatch cover skirt plates are to be equally subdivided into spans not exceeding $0.15L_1$ and the distance from the mid-point of the subdivisions to the after perpendicular is to be taken.

C_{b1}: Block coefficient. However, where C_b is 0.6 or under, C_{b1} is to be taken as 0.6 and where C_b is 0.8 and over, C_{b1} is to be taken as 0.8. When determining scantlings of the aft ends of coamings and aft hatch cover skirt plates forward of amidships, C_{b1} does not need to be taken as less than 0.8.

c: As given by the following formula. However, where $\frac{b'}{B'}$ is less than 0.25, $\frac{b'}{B'}$ is to be taken as 0.25.

$$0.3 + 0.7\frac{b'}{B'}$$

b': Breadth (m) of hatchway coamings at the position under consideration

B': Breadth (m) of ship on the exposed weather deck at the position under consideration

y: Vertical distance (m) from the designed maximum load line to the mid-point of the span of stiffeners when determining the scantlings of stiffeners and to the mid-point of the plating when determining the thickness of plating

Table CS19.3 Minimum Value of P_H (kN/m^2)

Unprotected front coamings and hatch cover skirt plates	others
$25 + \frac{L_1}{10}$	$12.5 + \frac{L_1}{20}$

(3) The load on hatch covers due to cargo loaded on said covers is to be obtained from the following **(a)** and **(b)**. Load cases with partial loading are also to be considered.

(a) Distributed load due to cargo load P_{cargo} (kN/m^2) resulting from heave and pitch is to be determined according to the following formula:

$$P_{cargo} = P_C(1 + a_V)$$

P_C: Static uniform cargo load (kN/m^2)

a_V: Acceleration addition given by the following formula:

$$a_V = \frac{0.11mV'}{\sqrt{L_1}}$$

m: As given by the following formulae:

$$m_0 - 5(m_0 - 1)\frac{x}{L_1} \quad \text{for } 0 \le \frac{x}{L_1} \le 0.2$$

$$1.0 \quad \text{for } 0.2 < \frac{x}{L_1} \le 0.7$$

$$1 + \frac{m_0 + 1}{0.3}\left(\frac{x}{L_1} - 0.7\right) \quad \text{for } 0.7 < \frac{x}{L_1} \le 1.0$$

m_0: As given by the following formula:

$$m_0 = 1.5 + \frac{0.11V'}{\sqrt{L_1}}$$

V': Speed of ship (*knots*) specified in **2.1.8, Part A** of the Rules. However, where V' is less than $\sqrt{L_1}$, V' is to be taken as $\sqrt{L_1}$.

x and L_1: As specified in **(2)** above

(b) Point load F_{cargo} (kN) due to a single force resulting from heave and pitch (e.g. in the case of containers) is to be determined by the following formula. When the load case of a partially loaded container is considered, the point load is at the discretion of the Society.

$$F_{cargo} = F_S(1 + a_V)$$

F_S: Static point load due to cargo (kN)

a_V: As specified in **(a)** above

(4) Where containers are stowed on hatch covers, cargo loads determined by following **(a)** and **(b)** are to be considered:

(a) Cargo loads (kN) due to heave, pitch and roll motion of the ship determined by the following formulae are to be considered (see **Fig. CS19.1**). When the load case of a partially loaded container is considered, the cargo load is at the discretion of the Society.

$$A_Z = 9.81\frac{M}{2}(1 + a_V)\left(0.45 - 0.42\frac{h_m}{b}\right)$$

$$B_Z = 9.81\frac{M}{2}(1 + a_V)\left(0.45 + 0.42\frac{h_m}{b}\right)$$

$$B_Y = 2.4M$$

M: Maximum designed mass of container stack (t)

h_m: Design height of the centre of gravity of the stack above hatch cover supports (m)

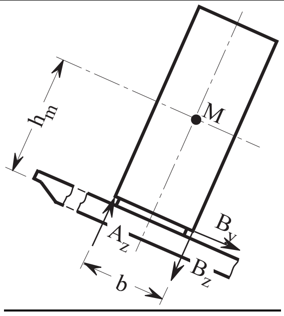
b: Distance between foot points (m)

A_Z and B_Z: Support forces in vertical direction at the forward and aft stack corners (kN)

B_Y: Support force in transverse direction at the forward and aft stack corners (kN)

a_V: As specified in **(3)** above

Fig. CS19.1 Forces due to Container Loads



(b) Details of the application of **(a)** above are to be in accordance with the following:

i) For the maximum design mass of container stack M and the design height of the centre of gravity of the stack above hatch cover supports h_m, it is recommended to apply the values which are used for the calculations of cargo securing (container lashing). If different assumptions are made for M and h_m, sufficient data which show that the hatch cover structure is not loaded by less than the recommended values is to be submitted.

ii) When the strength of a hatch cover structure is assessed by FEM analysis using shell or plane strain elements, h_m may be taken as the design height of the centre of gravity of the stack above the hatch cover top plate.

iii) The values of M and h_m applied for the assessment of hatch cover strength are to be shown in the drawings of the hatch covers.

iv) In the case of container stacks secured to lashing bridges or carried in cell guides, the forces acting on the hatch covers may be specially considered by the Society.

v) Container loads may be applied based on accelerations calculated by an individual acceleration analysis for the lashing system being used as deemed appropriate by the Society.

(5) In addition to the loads specified in **(1)** to **(4)** above, when the load in the ship's transverse direction by forces due to elastic deformation of the ship's hull is acting on the hatch covers, the sum of stresses is to comply with the permissible values specified in **19.2.5-1(1)**.

19.2.5 Strength Criteria of Steel Hatch Covers and Hatch Beams

1 Permissible stresses and deflections

(1) The equivalent stress σ_E (N/mm^2) in steel hatchway covers and steel weathertight covers are to be complied with the criteria as following **(a)** and **(b)**:

(a) For beam element calculations and grillage analysis:

$$\sigma_E = \sqrt{\sigma^2 + 3\tau^2} \le 0.8\sigma_F$$

σ : Nominal stress (N/mm^2)

τ : Shear stress (N/mm^2)

σ_F : Minimum upper yield stress (N/mm^2) or proof stress (N/mm^2) of the material. However, when material with a σ_F of more than 355 N/mm^2 is used, the value for σ_F is to be taken as deemed appropriate by the Society.

(b) For FEM calculations, in cases where the calculations use shell or plane strain elements, the stresses are to be taken from the centre of the individual element.

$\sigma_E = \sqrt{\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau^2} \le 0.8\sigma_F$ when assessed using the design load specified in

19.2.4(1)

$\sigma_E = \sqrt{\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau^2} \le 0.9\sigma_F$ when assessed using any other design loads

σ_x: Normal stress (N/mm^2) in the x-direction

σ_y: Normal stress (N/mm^2) in the y-direction

τ: Shear stress (N/mm^2) in the x-y plane

x, y: Coordinates of a two dimensional Cartesian system in the plane of the considered structural element

σ_F: As specified in **(a)** above

(2) The equivalent stress σ_E (N/mm^2) in steel pontoon covers and hatch beams is not to be greater than $0.68\sigma_F$, where σ_F is as specified in **(1)** above.

(3) Deflection is to comply with following **(a)** and **(b)**:

(a) When the design vertical wave load specified in **19.2.4(1)** is acting on steel hatchway covers, steel pontoon covers, steel weathertight covers and portable beams, the vertical deflection of primary supporting members is not to be taken as more than that given by the following:

$0.0056l$ for steel hatchway covers and steel weathertight covers

$0.0044l$ for steel pontoon covers and hatch beams

l: Span of primary supporting members (m)

(b) Where hatch covers are arranged for carrying containers and mixed stowage is allowed, i.e., a 40-foot container is stowed on top of two 20-foot containers, particular attention is to be paid to the deflections of hatch covers. In addition the possible contact of deflected hatch covers with in hold cargo has to be observed.

2 Local net plate thickness of steel hatch covers

(1) The local net thickness t_{net} (mm) of steel hatch cover top plating is not to be less than that obtained from the following formula, and it is not to be less than 1% of the spacing of the stiffeners or 6 mm, whichever is greater:

$$t_{net} = 15.8 F_p S \sqrt{\frac{P_{HC}}{0.95\sigma_F}}$$

F_p: Coefficient given by the following formula:

$1.9\,\sigma/\sigma_a$ (for $\sigma/\sigma_a \ge 0.8$, for the attached plate flange of primary supporting members)

1.5 (for $\sigma/\sigma_a < 0.8$, for the attached plate flange of primary supporting members)

σ: Normal stress (N/mm^2) of the attached plate flange of primary supporting members. The normal σ may be determined at a distance S from the webs of adjacent primary supporting members perpendicular to secondary stiffeners and at a distance $S/2$ from the web of an adjacent primary supporting member parallel to secondary stiffeners, whichever is greater (see Fig. **CS19.2**). The distribution of normal stress σ between two parallel girders is to be in accordance with **19.2.5-6.(3)(c)**.

σ_a: Permissible stress (N/mm^2) is to be as given by following formula:

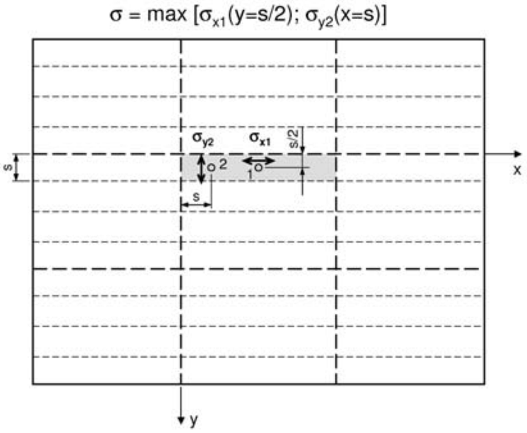
$$\sigma_a = 0.8\sigma_F$$

S: Stiffener spacing (m)

P_{HC}: Design load (kN/m^2) specified in **19.2.4(1)** and **19.2.4(3)(a)**

σ_F : Minimum upper yield stress (N/mm^2) or proof stress (N/mm^2) of the material

Fig. CS19.2 Determination of the Normal Stress of Hatch Cover Plating



(2) The net thickness of double skin hatch covers and box girders is to be obtained in accordance with 5 below taking into consideration of the permissible stresses specified in **19.2.5-1(1)**.

(3) In addition to **(2)** above, when the lower plating of double skin hatch covers is taken into account as a strength member of the hatch cover, the net thickness t_{net} (mm) of the lower plating is not to be less than that obtained from following formulae:

$$t_{net} = 6.5S$$

$$t_{net} = 5$$

S: As specified in **(1)** above

(4) When lower plating is not considered to be a strength member of the hatch cover, the thickness of the lower plating is to be determined as deemed appropriate by the Society.

3 Net scantling of secondary stiffeners

(1) The net section modulus Z_{net} (cm^3) of the secondary stiffeners of hatch cover top plates, based on stiffener net member thickness, is not to be less than that obtained from the following formula. The net section modulus of the secondary stiffeners is to be determined based on an attached plate width that is assumed to be equal to the stiffener spacing.

$$Z_{net} = \frac{104 S P_{HC} l^2}{\sigma_F}$$

l: Secondary stiffener span (m) is to be taken as the spacing of primary supporting members or the distance between a primary supporting member and the edge support, as applicable.

S: Stiffener spacing (m)

P_{HC}: Design load (kN/m^2) as specified in **-2(1)** above

σ_F : Minimum upper yield stress (N/mm^2) or proof stress (N/mm^2) of the material

(2) The net shear sectional area A_{net} (cm^2) of the secondary stiffener webs of hatch cover top plates is not to be less than that obtained from the following formula:

$$A_{net} = \frac{10 S P_{HC} l}{\sigma_F}$$

l, S and P_{HC}: As specified in **(1)** above

(3) For flat bar secondary stiffeners and buckling stiffeners, the following formula is to be applied:

$$\frac{h}{t_{W,net}} \leq 15\sqrt{k}$$

h: Height (mm) of the stiffener

$t_{W,net}$: Net thickness (mm) of the stiffener

$k = 235/\sigma_F$

σ_F: As specified in **(1)** above

(4) Stiffeners parallel to primary supporting members and arranged within the effective breadth according to **19.2.5-5(2)** are to be continuous at crossing primary supporting member and may be regarded for calculating the cross sectional properties of primary supporting members.

(5) The combined stress of those stiffeners induced by the bending of primary supporting members and lateral pressures is not to exceed the permissible stresses according to **19.2.5-1(1)**.

(6) For hatch cover stiffeners under compression, sufficient safety against lateral and torsional buckling according to **19.2.5-6(3)** is to be verified.

4 Primary supporting members of steel hatch covers and hatch beams

(1) The scantlings of the primary supporting members of steel hatch covers and hatch beams are to be determined according to **-5** below taking into consideration the permissible stresses specified in **19.2.5-1(1)**.

(2) The scantlings of the primary supporting members of steel hatch covers and hatch beam with variable cross-sections are to be not less than that obtained from the following formulae. For steel hatchway covers, *S* and *l* are to be read as *b* and *S*, respectively.

The net section modulus (cm^3) of hatch beams or primary supporting members at the mid-point

$$Z_{net} = Z_{net\_cs}$$

$$Z_{net} = k_1 Z_{net\_cs}$$

The net moment of inertia (cm^4) of hatch beams or primary supporting members at the mid-point

$$I_{net} = I_{net\_cs}$$

$$I_{net} = k_2 I_{net\_cs}$$

Z_{net_cs}: Net section modulus (cm^3) complying with requirement **(1)** above

I_{net_cs}: Net moment of inertia (cm^4) complying with requirement **(1)** above

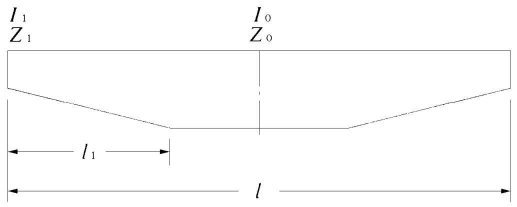
S: Spacing (m) of portable beams or primary supporting members

l: Unsupported span (m) of portable beams or primary supporting members

b: Width (m) of steel hatch covers

k_1 and k_2: Coefficients obtained from the formulae given in **Table CS19.4**

Table CS19.4　　Coefficient k_1 and k_2

$\boldsymbol{k_1}$	$1+\dfrac{3.2\alpha-\gamma-0.8}{7\gamma+0.4}$	k_1 is not to be taken as less than 1.0 $\alpha=\dfrac{l_1}{l}$　$\beta=\dfrac{I_1}{I_0}$　$\gamma=\dfrac{Z_1}{Z_0}$
$\boldsymbol{k_2}$	$1+8\alpha^3\dfrac{1-\beta}{0.2+3\sqrt{\beta}}$	
l = Overall length of portable beam (m) l_1 = Distance from the end of parallel part to the end of portable beam (m) I_0 = Moment of inertia at mid-span (cm^4) I_1 = Moment of inertia at ends (cm^4) Z_0 = Section modulus at mid-span (cm^3) Z_1 = Section modulus at ends (cm^3) 		

(3) In addition to **(1)** and **(2)** above, the scantlings of the primary supporting members of steel hatch cover are to comply with the requirements specified in **-6**.

(4) When biaxial compressed flange plates are considered, the effective width of flange plates is to comply with **19.2.5-6(3)**.

(5) In addition to **(1)** to **(4)** above, net thickness t_{net} (mm) of the webs of primary supporting members is not to be less than that obtained from the following formulae, whichever is greater:

$$t_{net}=6.5S$$

$$t_{net}=5$$

S: Stiffener spacing (m)

(6) In addition to **(1)** to **(5)** above, the net thickness t_{net} (mm) of edge girders exposed to sea wash is not to be less than that obtained from the following formulae, whichever is greater:

$$t_{net}=15.8S\sqrt{\frac{P_H}{0.95\sigma_F}}$$

$$t_{net}=8.5S$$

P_H:　Design horizontal wave load (kN/m^2) as specified in **19.2.4(2)**

S:　Stiffener spacing (m)

σ_F : Minimum upper yield stress (N/mm^2) or proof stress (N/mm^2) of the material

(7) The moment of inertia (cm^4) of the edge elements of hatch covers is not to be less than that obtained from the following formula:

$$I=6pa^4$$

a: Maximum of the distance (m), a_i, between two consecutive securing devices, measured along the hatch cover periphery, not to be taken as less than $2.5a_C$ (m), (see **Fig. CS19.3**)

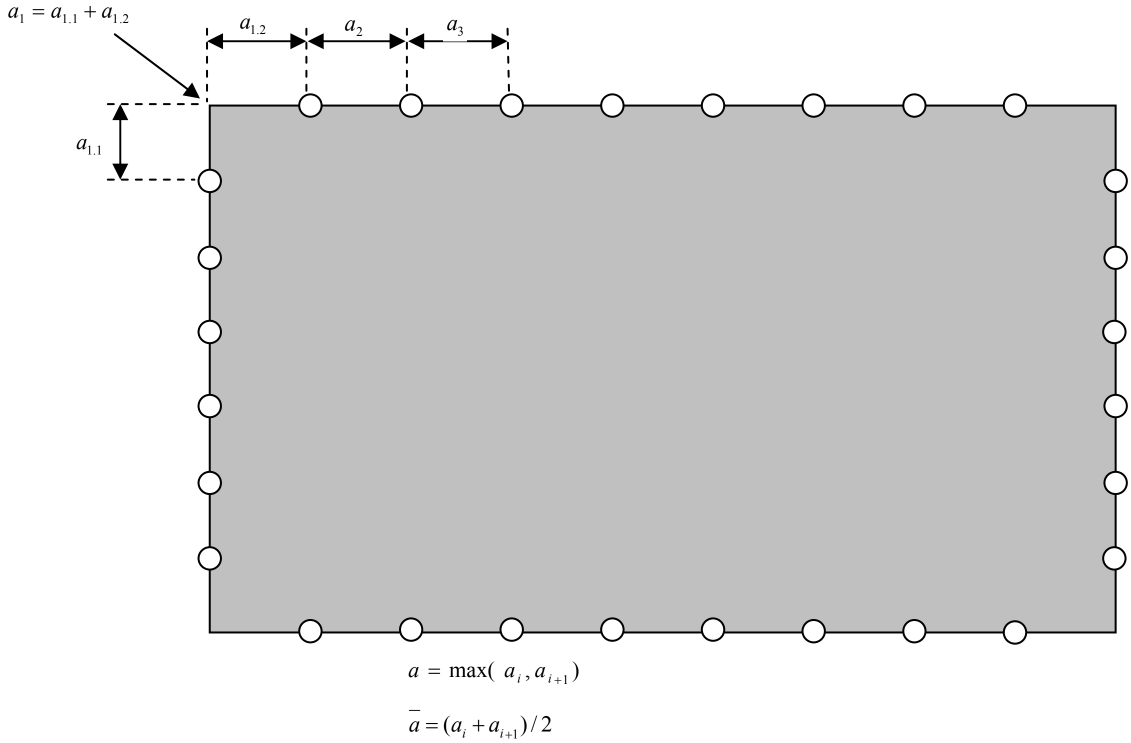
a_C : $\max(a_{1.1}, a_{1.2})$ (m) (see **Fig. CS19.3**)

p: Packing line pressure (N/mm), minimum 5 N/mm

When calculating the actual gross moment of inertia of the edge element, the effective breadth of the attached plating of hatch covers is to be taken as equal to the lesser of the following values:

0.165*a*
Half the distance between the edge element and the adjacent primary member

Fig. CS19.3 Distance between Securing Devices, Measured Along Hatch Cover Periphery



5 Strength calculation

(1) Strength calculation for steel hatch covers may be carried out by either using beam theory, grillage analysis or FEM. Net scantlings are to be used for modeling.

(2) Effective cross-sectional properties for calculation by beam theory or grillage analysis are to be determined by the following **(a)** to **(e)**:

(a) The effective breadth of attached plating e_m of the primary supporting members specified in **Table CS19.5** according to the ratio of l and e is to be considered for the calculation of effective cross-sectional properties. For intermediate values of l/e, e_m is to be obtained by linear interpolation.

(b) Separate calculations may be required for determining the effective breadth of one-sided or non-symmetrical flanges.

(c) The effective cross sectional areas of plates is not to be less than the cross sectional area of the face plate.

(d) The cross sectional area of secondary stiffeners parallel to the primary supporting member under consideration within the effective breadth may be included in the calculations (see **Fig. CS19.5**).

(e) For flange plates under compression with secondary stiffeners perpendicular to the web of the primary supporting member, the effective width is to be determined according to **19.2.5-6(3)**.

Table CS19.5 Effective Breadth e_m of Plating of Primary Supporting Members

l/e	0	1	2	3	4	5	6	7	8 and over
e_{m1}/e	0	0.36	0.64	0.82	0.91	0.96	0.98	1.00	1.00
e_{m2}/e	0	0.20	0.37	0.52	0.65	0.75	0.84	0.89	0.90

(Notes)

e_{m1}: Effective breadth (*mm*) to be applied where primary supporting members are loaded by uniformly distributed loads or by not less than 6 equally spaced single loads

e_{m2}: Effective breadth (mm) to be applied where primary supporting members are loaded by 3 or less single loads

l: Length between zero-points of bending moment curve taken equal to:
For simply supported primary supporting members : l_0
For primary supporting members with both ends constant : $0.6l_0$

l_0: Unsupported length of the primary supporting members

e: Width of plating supported, measured from centre to centre of the adjacent unsupported fields

(3) General requirements for FEM are as follows:

(a) The structural model is to be able to reproduce the behaviour of the structure with the highest possible fidelity. Stiffeners and primary supporting members subject to pressure loads are to be included in the modelling. However, buckling stiffeners may be disregarded for stress calculation.

(b) Net scantlings which exclude corrosion additions are to be used for modeling.

(c) Element size is to be suitable to take effective breadth into account.

(d) In no case is element width to be larger than stiffener spacing. The ratio of element length to width is not to exceed 4.

(e) The element height of the webs of primary supporting members is not to exceed one-third of the web height.

6 Buckling strength of steel hatch covers

The buckling strength of the structural members of steel hatch covers is to be in accordance with the following **(1)** to **(3)**:

(1) The buckling strength of a single plate panel of the top and lower steel hatch cover plating is to comply with following formulae:

$$\left(\frac{|\sigma_x| C_{sf}}{\kappa_x \sigma_F}\right)^{e_1} + \left(\frac{|\sigma_y| C_{sf}}{\kappa_y \sigma_F}\right)^{e_2} - B\left(\frac{\sigma_x \sigma_y C_{sf}^2}{\sigma_F^2}\right) + \left(\frac{|\tau| C_{sf}\sqrt{3}}{\kappa_\tau \sigma_F}\right)^{e_3} \leq 1.0$$

$$\left(\frac{\sigma_x C_{sf}}{\kappa_x \sigma_F}\right)^{e_1} \leq 1.0$$

$$\left(\frac{\sigma_y C_{sf}}{\kappa_y \sigma_F}\right)^{e_2} \leq 1.0$$

$$\left(\frac{|\tau| C_{sf}\sqrt{3}}{\kappa_\tau \sigma_F}\right)^{e_3} \leq 1.0$$

σ_x, σ_y: Membrane stress in the *x*-direction and the *y*-direction (N/mm^2). In cases where the stresses are obtained from FEM and already contain the Poisson-effect, the following modified stress values may be used. Both stresses σ_x^* and σ_y^* are to be compressive stress in order to apply stress reduction according to the following formulae:

$$\sigma_x = \left(\sigma_x^* - 0.3\sigma_y^*\right)/0.91$$

$$\sigma_y = \left(\sigma_y^* - 0.3\sigma_x^*\right)/0.91$$

σ_x^* and σ_y^*: Stresses containing the Poisson-effect. These values are to comply with the following formulae:

$$\sigma_y = 0 \text{ and } \sigma_x = \sigma_x^* \quad \text{for } \sigma_y^* < 0.3\sigma_x^*$$

$$\sigma_x = 0 \text{ and } \sigma_y = \sigma_y^* \quad \text{for } \sigma_x^* < 0.3\sigma_y^*$$

τ : Shear stress (N/mm^2) in x-y plane

σ_F : Minimum yield stress (N/mm^2) of the material.

Compressive and shear stresses are to be taken as positive values and tension stresses are to be taken as negative values.

C_{sf}: Safety factor taken as equal to:

C_{sf} = 1.25 for hatch covers when subjected to design vertical wave loads according to **19.2.4(1)**

C_{sf} = 1.10 for hatch covers when subjected to loads according to **19.2.4(2)** to **(5)**

F_1: Correction factor for the boundary condition of stiffeners on the longer side of elementary plate panels according to **Table CS19.6**

e_1, e_2, e_3 and B: Coefficient obtained from **Table CS19.7**

κ_x, κ_y and κ_τ : Reduction factor obtained from **Table CS19.8**. However, these values are to comply with the following formulae:

$$\kappa_x = 1.0 \quad \text{for } \sigma_x \le 0 \text{ (tension stress)}$$

$$\kappa_y = 1.0 \quad \text{for } \sigma_y \le 0 \text{ (tension stress)}$$

a: Length (mm) of the longer side of the partial plate field (x-direction)

b: Length (mm) of the shorter side of the partial plate field (y-direction)

n: Number of the elementary plate panel breadths within the partial or total plate panel (see **Fig. CS19.4**)

α : Aspect ratio of a single plate field obtained from the following formula:

$$\alpha = \frac{a}{b}$$

λ : Reference degree of slenderness, taken as equal to:

$$\lambda = \sqrt{\frac{\sigma_F}{K\sigma_e}}$$

K: Buckling factor according to **Table CS19.8**

σ_e: Reference stress (N/mm^2), taken as equal to:

$$\sigma_e = 0.9E\left(\frac{t}{b}\right)^2$$

E: Modulus of elasticity (N/mm^2) of the material, taken equal to:

$$E = 2.06 \times 10^5$$

t: Net thickness (mm) of plate under consideration

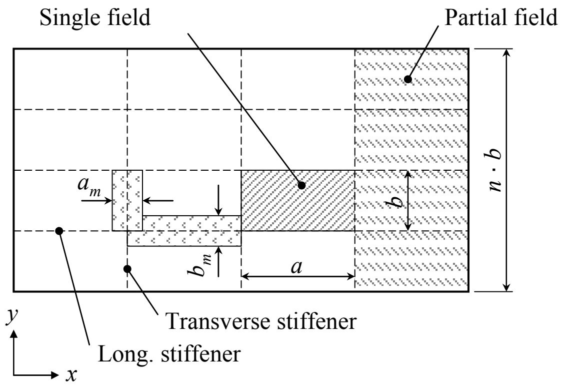
ψ : Edge stress ratio taken as equal to:

$$\psi = \frac{\sigma_2}{\sigma_1}$$

σ_1 : Maximum compressive stress (N/mm^2)

σ_2 : Minimum compressive stress or tension stress (N/mm^2)

Fig. CS19.4 General Arrangement of Panels



Longitudinal : stiffener in the direction of the length a
Transverse : stiffener in the direction of the breath b

Table CS19.6 Correction Factor F_1

Boundary condition	F_1 (2)	Edge stiffener
Stiffeners sniped at both ends	1.00	
Guidance value(1) where both ends are effectively connected to adjacent structures	1.05	Flat bars
	1.10	Bulb sections
	1.20	Angles and tee-sections
	1.30	U-type sections(3) and girders of high rigidity

(1) Exact values may be determined by direct calculations
(2) An average value of F_1 is to be used for plate panels having different edge stiffeners
(3) A higher value may be taken if it is verified by a buckling strength check of the partial plate field using non-linear FEA and deemed appropriate by the Society. However, such values are not to be greater than 2.0

Table CS19.7 Coefficient e_1, e_2, e_3 and B

Exponents e_1, e_2, e_3 and B		Plate panel
e_1		$1+\kappa_x^4$
e_2		$1+\kappa_y^4$
e_3		$1+\kappa_x\kappa_y\kappa_\tau^2$
B	For σ_x and σ_y positive (compressive stress)	$(\kappa_x\kappa_y)^5$
	For σ_x or σ_y negative (tension stress)	1

Table CS19.8 Buckling and Reduction Factors for Plane Elementary Plate Panels

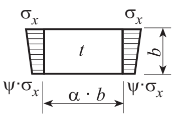
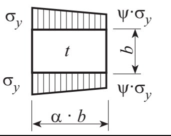
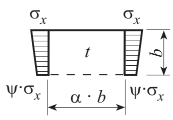
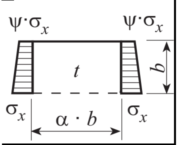
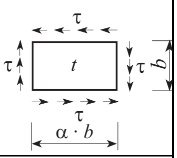
Load case	Edge stress ratio ψ	Aspect ratio $\alpha = a/b$	Buckling factor K	Reduction factor κ
1 	$1 \ge \psi \ge 0$	$\alpha \ge 1$	$K = \frac{8.4}{\psi + 1.1}$	$\kappa_x = 1$ for $\lambda \le \lambda_c$ $\kappa_x = c\left(\frac{1}{\lambda} - \frac{0.22}{\lambda^2}\right)$ for $\lambda > \lambda_c$ $c = (1.25 - 0.12\psi) \le 1.25$ $\lambda_c = \frac{c}{2}\left(1 + \sqrt{1 - \frac{0.88}{c}}\right)$
	$0 > \psi > -1$		$K = 7.63 - \psi(6.26 - 10\psi)$	
	$\psi \le -1$		$K = 5.975(1-\psi)^2$	
2 	$1 \ge \psi \ge 0$	$\alpha \ge 1$	$K = F_1\left(1 + \frac{1}{\alpha^2}\right)^2 \frac{2.1}{(\psi + 1.1)}$	$\kappa_y = c\left(\frac{1}{\lambda} - \frac{R + F^2(H - R)}{\lambda^2}\right)$ $c = (1.25 - 0.12\psi) \le 1.25$ $R = \lambda\left(1 - \frac{\lambda}{c}\right)$ for $\lambda < \lambda_c$ $R = 0.22$ for $\lambda \ge \lambda_c$ $\lambda_c = \frac{c}{2}\left(1 + \sqrt{1 - \frac{0.88}{c}}\right)$ $F = \left(1 - \frac{\frac{K}{0.91} - 1}{\lambda_p^2}\right) c_1 \ge 0$ $\lambda_p^2 = \lambda^2 - 0.5$ for $1 \le \lambda_p^2 \le 3$ $c_1 = \left(1 - \frac{F_1}{\alpha}\right) \ge 0$ $H = \lambda - \frac{2\lambda}{c\left(T + \sqrt{T^2 - 4}\right)} \ge R$ $T = \lambda + \frac{14}{15\lambda} + \frac{1}{3}$
	$0 > \psi > -1$	$1 \le \alpha \le 1.5$	$K = F_1\left[\left(1 + \frac{1}{\alpha^2}\right)^2 \frac{2.1(1+\psi)}{1.1} - \frac{\psi}{\alpha^2}(13.9 - 10\psi)\right]$	
		$\alpha > 1.5$	$K = F_1\left[\left(1 + \frac{1}{\alpha^2}\right)^2 \frac{2.1(1+\psi)}{1.1} - \frac{\psi}{\alpha^2}\left(5.87 + 1.87\alpha^2 + \frac{8.6}{\alpha^2} - 10\psi\right)\right]$	
	$\psi \le -1$	$1 \le \alpha \le \frac{3(1-\psi)}{4}$	$K = 5.975 F_1\left(\frac{1-\psi}{\alpha}\right)^2$	
		$\alpha > \frac{3(1-\psi)}{4}$	$K = F_1\left[3.9675\left(\frac{1-\psi}{\alpha}\right)^2 + 0.5375\left(\frac{1-\psi}{\alpha}\right)^4 + 1.87\right]$	
3 	$1 \ge \psi \ge 0$	$\alpha > 0$	$K = \frac{4\left(0.425 + \frac{1}{\alpha^2}\right)}{3\psi + 1}$	$\kappa_x = 1$ for $\lambda \le 0.7$ $\kappa_x = \frac{1}{\lambda^2 + 0.51}$ for $\lambda > 0.7$
	$0 > \psi > -1$		$K = 4\left(0.425 + \frac{1}{\alpha^2}\right)(1+\psi) - 5\psi(1 - 3.42\psi)$	
4 	$1 \ge \psi \ge -1$	$\alpha > 0$	$K = \left(0.425 + \frac{1}{\alpha^2}\right)\frac{3-\psi}{2}$	

Table CS19.8 Buckling and Reduction Factors for Plane Elementary Plate Panels (continued)

Load case	Edge stress ratio ψ	Aspect ratio $\alpha = a/b$	Buckling factor K	Reduction factor κ
5 	–		$K = K_\tau \sqrt{3}$	$\kappa_\tau = 1$ for $\lambda \le 0.84$ $\kappa_\tau = \frac{0.84}{\lambda}$ for $\lambda > 0.84$
		$\alpha \ge 1$	$K_\tau = \left[5.34 + \frac{4}{\alpha^2}\right]$	
		$0 < \alpha < 1$	$K_\tau = \left[4 + \frac{5.34}{\alpha^2}\right]$	
Boundary condition - - - - - plate edge free ——— plate edge simple support				

(2) The buckling strength of non-stiffened webs and the flanges of primary supporting members are to be according to requirement of **(1)** above.

(3) The buckling strength of partial and total fields included in the structural members of steel hatch covers is to comply with the following **(a)** to **(e)**:

(a) The buckling strength of longitudinal and transverse secondary stiffeners is to comply with following **(d)** and **(e)**:

(b) When buckling calculation is carried out according to **(d)** and **(e)**, the effective breadth of steel hatch cover plating may be in accordance with following **i)** and **ii)**:

i) The effective breadth a_m or b_m of attached plating may be determined by the following formulae (see **Fig. CS19.4**). However, the effective breadth of plating is not to be taken greater than the value obtained from **19.2.5-5**.

$b_m = \kappa_x b$ for longitudinal stiffeners

$a_m = \kappa_y a$ for transverse stiffeners

κ_x and κ_y : As obtained from **Table CS19.8**

a and b : As specified **(1)** above

ii) The effective breadth e'_m of stiffened flange plates of primary supporting members may be determined according to the following **1)** and **2)**. However, a_m and b_m for flange plates are in general to determined for $\psi = 1$.

1) Stiffening parallel to the webs of primary supporting members (see **Fig. CS19.5**). For $b \ge e_m$, b and a have to be exchanged.

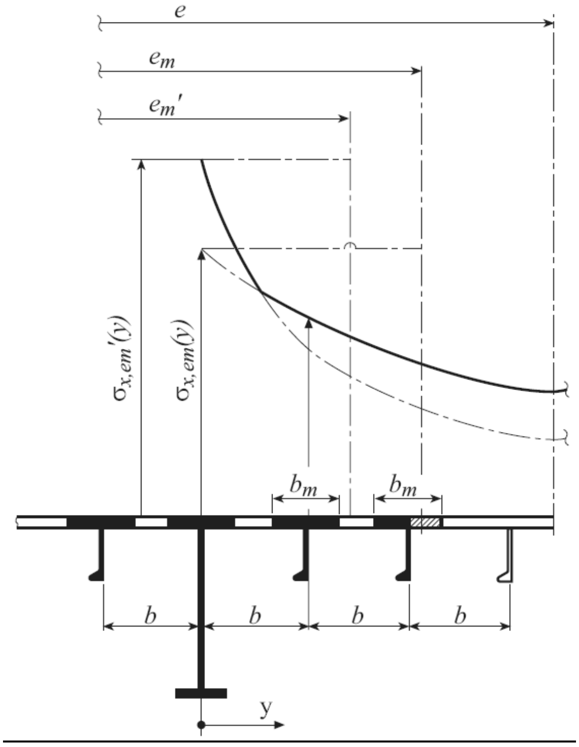
$b < e_m$

$e'_m = nb_m$

n: Integer number of stiffener spacing b inside the effective breadth e_m according to **19.2.5-5**, taken as equal to:

$$n = \text{int}\left(\frac{e_m}{b}\right)$$

Fig. CS19.5 Stiffening Parallel to Web of Primary Supporting Member



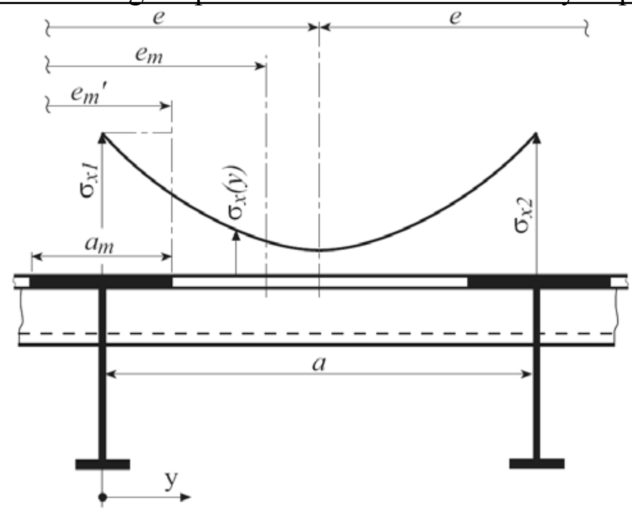
2) Stiffening perpendicular to the webs of primary supporting members (see **Fig. CS19.6**). For $a < e_m$, a and b have to be exchanged.

$$a \geq e_m$$

$$e'_m = n a_m < e_m$$

$$n = 2.7 \frac{e_m}{a} \leq 1$$

Fig. CS19.6 Stiffening Perpendicular to Web of Primary Supporting Member



(c) Stresses obtained from the calculation of the scantlings of plating and the stiffeners of steel hatch covers are to comply with the following:

i) The scantlings of plates and stiffeners are in general to be determined according to the maximum stresses $\sigma_x(y)$ at the webs of primary supporting members and stiffeners respectively.

ii) For stiffeners with spacing b under compression arranged parallel to primary supporting members no value less than $0.25\sigma_F$ is to be inserted for $\sigma_x(y=b)$.

iii) The stress distribution between two primary supporting members may be obtained by the following formula:

$$\sigma_x(y) = \sigma_{x1}\left\{1 - \frac{y}{e}\left[3 + c_1 - 4c_2 - 2\frac{y}{e}\left(1 + c_1 - 2c_2\right)\right]\right\}$$

c_1: As given by the following formula:

$$c_1 = \frac{\sigma_{x1}}{\sigma_{x2}}, \text{ however } 0 \le c_1 \le 1$$

c_2: As given by the following formula:

$$c_2 = \frac{1.5}{e}\left(e''_{m1} + e''_{m2}\right) - 0.5$$

σ_{x1} and σ_{x2}: Normal stresses in the flange plates of adjacent primary supporting members 1 and 2 with spacing *e*, based on cross-sectional properties considering the effective breadth or effective width, as appropriate

e''_{m1}: Proportionate effective breadth e_{m1} or proportionate effective width e'_{m1} of primary supporting member 1 within the distance *e*, as appropriate

e''_{m2}: Proportionate effective breadth e_{m2} or proportionate effective width e'_{m2} of primary supporting member 2 within the distance e, as appropriate

iv) The shear stress distribution in flange plates may be assumed to be linear.

(d) For lateral buckling, longitudinal and transverse stiffeners are to comply with following **i)** to **iii)**:

i) Secondary stiffeners subject to lateral loads are to comply with the following criteria:

$$\frac{\sigma_a + \sigma_b}{\sigma_F} C_{sf} \le 1$$

σ_a: Uniformly distributed compressive stress (N/mm^2) in the direction of the stiffener axis, given by the following formula:

$\sigma_a = \sigma_x$ for longitudinal stiffeners

$\sigma_a = \sigma_y$ for transverse stiffeners

σ_b: Bending stress (N/mm^2) in the stiffeners, given by the following formula:

$$\sigma_b = \frac{M_0 + M_1}{Z_{st}10^3} \text{ with } \sigma_x = \sigma_n \text{ and } \tau = \tau_{SF}$$

M_0: Bending moment (*N-mm*) due to deformation *w* of stiffener, given by the following formula:

$$M_0 = F_{Ki}\frac{p_z w}{c_f - p_Z} \text{ with } (c_f - p_z) > 0$$

M_1: Bending moment (*N-mm*) due to lateral load *P* given by the following formula:

$$M_1 = \frac{Pba^2}{24 \cdot 10^3}$$ for longitudinal stiffeners

$$M_1 = \frac{P(nb)^2}{8c_S 10^3}$$ for transverse stiffeners. Where n is to be taken as equal to 1 for ordinary transverse stiffeners

Z_{st}: Section modulus of stiffener (cm^3) including the effective breadth of plating according to **19.2.5-6(3)**

c_S: Factor accounting for the boundary conditions of the transverse stiffener taken as equal to:

$c_S = 1.0$ for a stiffener that is simply supported

$c_S = 2.0$ for a stiffener that is partially constrained

P: Lateral load (kN/m^2) as specified in **19.2.4** according to the condition under consideration

F_{Ki}: Ideal buckling force (N) of the stiffener given by the following formula:

$$F_{Kix} = \frac{\pi^2}{a^2} EI_x 10^4$$ for longitudinal stiffeners

$$F_{Kiy} = \frac{\pi^2}{(nb)^2} EI_y 10^4$$ for transverse stiffeners

I_x and I_y: Net moments of inertia (cm^4) of the longitudinal or transverse stiffener, including the effective breadth of attached plating according to **19.2.5-6(3)**. I_x and I_y are to comply with the following criteria:

$$I_x \geq \frac{bt^3}{12 \cdot 10^4}$$

$$I_y \geq \frac{at^3}{12 \cdot 10^4}$$

p_z: Nominal lateral load (N/mm^2) of the stiffener due to σ_x, σ_y and τ

$$p_{zx} = \frac{t_a}{b}\left(\sigma_{xl}\left(\frac{\pi b}{a}\right)^2 + 2c_y\sigma_y + \tau_1\sqrt{2}\right)$$ for longitudinal stiffeners

$$p_{zy} = \frac{t_a}{b}\left(2c_x\sigma_{xl} + \sigma_y\left(\frac{\pi a}{nb}\right)^2\left(1 + \frac{A_y}{at_a}\right) + \tau_1\sqrt{2}\right)$$ for transverse stiffeners

t_a: Net thickness (mm) of attached plating

c_x and c_y: Factor taking into account the stresses vertical to the stiffener's axis and distributed variable along the stiffener's length taken as equal to:

$0.5(1+\psi)$ for $0 \leq \psi \leq 1$

$\frac{0.5}{1-\psi}$ for $\psi < 0$

A_x and A_y: Net sectional area (mm^2) of the longitudinal or transverse stiffener respectively without attached plating

$$\sigma_{xl} = \sigma_x\left(1 + \frac{A_x}{bt_a}\right)$$

$$\tau_1 = \left[\tau - t\sqrt{\sigma_F E\left(\frac{m_1}{a^2} + \frac{m_2}{b^2}\right)}\right] \geq 0$$

m_1 and m_2: Coefficient given by the following formulae:

For longitudinal stiffeners:

$m_1 = 1.47 \quad m_2 = 0.49 \quad$ for $\frac{a}{b} \geq 2.0$

$m_1 = 1.96 \quad m_2 = 0.37 \quad$ for $\frac{a}{b} < 2.0$

For transverse stiffeners:

$m_1 = 0.37 \quad m_2 = \frac{1.96}{n^2} \quad$ for $\frac{a}{nb} \geq 0.5$

$m_1 = 0.49 \quad m_2 = \frac{1.47}{n^2} \quad$ for $\frac{a}{nb} < 0.5$

$w = w_0 + w_1$

w_0: Assumed imperfection (*mm*) taken as equal to:

$w_0 = \min\left(\frac{a}{250}, \frac{b}{250}, 10\right)$ for longitudinal stiffeners

$w_0 = \min\left(\frac{a}{250}, \frac{nb}{250}, 10\right)$ for transverse stiffeners

For stiffeners sniped at both ends w_0 is not to be taken as less than the distance from the mid-point of attached plating to the neutral axis of the stiffener calculated with the effective width of its attached plating.

w_1: Deformation of stiffener (*mm*) at the mid-point of stiffener span due to lateral load *p*. In the case of uniformly distributed loads, the following values for w_1 may be used:

$w_1 = \frac{Pba^4}{384 \cdot 10^7 EI_x}$ for longitudinal stiffeners

$w_1 = \frac{5Pa(nb)^4}{384 \cdot 10^7 EI_y c_S^2}$ for transverse stiffeners

c_f: Elastic support (N/mm^2) provided by the stiffener taken as equal to:

For longitudinal stiffeners:

$$c_f = F_{Kix}\frac{\pi^2}{a^2}\left(1 + c_{px}\right)$$

$$c_{px} = \frac{1}{1 + \dfrac{0.91\left(\dfrac{12 \cdot 10^4 I_x}{t^3 b} - 1\right)}{c_{xa}}}$$

c_{xa}: Coefficient taken as equal to:

$$c_{xa} = \left[\frac{a}{2b} + \frac{2b}{a} \right]^2 \quad \text{for } a \geq 2b$$

$$c_{xa} = \left[1 + \left(\frac{a}{2b} \right)^2 \right]^2 \quad \text{for } a < 2b$$

For transverse stiffeners:

$$c_f = c_S F_{Kiy} \frac{\pi^2}{(n \cdot b)^2} \left(1 + c_{py} \right)$$

$$c_{py} = \frac{1}{1 + \dfrac{0.91 \left(\dfrac{12 \cdot 10^4 I_y}{t^3 b} - 1 \right)}{c_{ya}}}$$

c_{ya}: Coefficient taken as equal to:

$$c_{ya} = \left[\frac{nb}{2a} + \frac{2a}{nb} \right]^2 \quad \text{for } nb \geq 2a$$

$$c_{ya} = \left[1 + \left(\frac{nb}{2a} \right)^2 \right]^2 \quad \text{for } nb < 2a$$

ii) For stiffeners not subject to lateral loads, the bending moment σ_b is to be calculated at the mid-point of the stiffener.

iii) When lateral loads are acting, stress calculations are to be carried out for both fibres of the stiffener's cross sectional area (if necessary for the biaxial stress field at the plating side).

(e) For torsional buckling, longitudinal and transverse stiffeners are to comply with the following **i)** and **ii)**:

i) Longitudinal stiffeners are to comply with following criteria:

$$\frac{\sigma_x}{\kappa_T \sigma_F} C_{sf} \leq 1.0$$

κ_T : Coefficient taken as equal to:

$$\kappa_T = 1.0 \quad \text{for } \lambda_T \leq 0.2$$

$$\kappa_T = \frac{1}{\Phi + \sqrt{\Phi^2 - \lambda_T^2}} \quad \text{for } \lambda_T > 0.2$$

$$\Phi = 0.5 \left(1 + 0.21 \left(\lambda_T - 0.2 \right) + \lambda_T^2 \right)$$

λ_T : Reference degree of slenderness taken as equal to:

$$\lambda_T = \sqrt{\frac{\sigma_F}{\sigma_{KiT}}}$$

$$\sigma_{KiT} = \frac{E}{I_P}\left(\frac{\pi^2 I_\omega 10^2}{a^2}\varepsilon + 0.385 I_T\right) \quad (N/mm^2)$$

I_P: Net polar moment of inertia of the stiffener (cm^4) defined in **Table CS19.9**, and related to point C as shown in **Fig. CS19.7**.

I_T: Net St. Venant's moment of inertia of the stiffener (cm^4) defined in **Table CS19.9**

I_ω: Net sectorial moment of inertia of the stiffener (cm^6) defined in **Table CS19.9**, related to point C as shown in **Fig. CS19.7**

ε: Degree of fixation taken as equal to:

$$\varepsilon = 1 + 10^{-3}\sqrt{\frac{a^4}{\frac{3}{4}\pi^4 I_w\left(\frac{b}{t^3} + \frac{4h_w}{3t_w^3}\right)}}$$

A_w: Net web area (mm^2) equal to:

$A_w = h_w t_w$

A_f: Net flange area (mm^2) equal to:

$A_f = b_f t_f$

$$e_f = h_w + \frac{t_f}{2} \quad (mm)$$

h_w, t_w, b_f and t_f: Dimensions of stiffener (mm) as specified in **Fig. CS19.7**

Fig. CS19.7 Dimensions of Stiffener

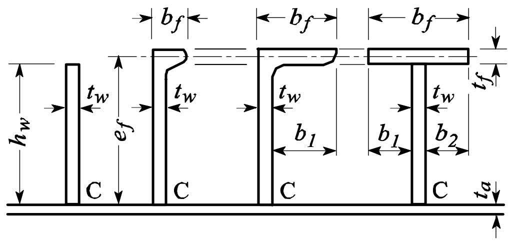


Table CS19.9 Moments of Inertia

Section	I_P	I_T	I_ω
Flat bar	$\frac{h_w^3 t_w}{3 \cdot 10^4}$	$\frac{h_w t_w^3}{3 \cdot 10^4}\left(1 - 0.63\frac{t_w}{h_w}\right)$	$\frac{h_w^3 t_w^3}{36 \cdot 10^6}$
Bulb, angle or tee sections	$\left(\frac{A_w h_w^2}{3} + A_f e_f^2\right)10^{-4}$	$\frac{h_w t_w^3}{3 \cdot 10^4}\left(1 - 0.63\frac{t_w}{h_w}\right)$ $\pm$ $\frac{b_f t_f^3}{3 \cdot 10^4}\left(1 - 0.63\frac{t_f}{b_f}\right)$	For bulb and angle sections: $\frac{A_f e_f^2 b_f^2}{12 \cdot 10^6}\left(\frac{A_f + 2.6A_w}{A_f + A_w}\right)$ For tee-sections: $\frac{b_f^3 t_f e_f^2}{12 \cdot 10^6}$

ii) For transverse secondary stiffeners loaded by compressive stress which are not supported by longitudinal stiffeners, sufficient torsional buckling strength is to be performed analogously in accordance with **i)** above.

19.2.6 Additional Requirements for Steel Hatch Covers Carrying Cargoes

1 Where concentrated loads, e.g. container loads, are acting on steel hatch covers, direct calculations deemed appropriate by the Society are required.

2 The scantlings of sub structures subject to concentrated loads acting on steel hatch covers are to be determined taking into consideration the design cargo loads and permissible stresses specified in this section.

3 The scantlings of top plates and stiffeners of steel hatch covers subject to wheel loads are determined by direct calculation or any other method which deemed appropriate by the Society.

19.2.7 Portable Beams, Hatchway Covers, Steel Pontoon Covers and Steel Weathertight Covers

1 Portable beams are to comply with the following **(1)** to **(7)**:

(1) The carriers and sockets for portable beams are to be of substantial construction, having a minimum beaming surface of 75 *mm*, and are to be provided with means for the efficient fitting and securing of the beams.

(2) Coamings are to be stiffened in way of carriers and sockets by providing stiffeners from these fittings to the deck or by equivalent strengthening.

(3) Where beams of a sliding type are used, the arrangement is to ensure that the beams remain properly in position when the hatchway is closed.

(4) The depth of portable beams and the width of their face plates are to be suitable to ensure the lateral stability of the beams. The depth of beams at their ends is not to be less than 0.40 *times* the depth at their mid-point or 150 *mm*, whichever is greater.

(5) The upper face plates of portable beams are to extend to the ends of the beams. The web plates are to be increased in thickness to at least twice that at the mid-point for at least 180 *mm* from each end or to be reinforced with doubling plates.

(6) Portable beams are to be provided with suitable gear for releasing them from slings without the need for personnel to get on the beam.

(7) Portable beams are to be clearly marked to indicate the deck, hatchway and position to which they belong.

2 Hatchway covers are to comply with the following **(1)** to **(5)**:

(1) Hatch rests are to be provided with at least a 65 *mm* bearing surface and are to be bevelled, if required, to suit the slope of the hatchways.

(2) Hatchway covers are to be provided with suitable hand grips according to their weight and size, except where such grips are unnecessary due to the cover's construction.

(3) Hatchway covers are to be clearly marked to indicate the deck, hatchway and position to which they belong.

(4) The wood for hatchway covers is to be of good quality, straight grained and reasonably free from knots, sap and shakes.

(5) The ends of all wood covers are to be protected by an encircling steel band.

3 Steel pontoon covers are to comply with the following **(1)** to **(3)**:

(1) The depth of steel pontoon covers at the supports is not to be less than one-third the depth at the mid-point or 150 *mm*, whichever is greater.

(2) The width of bearing surface for steel pontoon covers is not to be less than 75 *mm*.

(3) Steel pontoon covers are to be clearly marked to indicate the deck, hatchway and position to which they belong.

4 Steel weathertight covers are to comply with the following **(1)** to **(4)**:

(1) The depth of steel weathertight covers at the supports is not to be less than one-third the depth at mid-span or 150 *mm*, whichever is greater.

19.2.8 Tarpaulins and Securing Arrangements for Hatchways Closed by Portable Covers

1 At least two layers of tarpaulins of Grade A complying with the requirements in **Chapter 6, Part L** are to be provided for each exposed hatchway on the freeboard or superstructure decks and at least one layer of such a tarpaulin is to be provided for each exposed hatchway elsewhere.

2 Battens are to be efficient for securing the tarpaulins and not to be less than 65 *mm* in width and 9 *mm* in thickness.

3 Wedges are to be of tough wood or other equivalent materials. They are to have a taper not more than 1/6 and not to be less than 13 *mm* in thickness at the point.

4 Cleats are to be set to fit the taper of the wedges. They are to be at least 65 *mm* wide and to be spaced not more than 600 *mm* from centre to centre; the cleats along each side are to be arranged not more than 150 *mm* apart from the hatch corners.

5 For all hatchways in exposed freeboard and superstructure decks, steel bars or other equivalent means are to be provided in order to efficiently secure each section of the hatchway cover after the tarpaulins are battened down. Hatchway covers of more than 1.5 *metres* in length are to be secured by at least two such securing appliances. At all other hatchways in exposed positions on weather decks, ring bolts or other suitable fittings for lashing are to be provided.

19.2.9 Hatch Coaming Strength Criteria

1 Height of coamings is to comply with following **(1)** to **(3)**:

(1) Height of coamings above the upper surface of the deck is to be at least 600 *mm* in Position I and 450 *mm* in Position II.

(2) For hatchways closed by weathertight steel hatch covers, the height of coamings may be reduced from that prescribed in **(1)** or omitted entirely subject to the satisfaction of the Society.

(3) The height of hatchway coamings other than those provided in exposed portions of the freeboard or superstructure decks is to be to the satisfaction of the Society having regard to the position of hatchways or the degree of protection provided.

2 Scantlings of hatch coamings are to be in accordance with the followings.

(1) The local net plate thickness (*mm*) of the hatch coaming plating $t_{coam,net}$ is not to be less than that obtained from following formula:

$t_{coam,net} = 14.2 S \sqrt{\frac{P_H}{\sigma_{a,coam}}}$, but not to be less than $6 + \frac{L'}{100}$

S: Secondary stiffener spacing (*m*)

P_H: As specified in **19.2.4(2)**

$\sigma_{a,coam} = 0.95\sigma_F$

σ_F: Minimum upper yield stress (N/mm^2) or proof stress (N/mm^2) of the material

L': Length of ship L_1 (*m*)

(2) Where the hatch coaming secondary stiffener is snipped at both ends, gross thickness $t_{coam,gross}$ (*mm*) of the coaming plate at the sniped stiffener end is not to be less than that obtained from the following formula:

$t_{coam,gross} = 19.6\sqrt{\frac{P_H S(l - 0.5S)}{\sigma_F}}$

l: Secondary stiffener span (*m*) to be taken as the spacing of coaming stays

S, P_H and σ_F: As specified in **(1)** above

(3) The net section modulus Z_{net} (cm^3) and net shear area (cm^2) of hatch coaming secondary stiffeners are not to be less than that obtained from the following formula. For snipped stiffeners at coaming corners, section modulus and shear area at the fixed support are to be increased by 35%.

$$Z_{net} = \frac{83\, S l^2 P_H}{\sigma_F}$$

$$A_{net} = \frac{10\, S l P_H}{\sigma_F}$$

S, l, P_H and σ_F: As specified in **(2)** above

(4) Buckling strength assessment of hatch coaming is to be carried out by the method as deemed appropriate by the Society.

(5) The net scantlings of hatch coaming stays are to be in accordance with following **(a)** to **(d)**:

(a) The net section modulus Z_{net} (cm^3) of coaming stays with a height of less than 1.6 m is not to be less than that obtained from following formula.

$$Z_{net} = \frac{526 H_C^2 S P_H}{\sigma_F}$$

H_C: Hatch coaming stay height (m)

S: Hatch coaming stay spacing (m)

σ_F and P_H: As specified in **(1)** above

(b) The scantlings of hatch coaming stays with a height of 1.6 m and over are to be determined by direct calculations. The effective breadth of the coaming plate is to be in accordance with **19.2.5-5(2)** and stresses in hatch coaming stays are to comply with the criteria specified in **19.2.5-1**.

(c) For calculating the net section modulus of coaming stays, the area of their face plates is to be taken into account only when it is welded with full penetration welds to the deck plating and an adequate underdeck structure is fitted to support the stresses transmitted by them.

(d) The net scantling $t_{w,net}$ (mm) of hatch coaming stay webs is not to be less than that obtained from the following formula:

$$t_{w,net} = \frac{2 H_C S P_H}{\sigma_F\, h}$$

h: Hatch coaming stay depth (m)

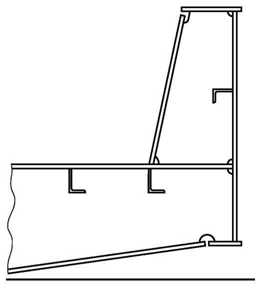
H_C, S, P_H and σ_F: As specified in **(a)** above

3 The coamings for hatchways in Position I or coamings of 760 mm or more in height for hatchways in Position II are to be stiffened in a suitable position below the upper edge by a horizontal stiffener; the breadth of the horizontal stiffener is not to be less than 180 mm.

4 Coamings are to be additionally supported by efficient brackets or stays provided from the horizontal stiffeners specified in **-3** to the deck at intervals of approximately 3 metres.

5 Coaming plates are to extend to the lower edge of the deck beams; moreover, they are to be flanged or fitted with face bars or half-round bars (see **Fig. CS19.8**), except where specially approved by the Society.

Fig. CS19.8 Example for the extension of coaming plates



6 Hatch coamings and hatch coaming stays are to comply with the following requirements:

(1) The local details of the structures are to be designed so as to transfer pressures on the hatch covers to the hatch coamings and, through them, to the deck structures below. Hatch coamings and supporting structures are to be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions.

(2) Underdeck structures are to be checked against the load transmitted by the stays.

(3) Double continuous welding is to be adopted for the connections of stay webs with deck plating and the weld throat is to be not less than $0.44t_{w,gross}$, where $t_{w,gross}$ is the gross thickness of the stay web.

(4) The toes of stay webs are to be connected to deck plating with deep penetration double bevel welds extending over a distance not less than 15% of the stay width.

(5) On ships carrying cargoes such as timber, coal or coke on deck, the stays are to be spaced not more than 1.5 *m* apart.

(6) Hatch coaming stays are to be supported by appropriate substructures.

(7) For hatch coamings that transfer friction forces at hatch cover supports, special consideration is to be given to fatigue strength.

(8) Longitudinal hatch coamings with a length exceeding $0.1L_1$ are to be provided with tapered brackets or equivalent transitions and a corresponding substructure at both ends. At the end of the brackets, they are to be connected to the deck by full penetration welds of minimum 300 *mm* in length.

(9) Hatch coamings and horizontal stiffeners on hatch coamings may be considered as a part of the longitudinal hull structure when designed according to the requirements for longitudinal strength and verified in cases deemed appropriate by the Society.

(10) Unless otherwise specified, the material and welding requirements for hatch coamings are to comply with the provisions of other Parts of the Rules.

19.2.10 Closing Arrangements

1 Securing devices

(1) Securing devices between covers and coamings and at cross-joints are to ensure weathertightness.

(2) The means for securing and maintaining weathertightness by using gaskets and securing devices are to comply with the following **(a)** to **(f)**. The means for securing and maintaining weathertightness of weathertight covers are to be to the satisfaction of the Society. Arrangements are to ensure that weathertightness can be maintained in any sea condition.

(a) The weight of covers and any cargo stowed thereon are to be transmitted to the ship structure through steel to steel contact.

(b) Gaskets and compression flat bars or angles which are arranged between covers and the ship structure and cross-joint elements are to be in compliance with the following **i)** to **iii)**:

i) Compression bars or angles are to be well rounded where in contact with the gaskets and are to be made of corrosion-resistant materials.
ii) The gaskets are to be of relatively soft elastic materials. The material is to be of a quality suitable for all environmental conditions likely to be experienced by the ship, and is to be compatible with the cargoes carried.
iii) A continuous gasket is to be effectively secured to the cover. The material and form of gasket selected are to be considered in conjunction with the type of cover, the securing arrangement and the expected relative movement between the cover and ship structure.

(c) Securing devices attached to hatchway coamings, decks or covers are to be in compliance with the following **i)** to **v)**:

i) Arrangement and spacing of securing devices are to be determined with due attention to the effectiveness for weathertightness, depending upon the type and the size of hatch cover as well as to the stiffness of the cover edges between the securing devices.
ii) The gross sectional area (cm^2) of each securing device is not to be less than that obtained from the following formula. However, rods or bolts are to have a net diameter not less than 19 *mm* for hatchways exceeding 5 m^2 in area.

$$A = 0.28\bar{a}p / f$$

$\bar{a}$: Half the distance (*m*) between two adjacent securing devices, measured along the hatch cover periphery (see **Fig. CS19.3**)
p: Packing line pressure (N/mm), minimum 5 N/mm
f: As obtained from the following formula:

$$f = (\sigma_F / 235)^e$$

σ_F: Minimum upper yield stress (N/mm^2) of the steel used for fabrication, but not to be taken greater than 70% of the ultimate tensile strength
e: Coefficient taken as equal to:
1.0 for $\sigma_F \le 235$ N/mm^2
0.75 for $\sigma_F > 235$ N/mm^2

iii) Individual securing devices on each cover are to have approximately the same stiffness characteristics.
iv) Where rod cleats are fitted, resilient washers or cushions are to be incorporated.
v) Where hydraulic cleating is adopted, a positive means is to be provided to ensure that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.

(d) A drainage arrangement equivalent to the standards specified in the following is to be provided.

i) Drainage is to be arranged inside the line of gaskets by means of a gutter bar or vertical extension of the hatch side and end coaming. If an application is made by the owner of a container carrier and the Society deems it to be appropriate, special consideration will be given to this requirement.
ii) Drain openings are to be arranged at the ends of drain channels and are to be provided with effective means such as non-return valves or the equivalent for preventing the ingress of water from outside.
iii) Cross-joints of multi-panel covers are to be arranged with a drainage channel for water from space above the gasket and a drainage channel below the gasket.

iv) If a continuous outer steel contact between cover and ship structure is arranged, drainage from the space between the steel contact and the gasket is also to be provided for.

(e) It is recommended that ships with steel weathertight covers are supplied with an operation and maintenance manual which includes the following **i)** to **v)**:

i) Opening and closing instructions

ii) Maintenance requirements for packing, securing devices and operating items

iii) Cleaning instructions for drainage systems

iv) Corrosion prevention instructions

v) List of spare parts

(f) Securing devices of special design in which significant bending or shear stresses occur may be designed as anti-lifting devices according to **-2** below.

2 The securing devices of hatch covers, on which cargo is to be lashed, are to be designed for a lifting force resulting from the loads according to **19.2.4(4)** (see **Fig. CS19.9**). Unsymmetrical loading, which may occur in practice, is to be considered. Under such loading, the equivalent stress (N/mm^2) in securing devices is not to be greater than that obtained from the following formula. Anti-lifting devices may be dispensed with at the discretion of the Society.

$$\sigma_E = \frac{150}{k_l}$$

k_l: As obtained from the following formula:

$$k_l = \left(\frac{235}{\sigma_F}\right)^e$$

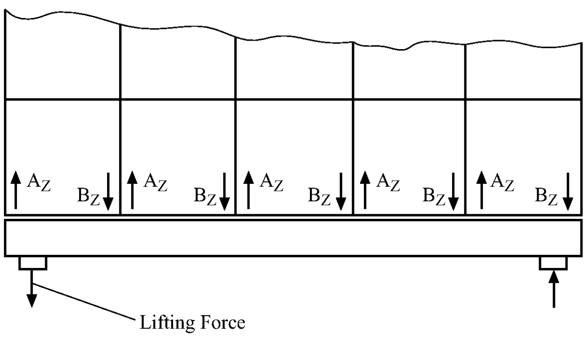
σ_F : Minimum upper yield stress (N/mm^2) or proof stress (N/mm^2) of the material

e: As given below

0.75 for $\sigma_F > 235$

1.00 for $\sigma_F \leq 235$

Fig. CS19.9 Lifting forces at a hatch cover



19.2.11 Hatch Cover Supports, Stoppers and Supporting Structures

Hatch cover supports, stoppers and supporting structures subject to the provisions of **19.2** are to comply with the following **(1)** to **(3)**:

(1) For the design of the securing devices for the prevention of shifting, the horizontal mass forces F obtained from the following formula are to be considered.

$$F = ma$$

m: Sum of mass of cargo lashed on the hatch cover and mass of hatch cover

a: Acceleration obtained from the following formula

$a_X = 0.2g$ for longitudinal direction

$a_Y = 0.5g$ for transverse direction

(2) The design load for determining the scantlings of stoppers is not to be less than that obtained from **19.2.4(2)** and **(1)**, whichever is greater. Stress in the stoppers is to comply with the criteria specified in **19.2.5-1(1)**.

(3) The details of hatch cover supporting structures are to be in accordance with the following **(a)** to **(g)**:

(a) The nominal surface pressure (N/mm^2) of a hatch cover is not to be greater than that obtained from the following formula:

$p_{n\max} = dp_n$ in general

$p_{n\max} = 3p_n$ for metallic supporting surface not subjected to relative displacements

d: As given by the following formula. Where *d* exceeds 3, *d* is to be taken as 3.

$d = 3.75 - 0.015L_1$

$d_{\min} = 1.0$ in general

$d_{\min} = 2.0$ for partial loading conditions

L_1: Length of ship specified in **2.1.2, Part A** of the Rules (*m*). However, L_1 need not be greater than 97% of the total length at the summer load waterline.

p_n: As obtained from **Table CS19.10**

Table CS19.10 Permissible nominal surface pressure p_n

Material	p_n when loaded by	
	Vertical force	Horizontal force (on stoppers)
Hull structure steel	25	40
Hardened steel	35	50
Plastic materials on steel	50	-

(b) Where large relative displacements of the supporting surfaces are to be expected, the use of material having low wear and frictional properties is recommended.

(c) Drawings of the supports are to be submitted. In these drawings, the permitted maximum pressure given by the material manufacturer related to long time stress is to be specified.

(d) Sufficient abrasive strength may be shown by tests demonstrating an abrasion of support surfaces of not more than 0.3 *mm* per year in service at a total distance of shifting of 15,000 *m* per year when deemed necessary by the Society.

(e) Irrespective of the arrangement of stoppers, the supports are to be able to transmit the following force p_h in the longitudinal and transverse direction.

$$p_h = \mu \frac{p_v}{\sqrt{d}}$$

p_v: Vertical supporting force

μ: Friction coefficient generally to be taken as 0.5. For non-metallic or low-friction materials, the friction coefficient may be reduced as appropriate by the Society. However, in no case μ is to be less than 0.35.

(f) Stresses in supporting structures are to comply with the criteria specified in **19.2.5-1(1)**.
(g) For substructures and adjacent constructions of supports subjected to horizontal forces p_h, special consideration is to be given to fatigue strength.

19.2.12 Steel Hatchway Covers for Container Carriers

1 For container carriers with unusually large freeboards, gaskets and securing devices for steel hatchway covers may be suitably dispensed with at the discretion of the Society upon request by the applicant for classification.

2 Treatment of towage and segregation of containers containing dangerous goods is to be at the discretion of the Society.

19.2.13 Additional Requirement for Small Hatches Fitted on Exposed Fore Deck

Small hatches located on exposed decks forward of $0.25L_1$ are to be of sufficient strength and weathertightness to resist green sea force if the height of the exposed deck in way of those hatches is less than $0.1L_1$ or 22 *m* above the designed maximum load line, whichever is smaller. The length L_1 is specified in **15.2.1-1**.

EFFECTIVE DATE AND APPLICATION (Amendment 2-4)

1. The effective date of the amendments is 1 July 2012.
2. Notwithstanding the amendments to the Rules, the current requirements may apply to ships for which the date of contract for construction* is before the effective date.
*"contract for construction" is defined in the latest version of IACS Procedural Requirement(PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
(1) such alterations do not affect matters related to classification, or
(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Notes:
This Procedural Requirement applies from 1 July 2009.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CS Hull Construction and Equipment of Small Ships

GUIDANCE

2011 AMENDMENT NO.2

Notice No.90 1st November 2011
Resolved by Technical Committee on 7th July 2011

Notice No.90 1st November 2011
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part CS HULL CONSTRUCTION AND EQUIPMENT OF SMALL SHIPS

Amendment 2-1

Appendix 1 APPLICATION OF PART C OF THE GUIDANCE

In Table CS, the column of
"

23.1.6	**C27.1.7**

"
has been added under the column of.
"

23.1.5	**C27.1.5** and **C27.1.6** [See Note 28]

".

EFFECTIVE DATE AND APPLICATION(Amendment 2-1)

1. The effective date of the amendments is 1 January 2012.

2. Notwithstanding the amendments to the Guidance, the current requirements may apply to ships for which the date of contract for construction* is before the effective date.
*"contract for construction" is defined in the latest version of IACS Procedural Requirement(PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
(1) such alterations do not affect matters related to classification, or
(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Notes:
This Procedural Requirement applies from 1 July 2009.

Amendment 2-2

CS19 HATCHWAYS, MACHINERY SPACE OPENINGS AND OTHER DECK OPENINGS

CS19.2 Hatchways

Paragraph CS19.2.1 has been added as follows.

CS19.2.1 Application

1 Notwithstanding ship length, the construction and means for closing cargo and other hatchways of bulk carriers defined in **1.3.1(13), Part B** of the Rules and ships intended to be registered as "bulk carriers" are to comply with the related requirements in **Part CSR-B** of the Rules.

2 When the requirements for hatchways in **Part CSR-B** of the Rules apply to hatchways of ships which are not subject to the application of **Part CSR-B** of the Rules, corrosion additions of hatch coaming may be taken as 1.5 *mm*.

Paragraph CS19.2.5 has been deleted.

~~**CS19.2.5 Special Requirements for Portable Beams, Hatchway Covers, Steel Pontoon Covers and Steel Weathertight Covers**~~

~~The provisions of **C20.2.6** of this Guidance are to apply with necessary modifications to the securing means for steel weathertight covers. In application of **C20.2.6-2(3)(a)**, the standard spacings of securing devices are 0.5*m* or less at the corner of the cover, and 1.0*m* or less elsewhere.~~

Appendix 1 APPLICATION OF PART C OF THE GUIDANCE

Table CS has been amended as follows.

Table CS Correspondence Table of Guidance between Part CS and Part C

Part CS	Part C	Part CS	Part C	Part CS	Part C
1.1.3	**C1.1.3**[See Note 1]	13.3	**C13.3**	19.4.2	**C20.4.2**
1.3.1	**C1.1.7**	14.1.3	**C14.1.3**	20.2.2	**C21.2.2**
	C1.1.11 and	14.2.3	**C14.2.3**	21.1.1	**C23.1.1**[See Note ~~15~~16]
	C1.1.12	15.1.1	**C15.1.1**	21.1.2	**C23.1.2**[See Note ~~16~~17]
2.1.1	**C2.1.1**	15.2.1	**C15.2.1**	21.1.3	**C23.1.3**[See Note ~~17~~18]
2.2.2	**C2.2.2**	15.2.3	**C15.2.3**	21.2.1	**C23.2.1**[See Note ~~18~~19]
2.2.3	**C2.2.3**	15.3	**C15.4.1-2**	21.2.2	**C23.2.2**[See Note ~~19~~20]
2.2.4	**C2.2.4**	16.3.3	**C16.3.3**	21.2.3	**C23.2.3**
3	**C3**	16.4.4	**C16.4.4**	21.3	**C23.3**
4	**C4**	16.5.3	**C16.6.1**	21.4	**C23.4**[See Note ~~20~~21]
5	**C5**	16.6.1	**C16.7.1**	21.5.1	**C23.5.1**
6.1.1	**C6.1.1-1** and **-2**	16.6.2	**C16.7.2**	21.5.3	**C23.5.3**[See Note ~~21~~22]
6.6.2-1	**C6.4.3-2**	17.1.1-1	**C10.2.1**[See Note 7]	21.5.7	**C23.5.7**[See Note ~~22~~23]
6.7.1	**C6.5.1-1** and **-4**	17.2.1	**C17.1.1**	21.6.5	**C23.6.5**[See Note ~~23~~24]
6.9	**C6.8**	17.2.2	**C17.1.2**	21.6.7	**C23.6.7**[See Note ~~24~~25]
7.5.2	**C7.6.2**[See Note 2]	17.2.4	**C17.1.4**[See Note 8]	21.7.1	**C23.7.1**[See Note ~~25~~26]
7.5.3	**C7.6.3**[See Note 3]	17.2.5	**C17.1.5**	21.7.2	**C23.7.2**
8.3	**C7.5.3**	17.3.2	**C17.2.2**	21.8.1	**C23.8.1**[See Note ~~26~~27]
9.1.2	**C9.1.2**[See Note 4]	17.3.4	**C17.2.4**	22.2.1	**C24.2.1**
9.1.3	**C9.1.3**	17.3.5	**C17.2.5**	22.4.1	**C25.2.1**[See Note ~~27~~28]
10.1.2	**C10.1.2**	17.4.1	**C17.3.1**	22.4.2	**C25.2.2**
10.2.3	**C10.3.3**[See Note 5]	17.4.5	**C17.3.5**	23.1.2	**C27.1.2**
10.3.2	**C10.4.2**	18	**C18**	23.1.5	**C27.1.5** and **C27.1.6**
10.7.1	**C10.9.1**	~~19.2.3~~	~~**C20.2.3**[See Note 9]~~		[See Note ~~28~~29]
11.1.2	**C11.1.2**	19.2.4	**C20.2.4**[See Note ~~10~~9]	23.2	**C27.2**
11.2.1	**C11.2.1**	19.2.5	**C20.2.5**[See Note ~~11~~10]	24.1.1	**C29.1.1**[See Note ~~29~~30]
12.1.3	**C12.1.3**	19.2.6	**C20.2.6**[See Note ~~12~~11]		[See Note ~~30~~31]
12.1.4	**C12.1.4**	~~19.2.9~~	~~**C20.2.9**[See Note 13]~~	24.1.2	**C29.1.2**[See Note ~~31~~32]
12.2.1	**C12.2.1**[See Note 6]	19.2.10	**C20.2.10**[See Note 12]	24.3.2	**C29.4.2**
13.1.1	**C13.1.1**	19.2.12	**C20.2.12**[See Note 13]	24.11.5	**C29.12.4**
13.1.4	**C13.1.4**	19.2.13	**C20.2.13**[See Note 14]	25.1.2	**C34.1.2**[See Note ~~32~~33]
13.2.3	**C13.2.3**	19.3.5	**C20.3.5**[See Note ~~14~~15]	26	**C35**

Notes :

1. In Guidance **C1.1.3-2(2)(a)**, **5.5.2, Part C of the Rules** is to be read as **5.4.3, Part CS of the Rules**.
   In Guidance **C1.1.3-2(2)(c)**, **10.2.1-2, Part C of the Rules** is to be read as **17.1.1-2, Part CS of the Rules**.
   In Guidance **C1.1.3-2(2)(g)**, **20.1.2, Part C of the Rules** is to be read as **19.1.2, Part CS of the Rules**.
2. In Guidance **C7.6.2**, **7.6.2, Part C of the Rules** is to be read as **7.5.2, Part CS of the Rules**.
3. In Guidance **C7.6.3**, **7.6.2-2**, **7.7.1** and **7.8.1, Part C of the Rules** are to be read as **7.5.2-1**, **7.6.1** and **7.6.3, Part CS of the Rules**.
4. In Guidance **C9.1.2**, **9.2.2-2(2), Part C of the Rules** is to be read as **9.2.2-5, Part CS of the Rules**.
5. In Guidance **C10.3.3**, **10.3.3-1** and **10.3.3-2, Part C of the Rules** is to be read as **10.2.3-1** and **10.2.3-2, Part CS of the Rules**.
6. In Guidance **C12.2.1**, **12.2.1-1** and **12.2.1-2, Part C of the Rules** is to be read as **12.2.1-1** and **12.2.1-2, Part CS of the Rules**.
7. In Guidance **C10.2.1**, **10.2.1-1, Part C of the Rules** is to be read as **17.1.1-1, Part CS of the Rules**.
8. In Guidance **C17.1.4**, **17.1.4-2, Part C of the Rules** is to be read as **17.2.4-2, Part CS of the Rules**.
9. ~~In Guidance **C20.2.3**, **20.2.3-1(1)(b)** and **20.2.3-1(4)(c), Part C of the Rules** are to read as **19.2.3-1(1)(b)** and **19.2.3-1(4)(c), Part CS of the Rules**.~~

~~10~~9. In Guidance **C20.2.4**, ~~**20.2.4-2**, **20.2.4-3**, **20.2.4-4**, **20.2.4-6**, **20.2.4-6(1)(c)**, **20.2.4-7** and **Table C20.2**~~ **20.2.4, Part C of the Rules** are to be read as ~~**19.2.4-2**, **19.2.4-3**, **19.2.4-4**, **19.2.4-6**, **19.2.4-6(1)(c)**, **19.2.4-7** and **Table CS19.2**~~ **19.2.4, Part CS of the Rules**.

~~11~~10. In Guidance **C20.2.5**, ~~**20.2.4-2**, **20.2.4-3** and **20.2.4-4**~~ **20.2.4** and **20.2.5, Part C of the Rules** are to be read as ~~**19.2.4-2**, **19.2.4-3** and **19.2.4-4**~~ **19.2.4** and **19.2.5, Part CS of the Rules**.

~~12~~11. In Guidance **C20.2.6**, ~~**20.2.4**, **20.2.5** and **20.2**~~ **20.2**, **20.2.4**, **20.2.6** and **20.2.5, Part C of the Rules** are to be read as ~~**19.2.4**, **19.2.5** and **19.2**~~ **19.2**, **19.2.4**, **19.2.6** and **19.2.5, Part CS of the Rules**.

12. In Guidance **C20.2.10**, **20.2.10-2, Part C of the Rules** is to be read as **19.2.10-2, Part CS of the Rules**.

13. In Guidance **C20.2.12**, **20.2.12, Part C of the Rules** is to be read as **19.2.12, Part CS of the Rules**.

~~13. In Guidance **C20.2.9**, **20.2.4**, **20.2.5**, **20.2.6** and **20.2.9**, **Table C20.4, Part C of the Rules** are to read as **19.2.4**, **19.2.5**, **19.2.6**, **19.2.9**, **Table CS19.4, Part CS of the Rules**.~~

14. In Guidance **C20.2.13**, **20.2.13, Part C of the Rules** is to be read as **19.2.13, Part CS of the Rules**.

~~14~~15. In Guidance **C20.3.5**, **20.3.5, Part C of the Rules** is to be read as **19.3.5, Part CS of the Rules**.

~~15~~16. In Guidance **C23.1.1**, **23.1.1-2(2)**, **Part C of the Rules** is to be read as **21.1.1-2(2)**, **Part CS of the Rules**.

~~16~~17. In Guidance **C23.1.2**, **23.1.2, Part C of the Rules** is to be read as **21.1.2, Part CS of the Rules**.

~~17~~18. In Guidance **C23.1.3**, **23.1.3-4, Part C of the Rules** is to be read as **21.1.3-4, Part CS of the Rules**.

~~18~~19. In Guidance **C23.2.1**, **23.2.1-3**, **23.2.1-4** and **23.2.2-4, Part C of the Rules** are to be read as **21.2.1-3**, **21.2.1-4** and **21.2.2-4, Part CS of the Rules**.

~~19~~20. In Guidance **C23.2.2**, **23.2.2**, **23.2.2-1**, **23.2.2-2** and **23.2.2-3, Part C of the Rules** are to be read as **21.2.2**, **21.2.2-1**, **21.2.2-2** and **21.2.2-3, Part CS of the Rules**.

~~20~~21. In Guidance **C23.4.5-2**, " L' " is to be read as "L". L is ship's length specified in **2.1.2, Part A of the Rules**.

~~21~~22. In Guidance **C23.5.3**, **23.5.3-5, Part C of the Rules** is to be read as **21.5.3-5, Part CS of the Rules**.

~~22~~23. In Guidance **C23.5.7**, **23.5.7-3, Part C of the Rules** is to be read as **21.5.7-3, Part CS of the Rules**.

~~23~~24. In Guidance **C23.6.5**, **23.6.5** and **23.6.5-1**, **Part C of the Rules** are to be read as **21.6.5** and **21.6.5-1**, **Part CS of the Rules**.

~~24~~25. In Guidance **C23.6.7**, **23.6.7** and **23.6.1, Part C of the Rules** are to be read as **21.6.7** and **21.6.1, Part CS of the Rules**.

~~25~~26. In Guidance **C23.7.1**, **Chapter 19**, **23.1.2-2** and **23.7.1, Part C of the Rules** are to be read as **Chapter 18**, **21.1.2-2** and **21.7.1, Part CS of the Rules**.

~~26~~27. In Guidance **C23.8.1**, **23.8.1, Part C of the Rules** is to be read as **21.8.1, Part CS of the Rules**.

~~27~~28. Ships not engaged on international voyages need not to apply the provisions of **C25.2.1-2**.

~~28~~29. The title of Guidance **C27.1.6** is to be read as "Tow Lines".

~~29~~30. In Guidance **C29.1.1-1(1)**, **Chapter 29, Part C of the Rules** is to be read as **Chapter 24, Part CS of the Rules**.

~~30~~31. In Guidance **C29.1.1-3(1)(b)i)**, **29.4**, **29.5** and **29.6, Part C of the Rules** are to be read as **24.3**, **24.4** and **24.7, Part CS of the Rules**.

~~31~~32. In Guidance **C29.1.2-4(1)**, **29.1.2-2, Part C of the Rules** is to be read as **24.1.2-2, Part CS of the Rules**.

~~32~~33. In Guidance **C34.1.2**, **34.1.2-1, Part C of the Rules** is to be read as **25.1.2-1, Part CS of the Rules**.

EFFECTIVE DATE AND APPLICATION (Amendment 2-2)

1. The effective date of the amendments is 1 July 2012.

2. Notwithstanding the amendments to the Guidance, the current requirements may apply to ships for which the date of contract for construction* is before the effective date.
*"contract for construction" is defined in the latest version of IACS Procedural Requirement(PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
(1) such alterations do not affect matters related to classification, or
(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Notes:
This Procedural Requirement applies from 1 July 2009.