Common Structural Rules for Bulk Carriers and Oil Tankers, 1 January 2021, Rule Change Notice 1

Amended Rules

Rules for the Survey and Construction of Steel Ships Part CSR-B&T

Reason for Amendment

Rule Change Notice 1 related to the 1 January 2021 edition of the Common Structural Rules for Bulk Carriers and Oil Tankers were published by IACS in December 2021. The relevant requirements are amended in accordance with the Rule Change Notice 1.

Outline of Amendment

Relevant requirements are amended in accordance with the Rule Change Notice 1.

Effective Date and Application

This amendment applies to ships for which the date of contract for construction is on or after 1 July 2022.

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

Part CSR-B&T COMMON STRUCTURAL RULES FOR BULK CARRIERS AND OIL TANKERS

Part 1 GENERAL HULL REQUIREMENTS

Chapter 1 RULE GENERAL PRINCIPLES

Section 4 SYMBOLS AND DEFINITIONS

2. Symbols

2.4 Scantlings

2.4.1

Unless otherwise specified, symbols regarding scantlings and their units used in these Rules are those defined in **Table 5**.

Table 5 has been amended as follows.

Table 5 Scantlings

Symbol	Meaning	Units
(Omitted)		
$\cancel{d_e}$	~~Distance from the upper edge of the web to the top of the flange for *L*3 profiles~~	~~*mm*~~
(Omitted)		

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 2 NET SCANTLING APPROACH

Symbols has been amended as follows.

Symbols

For symbols not defined in this section, refer to **Ch 1, Sec 4**

(Omitted)

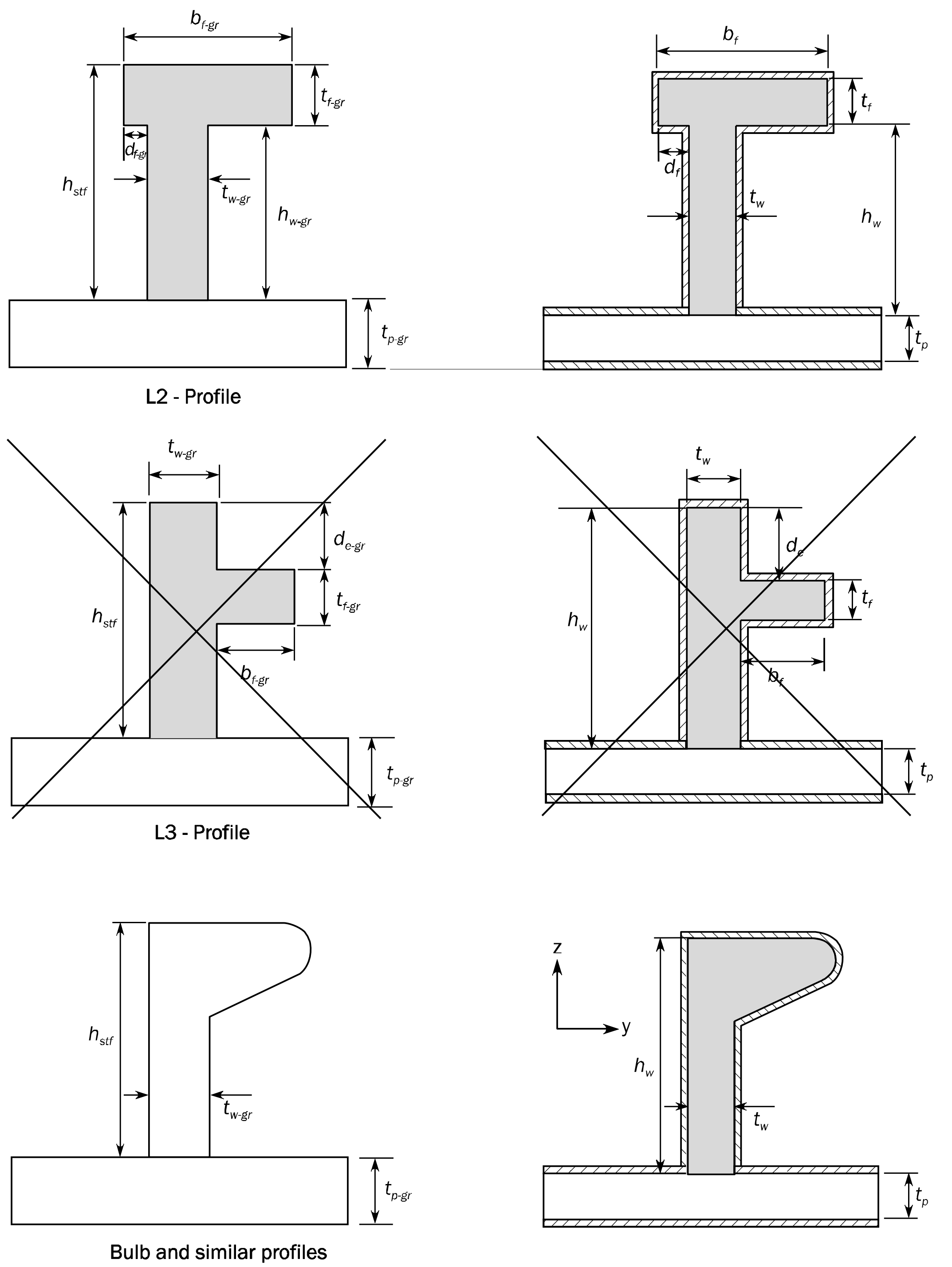
~~d_e : Distance in *mm*, from the upper edge of the web to the top of the flange for $L3$ profiles, see **Fig. 3**.~~

d_f : Distance in *mm*, for the extension of flange for $L2$ profiles, see **Fig. 3**.

(Omitted)

Fig. 3 has been amended as follows.

Fig. 3 Net Sectional Properties of Local Supporting Members (Continued)



The net cross-sectional area, the moment of inertia about the y-axis and the associated neutral axis position are to be determined applying a corrosion magnitude of 0.5 t_c deducted from the surface of the profile cross-section.

Section 3 CORROSION ADDITIONS

1. General

1.2 Corrosion Addition Determination

Paragraph 1.2.4 has been amended as follows.

1.2.4

When a local structural member/plate is affected by more than one value of corrosion addition, the most onerous value is to be applied to the entire strake.

However, for the vertical corrugations arranged by vertical seams in oil tankers, the actual corrosion additions above and below the line 3 *m* below top of tank (as defined in **Table 1**) can be used for the parts above and below the line, respectively.

Section 7 STRUCTURAL IDEALISATION

1. Structural Idealisation of Stiffeners and Primary Supporting Members

1.4 Geometrical Properties of Stiffeners and Primary Supporting Members

Paragraph 1.4.6 has been amended as follows.

1.4.6 Effective net plastic section modulus of stiffeners

The effective net plastic section modulus, Z_{pl}, of stiffeners, in cm^3, which is used for assessment against impact loads, is to be taken as:

$$Z_{pl} = \frac{f_w\, h_w^2\, t_w}{2000} + \frac{(2\gamma-1)A_f h_{f-ctr}}{1000} \quad \text{for } 75° \leq \varphi_w \leq 90°$$

$$Z_{pl} = \frac{f_w\, h_w^2\, t_w \sin\varphi_w}{2000} + \frac{(2\gamma-1)A_f\left(h_{f-ctr}\sin\varphi_w - b_{f-ctr}\cos\varphi_w\right)}{1000} \quad \text{for } \varphi_w < 75°$$

where:

f_w : Web shear stress factor, taken equal to:

- For flanged profile cross sections with n = 1 or 2, f_w = 0.75.
- For flanged profile cross sections with n = 0, f_w = 1.0.
- For flat bar stiffeners, f_w = 1.0.

n : Number of plastic hinges at end supports of each member, taken equal to: 0, 1 or 2.
A plastic hinge at end support may be considered where:

- The stiffener is continuous at the support.
- The stiffener passes through the support plate while it is connected at its termination point by a carling (or equivalent) to adjacent stiffeners.
- The stiffener is attached to an abutting stiffener effective in bending (not a buckling stiffener).
- The stiffener is attached to a bracket effective in bending. The bracket is assumed to be effective in bending when it is attached to another stiffener (not a buckling stiffener).

h_w : Depth of stiffener web, in mm, taken equal to:

- For T, L (rolled and built-up) profiles and flat bar, as defined in **Ch 3**, **Sec 2**, **Fig. 2**.
- For $L2$ ~~and $L3$~~ profile~~s~~ as defined in **Ch 3**, **Sec 2**, **Fig. 3.**
- For bulb profiles, to be taken as defined in **1.4.1**.

γ : Coefficient equal to:

$$\gamma = \frac{1+\sqrt{3+12\beta}}{4}$$

β : Coefficient equal to:

- $\beta = \frac{t_w^2\, f_b\, \ell_{shr}^2}{80 b_f^2\, t_f\, h_{f-ctr}} 10^6 + \frac{t_w}{2b_f}$ for L profiles without a mid-span tripping bracket, but not to be taken greater than 0.5.
- $\beta = 0.5$ for other cases.

A_f : Net cross sectional area of flange, in mm^2:

- $A_f = 0$ for flat bar stiffeners.
- $A_f = b_f\, t_f$ for other stiffeners.

b_{f-ctr} : Distance from mid thickness of stiffener web to the centre of the flange area:

- $b_{f-ctr} = 0.5\ (b_f - t_w)$ for rolled angle profiles and bulb profiles.
- $b_{f-ctr} = 0$ for T profiles.

h_{f-ctr} : Height of stiffener measured to the mid thickness of the flange:

- $h_{f-ctr} = h_w + 0.5\ t_f$ for profiles with flange of rectangular shape ~~except for $L3$ profiles~~ and for bulb profiles.
- ~~$h_{f-ctr} = h_w - d_e - 0.5\ t_f$ for $L3$ profiles as defined in **Ch 3, Sec 2, Fig. 3**.~~

~~d_e : Distance from upper edge of web to the top of the flange, in *mm*, for $L3$ profiles, see **Ch 3, Sec 2, Fig. 3**.~~

f_b : Coefficient taken equal to:

- $f_b = 0.8$ for flanges continuous through the primary supporting member, with end bracket(s).
- $f_b = 0.7$ for flanges sniped at the primary supporting member or terminated at the support without aligned structure on the other side of the support, and with end bracket(s).
- $f_b = 1.0$ for other stiffeners.

t_f : Net flange thickness, in *mm*.

- $t_f = 0$ for flat bar stiffeners.
- For bulb profiles t_f is defined in **1.4.1**.

3. Stiffeners

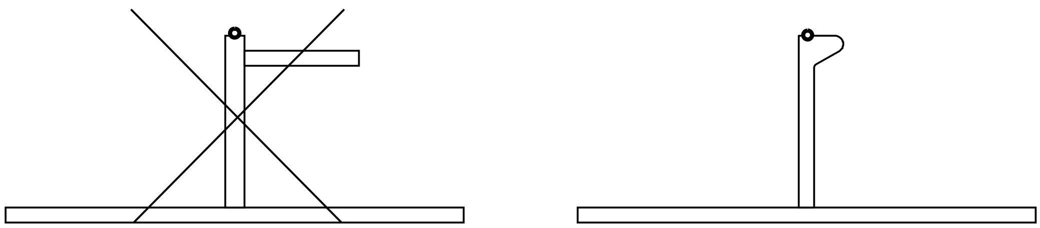
3.1 Reference Point

3.1.1

The requirements of section modulus for stiffeners relate to the reference point giving the minimum section modulus. This reference point is generally located as shown in **Fig. 23** for typical profiles.

Fig. 23 has been amended as follows.

Fig. 23 Reference Point for Calculation of Section Modulus and Hull Girder Stress for Local Scantling Assessment



Chapter 4 LOADS

Section 5 EXTERNAL LOADS

3. External Impact Pressures for the Bow Area

3.3 Bow Impact Pressure

Paragraph 3.3.1 has been amended as follows.

3.3.1 Design pressures

The bow impact pressure P_{FB}, in kN/m^2, to be considered for the bow impact design load scenario is to be taken as:

$$P_{FB} = 1.025 f_{FB} c_{FB} V_{im}^2 \sin\gamma_{wl}$$

where:

f_{FB}: Longitudinal bow flare impact pressure distribution factor. To be taken as:

$f_{FB} = 0.55$ for $x/L_{CSR} \leq 0.9$

$f_{FB} = 4(x/L_{CSR} - 0.9) + 0.55$ for $0.9 < x/L_{CSR} \leq 0.9875$

$f_{FB} = 8(x/L_{CSR} - 0.9875) + 0.9$ for $0.9875 < x/L_{CSR} \leq 1.0$

$f_{FB} = 1.0$ for $x/L_{CSR} > 1.0$

V_{im} : Impact speed, in *knots*, to be taken as:

$V_{im} = 0.514 V_{ref} \sin\alpha_{wl} + \sqrt{L_{CSR}}$

V_{ref} : Forward speed, in *knots*, to be taken as:

$V_{ref} = 0.75V$ but not less than 10.

α_{wl} : Local waterline angle, in *deg*, at the considered position, but not less than 35 *deg*. See **Fig. 12**.

γ_{wl} : Local bow impact angle, in *deg*, measured in a vertical plane containing the normal to the shell, from the horizontal to the tangent line at the considered position but not less than 50 *deg*, as shown in **Fig. 12**. Where this value is not available, it may be taken as:

$$\gamma_{wl} = \tan^{-1}\left(\frac{\tan\beta_{pl}}{\cos\alpha_{wl}}\right)$$

<u>For ships with bow impact angle less than 50 *deg*, the impact pressure is to be individually considered by the Society. The resulting scantling individually considered by the Society is in no case to be less than the scantling calculated in accordance with **3.3.1** for local bow impact angle equal to 50 *deg*.</u>

β_{pl} : Local body plan angle, in *deg*, at the considered position from the horizontal to the tangent line, but not less than 35 *deg*.

c_{FB} : Coefficient to be taken as:

$c_{FB} = 1.0$ for positions between draughts T_{BAL} and T_{SC}.

$c_{FB} = \sqrt{1.0 + \cos^2\left[90\frac{(h_{fb} - 2h_0)}{h_{fb}}\right]}$ for positions above draught T_{SC}.

h_{fb}: Vertical distance, in *m*, from the waterline at the draught T_{SC} to the highest deck at side. See **Fig. 12**.

h_0: Vertical distance, in *m*, from the waterline at the draught T_{SC} to the considered position. See **Fig. 12**.

Section 8 LOADING CONDITIONS

3. Oil Tankers

3.1 Specific Design Loading Conditions

Paragraph 3.1.1 has been amended as follows.

3.1.1 Seagoing conditions

The following seagoing loading conditions are to be included, as a minimum, in the loading manual:

(a) Heavy ballast condition where the ballast tanks may be full, partially full or empty. Where ballast tanks are partially full, the conditions in **2.2.1** are to be complied with. The fore peak water ballast tank is to be full, if fitted. If upper and lower fore peak tanks are fitted, the lower is required to be full and the upper tank may be full, partially full or empty. All the cargo tanks are to be empty including cargo tanks suitable for the carriage of water ballast at sea. The draught at the forward perpendicular is not to be less than that for the normal ballast condition. The propeller is to be fully immersed. The trim is to be by the stern and is not to exceed $0.015L_{LL}$.

(b) Mid-voyage conditions relating to tank cleaning or other operations where these differ significantly from the ballast conditions.

(c) Any specified non-uniform distribution of loading.

(d) Conditions with high density cargo including the maximum design cargo density, when applicable.

(e) Design ballast condition in which all segregated ballast tanks in the cargo tank region are full and all other tanks are empty including fuel oil and fresh water tanks. This design condition is for assessment of hull strength and is not intended for ship operation. ~~This condition will also be covered by the *IMO 73/78 SBT* condition provided the corresponding condition in the loading manual only includes ballast in segregated ballast tanks in the cargo tank region.~~

Chapter 8 BUCKLING

Section 2 SLENDERNESS REQUIREMENTS

Fig. 1 has been amended as follows.

Fig. 1 Stiffener Scantling

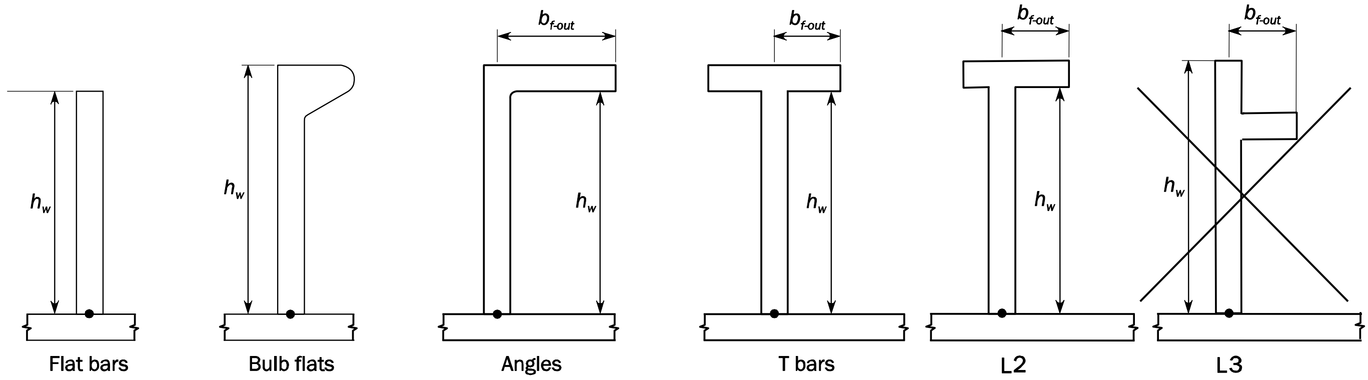


Table 1 has been amended as follows.

Table 1 Slenderness Coefficients

Type of Stiffener	C_w	C_f
Angle~~,~~ <u>and</u> L2 ~~and L3~~ bars	75	12
T-bars	75	12
Bulb bars	45	-
Flat bars	22	-

Section 5 BUCKLING CAPACITY

Symbols has been amended as follows.

Symbols

For symbols not defined in this section, refer to **Ch 1**, **Sec 4**.

~~A_p : Net sectional area of the stiffener attached plating, in mm^2, taken as:~~

~~$A_p = st_p$~~

(Omitted)

d_f : Distance, in *mm*, for the extension of flange for L2 profiles, as defined in **Ch 3, Sec 2, Fig. 3**.

~~d_e : Distance from upper edge of web to the top of the flange, in *mm*, as defined in **Ch 3, Sec 2, Fig. 3.**~~

e_f : Distance from attached plating to centre of flange, in *mm*, as shown in **Fig.1** to be taken as:

$e_f = h_w$ for flat bar profile.

$e_f = h_w - 0.5t_f$ for bulb profile.

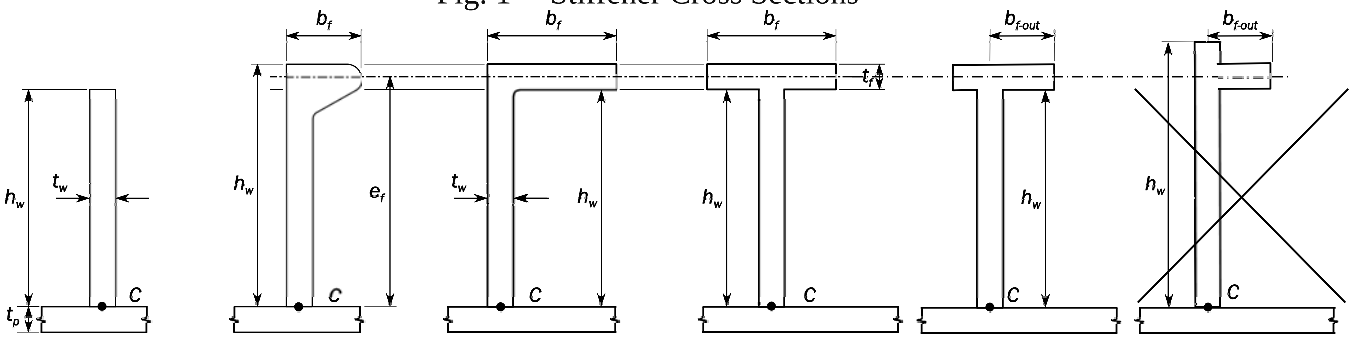
$e_f = h_w + 0.5t_f$ for angle, L2 and Tee profiles.

~~$e_f = h_w - d_e - 0.5t_f$ for L3 profile.~~

(Omitted)

Fig. 1 has been amended as follows.

Fig. 1 Stiffener Cross Sections



2. Buckling Capacity of Plates and Stiffeners

2.1 Overall Stiffened Panel Capacity

Paragraph 2.1.2 has been amended as follows.

2.1.2

The stress multiplier factor $\gamma_{GEB,bi}$ for the stiffened panel subjected to biaxial loads is taken as:

$$\gamma_{GEB,bi} = \frac{\pi^2}{L_{B1}^2 L_{B2}^2} \frac{[D_{11}L_{B2}^4 + 2(D_{12} + D_{33})n^2 L_{B1}^2 L_{B2}^2 + n^4 D_{22} L_{B1}^4]}{L_{B2}^2 N_x + n^2 L_{B1}^2 K_{tran} N_y}$$

where:

N_x: Load per unit length applied on the edge along x axis of the stiffened panel, in N/mm, taken as

$$\cancel{N_x = \sigma_{x,av}(t_p s + t_w h_w + t_f b_f)/s}$$

$$\underline{N_x = \sigma_{x,av}(A_p + A_s)/s}$$

<u>For stiffened panels fitted with U-type stiffeners, stiffener spacing s is taken as:</u>

$$\underline{s = b_1 + b_2}$$

<u>where b_1 and b_2 are as defined in **Pt 2, Ch 1, Sec 5, Fig. 1**.</u>

(Omitted)

$D_{11}, D_{12}, D_{22}, D_{33}$: Bending stiffness coefficients, in Nmm, of the stiffened panel, defined <u>in general</u> as:

$$\left.\begin{aligned} D_{11} &= \frac{EI_{eff}10^4}{s} \\ D_{12} &= \frac{Et_p^3 \nu}{12(1-\nu^2)} \\ D_{22} &= \frac{Et_p^3}{12(1-\nu^2)} \\ D_{33} &= \frac{Et_p^3}{12(1+\nu)} \end{aligned}\right\}$$

<u>For stiffened panels fitted with U-type stiffeners, D_{12} and D_{22} are defined as:</u>

$$\underline{D_{22} = \frac{Et_p^3}{12(1-\nu^2)}\left[1.2 + 4.8 \times Min\left(1.0, \frac{b_1^2}{h_w(b_1+b_2)}\right) \times Min\left(1.0, \left(\frac{t_w}{t_p}\right)^3\right)\right]}$$

$$\underline{D_{12} = \nu D_{22}}$$

<u>h_w: Breadth of U-type stiffener web as defined in **Pt 2, Ch 1, Sec 5, Fig. 1**.</u>

I_{eff}: Moment of inertia, in cm^4, of the stiffener including effective width of attached plating, the same as I defined in **2.3.4**.

2.2 Plate capacity

2.2.4 Correction factor F_{long}

Table 2 has been amended as follows.

Table 2 Correction Factor F_{long}

<table>
<tr><td colspan="3">Structural element types</td><td>F_{long}</td><td>c</td></tr>
<tr><td colspan="3">Unstiffened Panel</td><td>1.0</td><td>N/A</td></tr>
<tr><td rowspan="7">Stiffened Panel</td><td colspan="2">Stiffener not fixed at both ends</td><td>1.0</td><td>N/A</td></tr>
<tr><td rowspan="6">Stiffener fixed at both ends</td><td>Flat bar (1)</td><td rowspan="4">$F_{long} = c + 1$ for $\frac{t_w}{t_p} > 1$

$F_{long} = c\left(\frac{t_w}{t_p}\right)^3 + 1$ for $\frac{t_w}{t_p} \leq 1$</td><td>0.10</td></tr>
<tr><td>Bulb profile</td><td>0.30</td></tr>
<tr><td>Angle~~,~~ and L2 ~~and L3~~ profiles</td><td>0.40</td></tr>
<tr><td>T profile</td><td>0.30</td></tr>
<tr><td>Girder of high rigidity (e.g. bottom transverse)</td><td>1.4</td><td>N/A</td></tr>
<tr><td>U-type profile fitted on hatch cover (2)</td><td>• Plate on which the U type profile is fitted, including EPP b_1 and EPP b_2
• For $b_2 < b_1$: F_{long} =1
• For $b_2 \geq b_1$:
$F_{long} = \left(1.55 - 0.55\frac{b_1}{b_2}\right)\left[1 + c\left(\frac{t_w}{t_p}\right)^3\right]$
• Other plate of the U type profile: F_{long} =1</td><td>0.2</td></tr>
<tr><td colspan="5">(1) t_w is the net web thickness, in mm, without the correction defined in **2.3.2**.
(2) b_1 and b_2 are defined in **Pt 2, Ch 1, Sec 5, Fig. 1**.</td></tr>
</table>

Paragraph 2.2.5 has been amended as follows.

2.2.5 Correction factor F_{tran}

The correction factor F_{tran} is to be taken as:

- For transversely framed EPP of single side skin bulk carrier, between the hopper and top wing tank:
  - F_{tran} = 1.25 when the two adjacent frames are supported by one tripping bracket fitted in way of the adjacent plate panels.
  - F_{tran} = 1.33 when the two adjacent frames are supported by two tripping brackets each fitted in way of the adjacent plate panels.
  - F_{tran} = 1.15 elsewhere.
- For the attached plate of a U-type stiffener fitted on a hatch cover:

  $F_{tran} = Max(3 - 0.08(F_{tran0} - 6)^2, 1.0) \leq 2.25$

  where,

$F_{tran0} = Min\left(\frac{b_2}{b_1} + \frac{6b_2^2}{\pi^2 h_w(b_1+b_2)}\left(\frac{t_w}{t_p}\right)^3, 6\right)$ for EPP b_2

$F_{tran0} = Min\left(\frac{b_1}{b_2} + \frac{6b_1^2}{\pi^2 h_w(b_2+b_1)}\left(\frac{t_w}{t_p}\right)^3, 6\right)$ for EPP b_1

with b_1, b_2 and h_w as defined in **Pt 2, Ch 1, Sec 5, Fig. 1**.

Coefficient F defined in Case 2 of **Table 3** is to be replaced by the following formula:

$$F = \left[1 - \left(\frac{K_y}{0.91F_{tran}} - 1\right)/\lambda_p^2\right] c_1 \geq 0$$

- For other cases: $F_{tran} = 1$

2.3 Stiffeners

Paragraph 2.3.4 has been amended as follows.

2.3.4 Ultimate buckling capacity

When $\sigma_a + \sigma_b + \sigma_w > 0$ while initially setting $\gamma = 1$, the ultimate buckling capacity for stiffeners is to be checked according to the following interaction formula:

$$\frac{\gamma_c \sigma_a + \sigma_b + \sigma_w}{R_{eH}} S = 1$$

(Omitted)

- For stiffener induced failure (*SI*)
  - For $\sigma_a > 0$

    $\cancel{\sigma_w = E y_w \left(\frac{t_f}{2} + h_w\right) \Phi_0 \left(\frac{m_{tor}\pi}{\ell_{tor}}\right)^2 \left(\frac{1}{1 - \frac{\gamma\sigma_a}{\sigma_{ET}}} - 1\right)}$

    $\sigma_w = E y_w e_f \Phi_0 \left(\frac{m_{tor}\pi}{l_{tor}}\right)^2 \left(\frac{1}{1 - \frac{\gamma\sigma_a}{\sigma_{ET}}} - 1\right)$ with precondition $\sigma_{ET} - \gamma\sigma_a > 0$ ~~for stiffener induced failure (*SI*).~~
  - For $\sigma_a \leq 0$

    $\sigma_w = 0$
- For plate induced failure (*PI*)

  $\sigma_w = 0$ ~~for plate induced failure (*PI*).~~

ℓ_{tor}: Stiffener span, distance equal to spacing between primary supporting members, i.e. $\ell_{tor} = \ell$. When the stiffener is supported by tripping brackets, ℓ_{tor} should be taken as the maximum spacing between the adjacent primary supporting members and fitted tripping brackets.

y_w: Distance, in *mm*, from centroid of stiffener cross section to the free edge of stiffener flange, to be taken as:

$y_w = \frac{t_w}{2}$ for flat bar.

$y_w = b_f - \frac{h_w t_w^2 + t_f b_f^2}{2A_s}$ for angle and bulb profiles.

$y_w = b_{f-out} + 0.5t_w - \frac{h_w t_w^2 + t_f\left(b_f^2 - 2b_f d_f\right)}{2A_s}$ for L2 profile

~~$y_w = b_{f-out} + 0.5t_w - \frac{(h_w - t_f)t_w^2 + t_f(b_f + t_w)^2}{2A_s}$ for L3 profile~~

$y_w = \frac{b_f}{2}$ for T profile.

(Omitted)

Table 5 has been amended as follows.

Table 5 Moments of Inertia

	Flat bars [1]	Bulb, angle, L2~~, L3~~ and T profiles
I_P	$\frac{h_w^3 t_w}{3 \times 10^4}$	$\left(\frac{A_w(e_f - 0.5t_f)^2}{3} + A_f e_f^2\right)10^{-4}$
I_T	$\frac{h_w t_w^3}{3 \times 10^4}\left(1 - 0.63\frac{t_w}{h_w}\right)$	$\frac{(e_f - 0.5t_f)t_w^3}{3 \times 10^4}\left(1 - 0.63\frac{t_w}{e_f - 0.5t_f}\right) + \frac{b_f t_f^3}{3 \times 10^4}\left(1 - 0.63\frac{t_f}{b_f}\right)$
I_ω	$\frac{h_w^3 t_w^3}{36 \times 10^6}$	$\cancel{\frac{A_f^3 + A_w^3}{36 \cdot 10^6} + \frac{e_f^2}{10^6}\left(\frac{A_f b_f^2 + A_w t_w^2}{3} - \frac{(A_f b_f + A_w t_w)^2}{4(A_f + A_w)}\right)}$ ~~f~~For bulb, angle~~,~~ and L2 ~~and L3~~ profiles[2]. $\frac{A_f^3 + A_w^3}{36 \times 10^6} + \frac{e_f^2}{10^6}\left(\frac{A_f b_f^2 + A_w t_w^2}{3} - \frac{(A_f(b_f - 2d_f) + A_w t_w)^2}{4(A_f + A_w)} - A_f d_f(b_f - d_f)\right)$ For T profiles. ~~$\frac{b_f^3 t_f e_f^2}{12 \times 10^6}$ for T profiles.~~

(1) t_w is the net web thickness, in *mm*. t_{w_red} as defined in **2.3.2** is not to be used in this table.
(2) d_f is to be taken as 0 for bulb and angle profiles.

Part 2 SHIP TYPES

Chapter 1 BULK CARRIERS

Section 5 CARGO HATCH COVERS

Symbols has been amended as follows.

Symbols

For symbols not defined in this section, refer to **Pt 1, Ch 1, Sec 4**.
(Omitted)
b_p : Effective breadth, in mm, of the plating attached to the stiffener ~~or primary supporting member~~, as defined in **3**.
(Omitted)

1. General

1.5 Allowable Stresses

Paragraph 1.5.1 has been amended as follows.

1.5.1

The allowable stresses σ_a ~~and τ_a~~, in N/mm^2, are to be obtained from **Table 2**.

Table 2 Allowable Stresses~~, in N/mm^2~~

Members of	Subjected to	σ_a, in N/mm^2	~~τ_a, in N/mm^2~~
Weathertight hatch cover	External pressure, as defined in **4.1.2**	0.80 R_{eH}	~~0.46 R_{eH}~~
Weathertight hatch cover	Other loads, as defined in **4.1.3** to **4.1.6**	0.90 R_{eH} for load combination: $S+D$ 0.72 R_{eH} for load combination: S	~~0.51 R_{eH}~~

The allowable buckling utilisation factors are given in **Table 3**:

Table 3 Allowable Buckling Utilisation Factors

Structural component	Subject to	η_{all}, Allowable buckling utilisation factor
Plates and stiffeners Web of PSM	External pressure, as defined in **4.1.2**	0.80 for load combination: $S+D$
	Other loads, as defined in **4.1.3** to **4.1.6**	~~0.80~~ 0.90 for load combination: $S+D$ ~~0.64~~ 0.72 for load combination: S

3. Width of Attached Plating

3.1 Stiffeners

3.1.1

The width of the attached plating bp, in mm, to be considered for the check of stiffeners is to be taken as:

- Where the attached plating extends on both sides of the stiffener:

  $b_p = s$

- Where the attached plating extends on one side of the stiffener:

  $b_p = 0.5\ s$

Paragraph 3.2 has been deleted.

~~3.2 Primary Supporting Members~~

~~3.2.1~~

~~The effective breadth, in mm, of the attached plating to be considered for the yielding and buckling checks of primary supporting members analysed through isolated beam or grillage model is to be taken as:~~

- ~~Where the plating extends on both sides of the primary supporting member:~~

  $\cancel{b_p = b_{eff}}$

- ~~Where the plating extends on one side of the primary supporting member:~~

  $\cancel{b_p = 0.5 b_{eff}}$

  ~~where:~~

  $\cancel{b_{eff}}$~~: Effective breadth of attached plating, in~~ $\cancel{m}$~~, as defined in **Pt 1 Ch 3 Sec 7, 1.3.2**~~

~~For structural evaluations based on isolated beam or grillage models, the areas of stiffeners are not to be included in the idealisation of the attached plating of the primary members.~~

5. Strength Check

5.1 General

Paragraph 5.1.1 has been amended as follows.

5.1.1 Application

The strength check is applicable to rectangular hatch covers subjected to ~~a uniform~~ lateral pressure and/or concentrated loads, designed with primary supporting members arranged in one direction or as a grillage of longitudinal and transverse primary supporting members.

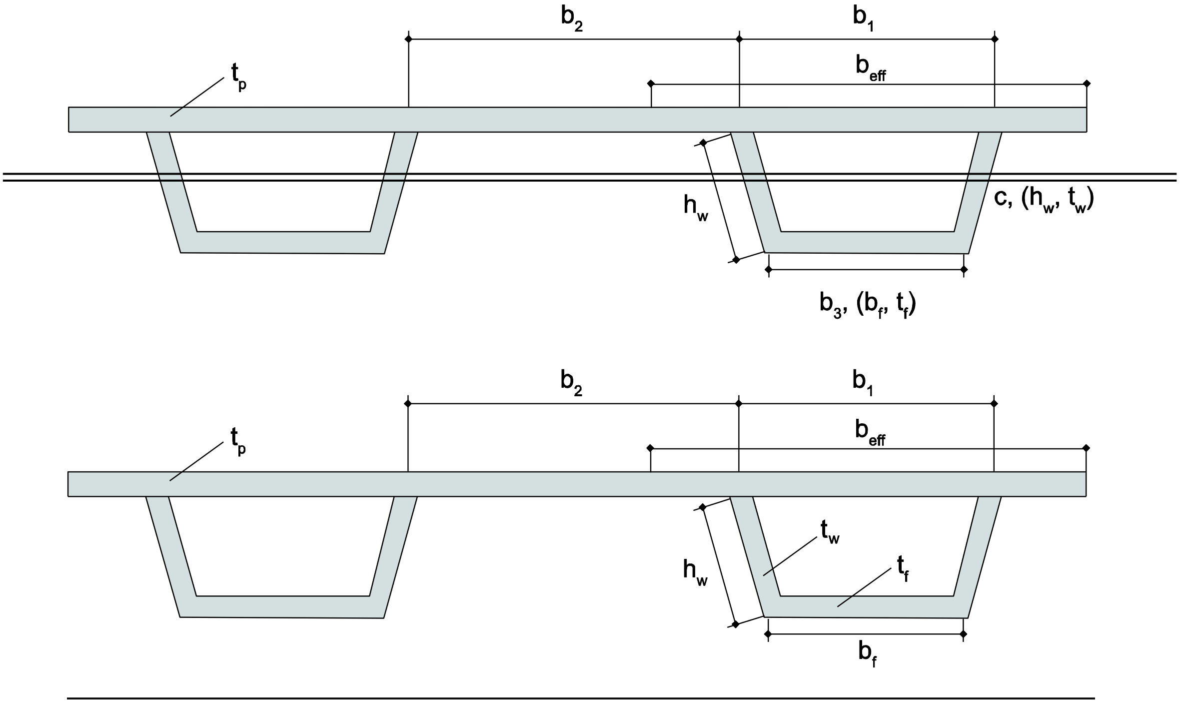
~~In the latter case, i.e. when the hatch cover is arranged as a grillage of longitudinal and transverse primary supporting members, or when the Society deems it necessary,~~ It is also applicable for hatch covers fitted with U-type stiffeners as shown in **Fig. 1**. ~~t~~The stresses in ~~the primary supporting~~ all structural members are to be determined by ~~a grillage or~~ a finite element analysis with the modelling requirements as described in **5.6.1**.

It is to be checked that stresses ~~induced by concentrated loads are in accordance with the criteria in **5.4.4**.~~ of all structural members comply with the yield strength assessment requirement in **5.6.2**

~~When FE analysis is carried out,~~ and the buckling strength assessment as described in **5.2.3**, **5.3.4** ~~and~~, **5.4.6** ~~can be made considering only the stresses given by the FE analysis~~, **5.6.3** and **5.6.4**.

~~The hatch covers fitted with U type stiffeners as shown in **Fig. 1** are to be checked by means of FE analysis. In transverse section of the stiffener, nodes are to be located at the connection between the web of the U type stiffener and the hatch cover plate as well as at the connection between the web and the flange of the U type stiffener. The buckling assessment as described in **5.2.3**, **5.3.4** and **5.4.6** can be made considering only the stresses given by the FE analysis.~~

Fig. 1 Example of Hatch Cover Fitted with U Type Stiffener



5.2 Plating

Paragraph 5.2.3 has been amended as follows.

5.2.3 Buckling strength

The buckling strength of the hatch cover plating subjected to loading conditions as defined in **4.1** is to comply with the ~~following formula:~~ requirements in **5.6.3**.

~~$\eta_{Plate} \le \eta_{all}$~~

~~where:~~

~~η_{Plate} : Maximum plate utilisation factor calculated according to Method A, as defined in **Pt 1, Ch 8, Sec 5, 2.2**.~~

- ~~For stresses obtained from beam theory, i.e. not calculated by means of finite element analysis:~~
  - ~~σ_x or σ_y is selected for the uniaxial check of the plate in the direction parallel to the primary supporting member,~~
  - ~~$\tau = 0$.~~
- ~~For stresses calculated by means of finite element analysis: σ_x, σ_y, τ obtained from FE analysis.~~

~~η_{all} : Allowable utilisation factor, as given in **Table 3**.~~

For hatch covers fitted with U type stiffeners, it is to comply with the requirements in **5.6.4** ~~the buckling panels b_1,b_2 and c (see **Fig. 1**) are to be assessed separately~~.

5.3 Stiffeners

Paragraph 5.3.1 has been amended as follows.

5.3.1

~~For flat bar stiffeners, the ratio h_w /t_w is to comply with the following formula:~~ Stiffeners are to comply with the applicable slenderness and proportion requirements given in **Pt 1, Ch 8, Sec 2, 3.1.1** and **3.1.2**.

$$\cancel{\frac{h_w}{t_w} \leq 15\sqrt{\frac{235}{R_{eH}}}}$$

Paragraph 5.3.4 has been amended as follows.

5.3.4 Buckling strength

The buckling strength of the hatch cover stiffeners subjected to loading conditions as defined in **4.1** is to comply with ~~following formula:~~ the requirements in **5.6.3**.

$$\cancel{\eta_{Stiffener} \leq \eta_{all}}$$

~~where:~~

$\cancel{\eta_{Stiffener}}$: ~~Maximum stiffener utilisation factor calculated according to **Pt 1, Ch 8, Sec 5, 2.3**.~~

- ~~For uniaxial stresses obtained by beam theory, i.e. not calculated by means of finite element analysis:~~
  - $\cancel{\sigma_x}$ ~~: stiffener axial stress,~~
  - $\cancel{\sigma_y = 0}$,
  - $\cancel{\tau = 0}$.
- ~~For stresses calculated by means of finite element analysis:~~
  - $\cancel{\sigma_x}$: ~~stiffener axial stress from FE analysis,~~
  - $\cancel{\sigma_y}$: ~~stress perpendicular to the stiffener,~~
  - $\cancel{\tau}$: ~~shear stress in the attached plate.~~

$\cancel{\eta_{all}}$: ~~Allowable utilisation factor, as given in **Table 3**.~~

The buckling strength of the hatch cover fitted with U type stiffeners subjected to loading conditions as defined in **4.1** ~~is to be checked as detailed above, considering the U type as an equivalent T-bar profile as follows:~~ is to comply with the requirements in **5.6.4**.

- ~~Web height taken equal to d as defined in **Pt 1, Ch 3, Sec 6, Fig. 21**.~~
- ~~Web thickness equal to 2 t_w.~~
- ~~Flange breadth taken as b_3, as shown on **Fig. 1**.~~
- ~~Flange thickness taken as t_f, as shown on **Fig. 1**.~~
- ~~Effective width of the attached plating, b_{eff}, taken as:~~

  $$\cancel{b_{eff} = C_{x1}b_1 + C_{x2}b_2}$$

~~Where:~~

~~C_{x1}, C_{x2}: Reduction factor defined in **Pt 1, Ch 8, Sec 5, Table 3** calculated for the EPP b1 and b2 according to case 1.~~

5.4 Primary Supporting Members

Paragraph 5.4.1 has been amended as follows.

5.4.1 Application

~~The requirements in **5.4.3** to **5.4.5** apply to primary supporting members which may be analysed through isolated beam models.~~

Primary supporting members ~~whose arrangement is of a grillage type and which cannot be analysed through isolated beam models~~ are to be checked ~~by direct calculations, using the checking criteria in **5.4.4**~~ with the requirements in **5.4.2** to **5.4.7**.

Paragraphs 5.4.3 and 5.4.4 have been deleted.

5.4.3 ~~Normal and shear stress for isolated beam~~ (Void)

~~In case that grillage analysis or finite element analysis are not carried out, according to the requirements in **5.1.1**, the maximum normal stress σ and shear stress τ, in *N/mm²*, in the primary supporting members are to be taken as given by the following formulae:~~

$$\cancel{\sigma = \frac{S(F_S P_S + F_W P_W)\,\ell_m^2}{f_{bc} Z}}$$

$$\cancel{\tau = \frac{5S(F_S P_S + F_W P_W)\,\ell_m}{A_{shr}}}$$

~~where:~~

~~ℓ_m : Bending span, in *m*, of the primary supporting member.~~

5.4.4 ~~Checking criteria~~ (Void)

~~The normal stress σ and the shear stress τ, calculated according to **5.4.3** or determined through a grillage analysis or finite element analysis, as the case may be, are to comply with the following formulae:~~

$$\cancel{\sigma \le \sigma_a}$$

$$\cancel{\tau \le \tau_a}$$

Paragraph 5.4.6 has been amended as follows.

5.4.6 Buckling strength of the web panels of the primary supporting members

The web of primary supporting members subject to loading conditions as defined in **4.1** is to ~~be taken as:~~ comply with the requirements in **5.6.3**.

$$\cancel{\eta_{Plate} \le \eta_{all}}$$

~~where:~~

~~η_{Plate} : Maximum plate utilisation factor calculated according to Method A, as defined in **Pt 1, Ch 8, Sec 5, 2.2**. For web plate in way of opening, it is to be calculated according to Method A, as defined in **Pt 1, Ch 8, Sec 5, 2.4**.~~

- ~~Shear stress obtained by beam theory (i.e. calculated according to **5.4.3** or determined through a grillage analysis), or~~
- ~~σ_x, σ_y, τ obtained by FE analysis.~~

~~η_{all} : Allowable utilisation factor, as given in **Table 3**.~~

Section 5.6 has been added as follows.

5.6 Finite element model and buckling assessment

5.6.1 Finite element model

For the strength assessments of hatch covers subjected to loading conditions as defined in **4.1**, by means of FE analysis, the hatch cover geometry shall be idealized as realistically as possible. In no case shall the element width be larger than stiffener spacing. In way of force transfer points and cutouts the mesh is to be refined where applicable. The ratio of element length to width shall not exceed 3.

The element size along the height of webs of primary supporting member is not to exceed one-third of the web height. Stiffeners, which support plates subjected to lateral pressure loads, are to be included in the FE model idealization. Stiffeners may be modelled by using beam elements, or shell/plate elements. Buckling stiffeners may be disregarded for the stress calculation.

Hatch covers fitted with U-type stiffeners as shown in **Fig. 1** are to be assessed by means of FE analysis. The geometry of the U-type stiffeners is to be accurately modelled using shell/plate elements. Nodal points are to be properly placed on the intersections between the webs of a U-type stiffener and the hatch cover plate, and between the webs and flange of the U-type stiffener.

5.6.2 Yield strength assessment

All hatch cover structural members are to comply with the following formula

$\sigma_{vm} \leq \sigma_a$ for shell elements in general.

$\sigma_{axial} \leq \sigma_a$ for rod or beam elements in general.

where,

σ_a : Allowable stress as defined in **1.5.1**, **Table 2**.

σ_{vm} : Von Mises stress, in N/mm^2, to be taken as follows:

$$\sigma_{vm} = \sqrt{\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau_{xy}^2}$$

σ_x : Normal stress, in N/mm^2, in x-direction.

σ_y : Normal stress, in N/mm^2, in y-direction.

τ_{xy} : Shear stress, in N/mm^2, in the x-y plane.

σ_{axial} : Axial stress in rod or beam element, in N/mm^2.

Indices x and y are coordinates of a two-dimensional Cartesian system in the plane of the considered structural element.

In case of FEM calculations using shell (or plate) elements, the stresses are to be read from the centre of the individual element. It is to be observed that, in particular, at flanges of unsymmetrical girders, the evaluation of stress from element centre may lead to non-conservative results. Thus, a sufficiently fine mesh is to be applied in these cases or, the stress at the element edges shall not exceed the allowable stress. Where shell elements are used, the stresses are to be evaluated at the mid plane of the element.

5.6.3 Buckling strength assessment

The plate panel of a hatch cover structure is to be modelled as stiffened panel (SP) or unstiffened panel (UP). Assessment Method A (-A) and Method B (-B) as defined in **Pt 1, Ch 8, Sec 1, 3** are to be used in accordance with **Table 4**, **Fig. 3** and **Fig. 4**. For a web panel with opening, the procedure for opening should be used for its buckling assessment.

Wherever necessary, the following corresponding buckling requirements for direct strength analysis in **Pt 1, Ch 8, Sec 4** can be referred to:

(1) Average thickness of plate panel, in **Pt 1, Ch 8, Sec 4, 2.1.2.**

(2) Irregular plate panel, in **Pt 1, Ch 8, Sec 4, 2.3**.

(3) Reference stress, in **Pt 1, Ch 8, Sec 4, 2.4**.

(4) Lateral pressure, in **Pt 1, Ch 8, Sec 4, 2.5**.

(5) Buckling criteria, in **Pt 1, Ch 8, Sec 4, 2.6**, but using allowable buckling utilisation factors as defined in **Pt 2, Ch 1, Sec 5, Table 3**.

Table 4 Structural members and assessment methods

Structural elements	Assessment method (1) (2)	Normal panel definition
Hatch cover top/bottom plating structures, see **Fig. 3**		
Hatch cover top/bottom plating	SP-A	Length: between transverse girders Width: between longitudinal girders
Irregularly stiffened panels	UP-B	Plate between local stiffeners/PSM
Hatch cover webs of primary supporting members, see **Fig. 4**		
Web of transverse/longitudinal girder (single skin type)	UP-B	Plate between local stiffeners/face plate/PSM
Web of transverse/longitudinal girder (double skin type)	SP-B(3)	Length: between PSM Width: full web depth
Web panel with opening	Procedure for opening	Plate between local stiffeners/face plate/PSM
Irregularly stiffened panels	UP-B	Plate between local stiffeners/face plate/PSM
Note 1: SP and UP stand for stiffened and unstiffened panel respectively. Note 2: A and B stand for Method A and Method B respectively. Note 3: In case that the buckling carlings/brackets are irregularly arranged in the web of transverse/longitudinal girder, UP-B method may be used.		

Fig. 3 Hatch cover top/bottom plating structures

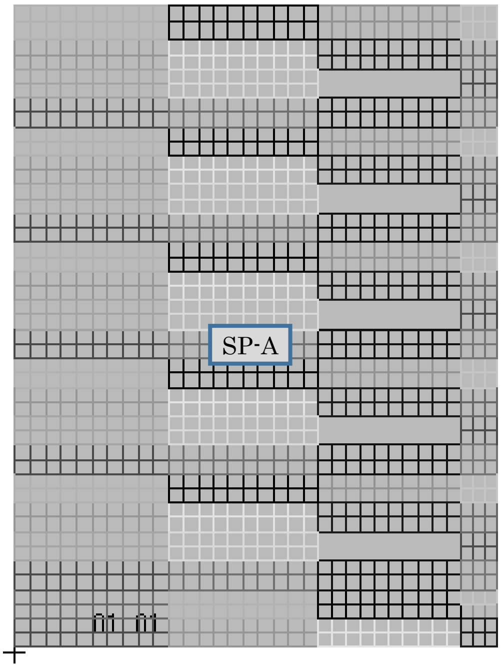
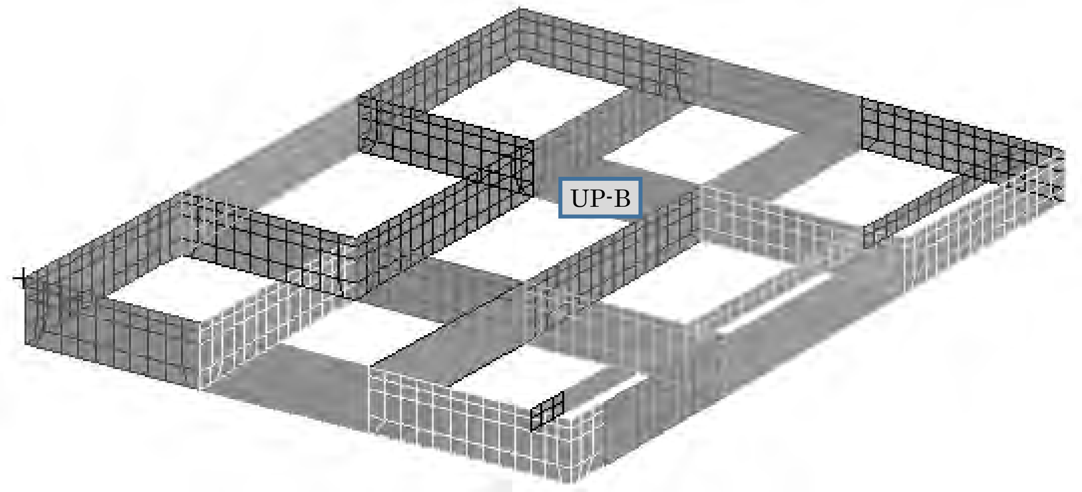


Fig. 4 Hatch cover webs of primary supporting members



5.6.4 Buckling assessment of stiffened panels with U-type stiffeners

For hatch covers fitted with U-type stiffeners, local plate buckling is to be checked for each of the plate panels EPP b_1, b_2, b_f and h_w (see **Fig. 1**) separately as follows:

- The attached plate panels EPP b_1 and b_2 are to be assessed using SP-A model, where in the calculation of buckling factors K_x as defined in **Pt 1, Ch 8, Sec 5, Table 3**, the correction factor Flong for U-type stiffeners as defined in **Pt 1, Ch 8, Sec 5, Table 2** is to be used; and in the calculation of K_y as defined in **Pt 1, Ch 8, Sec 5, Table 3**, the F_{tran} for U-type stiffeners as defined in **Pt 1, Ch 8, Sec 5, 2.2.5** is to be used.
- The face plate and web plate panels EPP b_f and h_w are to be assessed using UP-B model with F_{long} =1 and F_{tran} =1.

The overall stiffened panel capacity and ultimate capacity of stiffeners of the hatch cover fitted with U-type stiffeners are to be checked with warping stress $\sigma_w = 0$, and with bending moment of inertia including effective width of attached plating being calculated based on the following assumptions:

- The two web panels of a U-type stiffener are to be taken as perpendicular to the attached plate with thickness equal to t_w and height equal to the distance between the attached plate and the face plate of the stiffener.
- Effective width of the attached plating, b_{eff}, taken as the sum of the b_{eff} calculated for the EPP b_1 and b_2 respectively according to SP-A model.
- Effective width of the attached plating of a stiffener without the shear lag effect, b_{eff1}, taken as the sum of the b_{eff1} calculated for the EPP b_1 and b_2 respectively.

6. Hatch Coamings

6.3 Scantlings

Paragraph 6.3.3 has been amended as follows.

6.3.3 Coaming stays

At the connection with deck, the net section modulus Z, in cm^3, and the net thickness t_w, in mm, of the coaming stays designed as beams with flange connected to the deck or sniped and fitted with a bracket (examples shown in **Fig. ~~3~~5** and **Fig. ~~4~~6**) are to be taken not less than:

(Omitted)

Fig. 3 to Fig. 6 have been renumbered to Fig. 5 to Fig. 8 respectively.

Fig. ~~3~~5 Coaming Stay (Example 1)

(Omitted)

Fig. ~~4~~6 Coaming Stay (Example 2)

(Omitted)

(Omitted)

For other designs of coaming stays, such as those shown in **Fig. ~~5~~7** and **Fig. ~~6~~8**, the stress levels determined through a grillage analysis or finite element analysis, as the case may be, apply and are to be checked at the highest stressed locations. The stress levels are to comply with the following formulae:

Fig. ~~5~~7 Coaming Stay (Example 3)

(Omitted)

Fig. ~~6~~8 Coaming Stay (Example 4)

(Omitted)