RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CSR-B&T Common Structural Rules for Bulk Carriers and Oil Tankers

Rules for the Survey and Construction of Steel Ships
Part CSR-B&T 2016 AMENDMENT NO.2

Rule No.82 27th December 2016
Resolved by Technical Committee on 27th July 2016
Approved by Board of Directors on 20th September 2016

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Rule No.82 27th December 2016
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 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

Table 7 has been amended as follows.

Table 7 Definition of terms

Terms	Definition
(Omitted)	
'Tween deck	An abbreviation of between decks, placed between the upper deck and the tank top in the cargo tanks.
(Omitted)	

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 5 LIMIT STATES

3. Strength Check against Impact Loads

3.1 General

Paragraph 3.1.1 has been amended as follows.

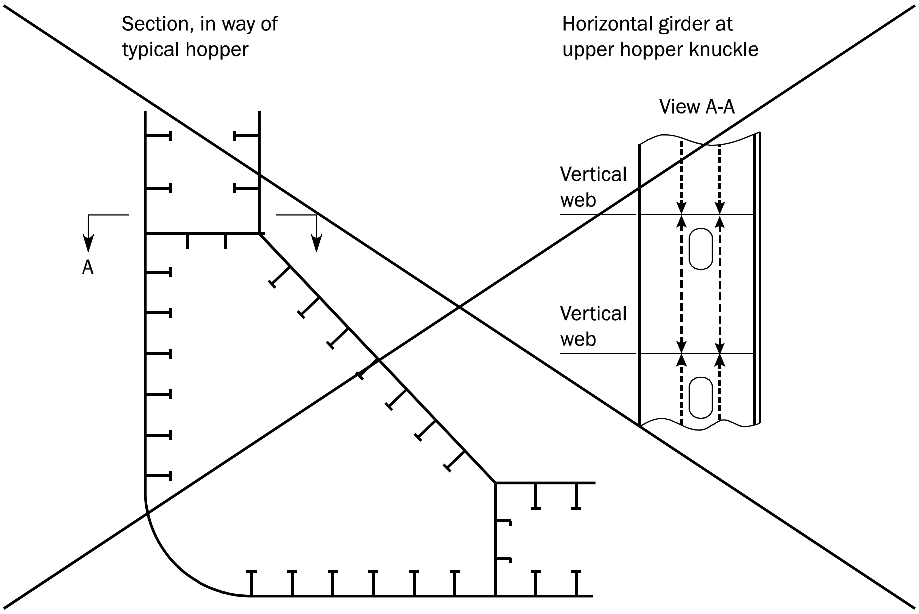
3.1.1

Structural response against impact loads such as forward bottom slamming, bow ~~flare slamming~~ impact and grab chocks depends on the loaded area, magnitude of loads and structural grillage.

Section 6　STRUCTURAL DETAIL PRINCIPLES

Fig. 1 has been amended as follows.

Fig. 1　Example of Reinforcement at Knuckles



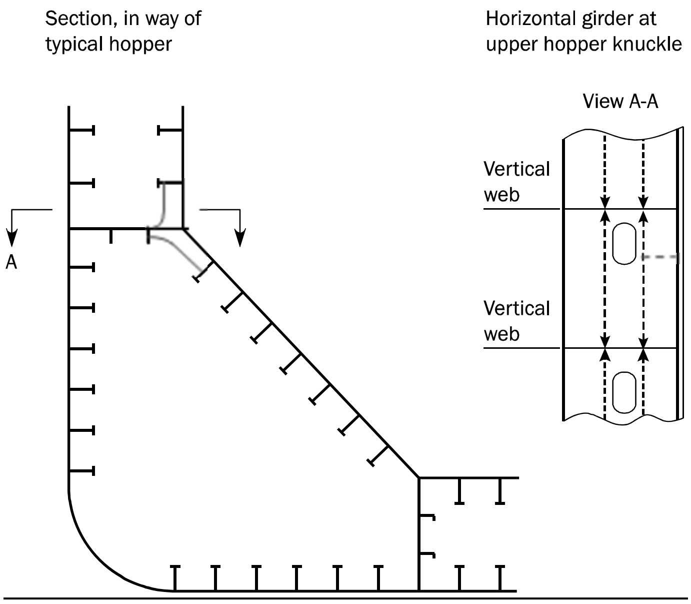
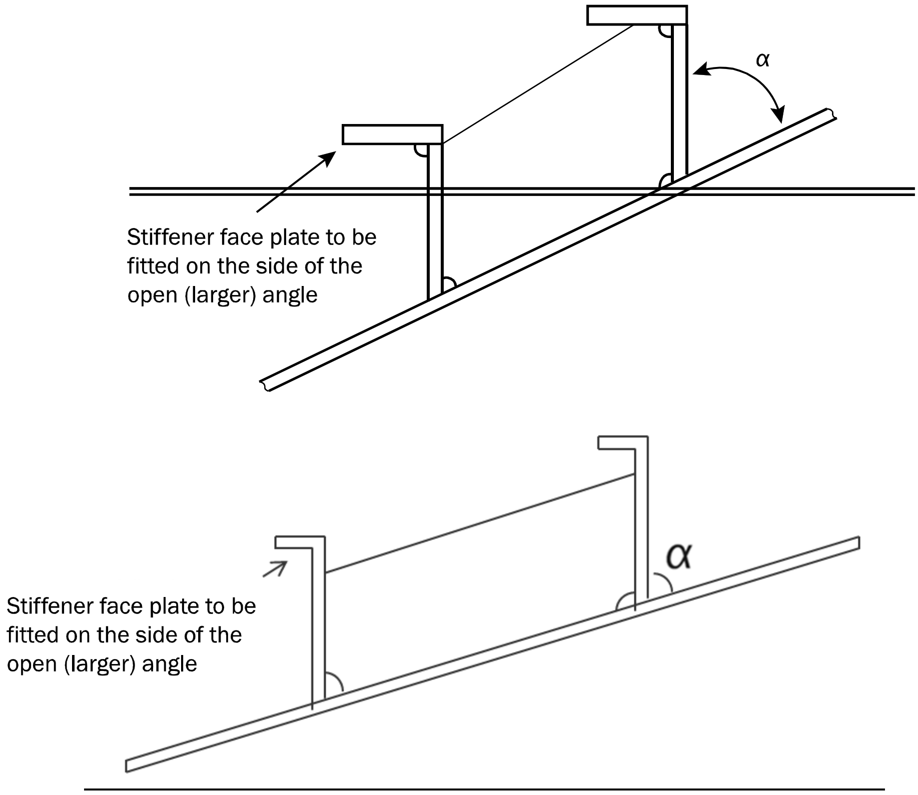


Fig. 2 has been amended as follows.

Fig. 2 Stiffener on Attached Plating with an Angle less than 50 *deg*



3. Stiffeners

3.2 Bracketed End Connections of Non-continuous Stiffeners

Paragraph 3.2.5 has been amended as follows.

3.2.5 Brackets at the ends of non-continuous stiffeners

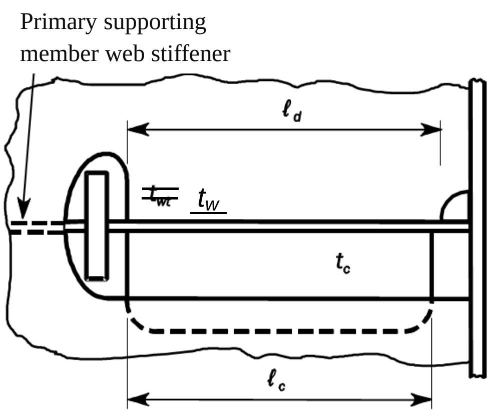
Brackets are to be fitted at the ends of non-continuous stiffeners, with arm lengths, ℓ_{bkt} , in *mm*, taken as:

(Omitted)

For connections similar to items **(c)** and **(d)** in **Fig. 3** where the smaller stiffener is connected to a primary supporting member or bulkhead, the bracket arm length is not to be less than two times of h_{stf}.

Fig. 8(e) has been amended as follows.

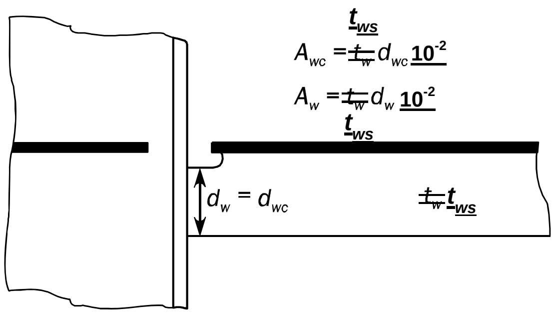
Fig. 8 Symmetric and Asymmetric Cut-outs



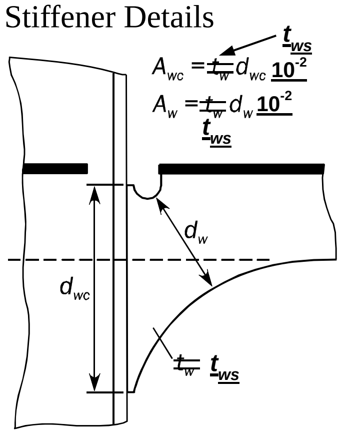
(e) Lug or collar plate and direct connection

Fig. 9 has been amended as follows.

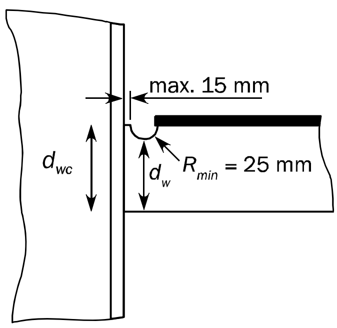
Fig. 9 Primary Supporting Member Web Stiffener Details



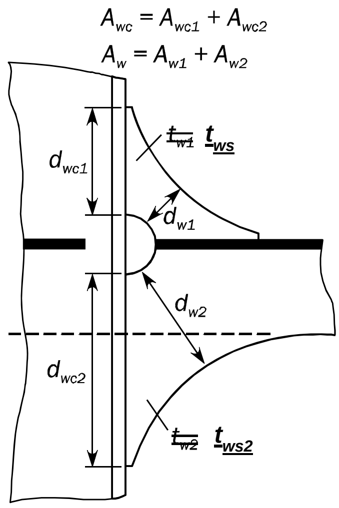
(a) Straight heel no bracket



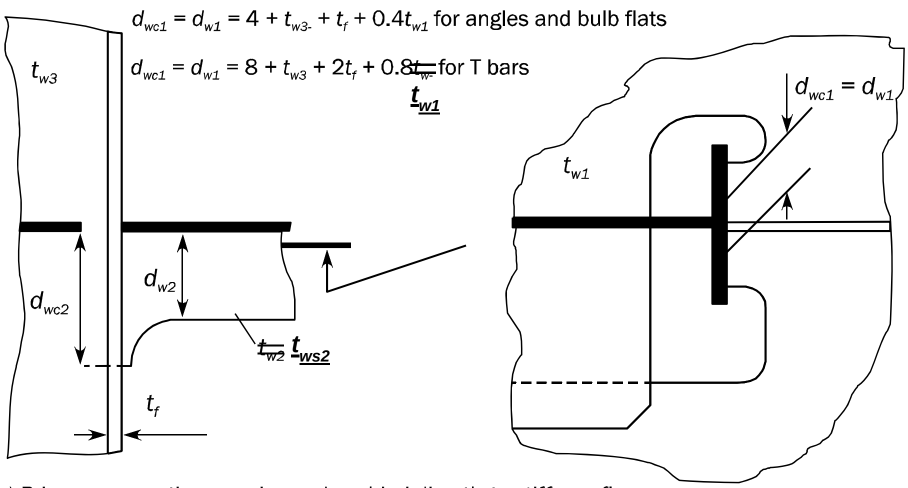
(b) Soft toe and soft heel



(c) Keyhole in way of soft heel



(d) Symmetrical soft toe brackets



(e) Primary supporting member web welded directly to stiffener flange

t_{ws}, t_{ws1}, t_{ws2} : Net thickness of the primary supporting member web stiffener/backing bracket, in *mm*.
d_w, d_{w1}, d_{w2} : Minimum depth of the primary supporting member web stiffener/backing bracket, in *mm*.
d_{wc}, d_{wc1}, d_{wc2} : Length of connection between the primary supporting member web stiffener/backing bracket and the stiffener, in *mm*.

t_f : Net thickness of the flange in *mm*. For bulb profile, t_f is to be obtained as defined in **Pt 1, Ch 3, Sec7, 1.4.1.**

5. Intersection of Stiffeners and Primary Supporting Members

5.2 Connection of Stiffeners to PSM

Paragraph 5.2.3 has been amended as follows.

5.2.3

The load, W_2, in *kN*, transmitted through the PSM web stiffener is to be taken as:
(Omitted)

τ_w : Shear stress, in N/mm^2, in the shear connection to the PSM web:

$$\cancel{\tau_{wc} = \frac{10W_1}{A_1}} \qquad \underline{\tau_w = \frac{10W_1}{A_1}}$$

(Omitted)

8. Double Side Structure

8.1 General

Paragraph 8.1.1 has been amended as follows.

8.1.1

Side shell~~,~~ and inner hull bulkheads ~~and longitudinal bulkheads~~ are generally to be longitudinally framed. Where the side shell is longitudinally framed, the inner hull bulkheads are to be longitudinally framed. Alternative framing arrangements are to be specially considered by the Society.

Section 7 STRUCTURAL IDEALISATION

1. Structural Idealisation of Stiffeners and Primary Supporting Members

1.4 Geometrical Properties of Stiffeners and Primary Supporting Members

Paragraph 1.4.8 has been amended as follows.

1.4.8 Shear area of primary supporting members with web openings

The effective web height, h_{eff}, in *mm*, to be considered for calculating the effective net shear area, $A_{sh\text{-}n50}$ is to be taken as the lesser of the following, where the third formula is only taken into account for an opening located at a distance less than $h_w/3$ from the cross-section considered. ~~:~~

$h_{eff} = h_w$

$h_{eff} = h_{w3} + h_{w4}$

$h_{eff} = h_{w1} + h_{w2} + h_{w4}$

where:

h_w: Web height of primary supporting member, in *mm*.

h_{w1}, h_{w2}, h_{w3}, h_{w4}: Dimensions as shown in **Fig. 16**.

Fig. 16 Effective Shear Area in way of Web Openings

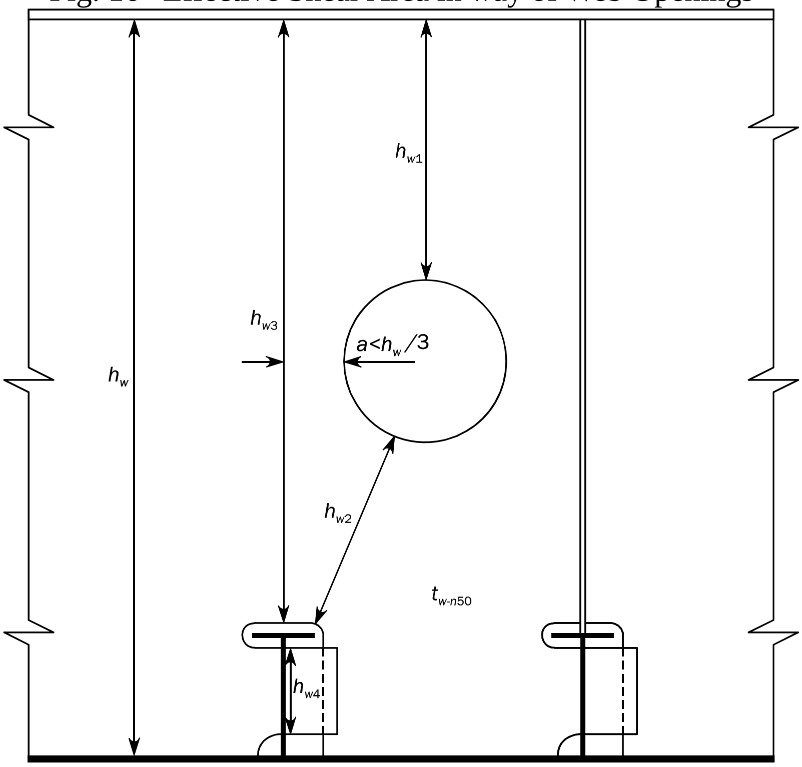


Table 5 has been amended as follows.

Table 5 *LCP* Coordinates for Plate Buckling

LCP coordinates	*LCP* for pressure	*LCP* for hull girder stresses (**Fig. 23**)		
		Bending stresses(1)		Shear stresses
		Non horizontal plate	Horizontal plate	
x coordinate	Same coordinates as *LCP* for yielding See **Table 4**	Mid-length of the *EPP*		
y coordinate		Both upper and lower ends of the *EPP* (points *A*1 and *A*2)	Outboard and inboard ends of the *EPP* (points *A*1 and *A*2)	Mid-point of *EPP* (point *B*)
z coordinate		Corresponding to *x* and *y* values		
(1) The bending stress for curved plate panel is the mean value of the stresses calculated at points *A*1 and *A*2.				

LCP coordinates	*LCP* for pressure	*LCP* for hull girder stresses (**Fig. 23**)		
		Bending stresses(1)		Shear stresses
		Non horizontal plate	Horizontal plate	
x coordinate	Same coordinates as *LCP* for yielding See **Table 4**	Mid-length of the *EPP*		
y coordinate		Corresponding to *x* and *z* values	Outboard and inboard ends of the *EPP* (points *A*1 and *A*2)	Mid-point of *EPP* (point *B*)
z coordinate		Both upper and lower ends of the *EPP* (points *A*1 and *A*2)	Corresponding to *x* and *y* values	
(1) The bending stress for curved plate panel is the mean value of the stresses calculated at points *A*1 and *A*2.				

Chapter 4 LOADS

Section 3 SHIP MOTIONS AND ACCELERATIONS

2. Ship Motions and Accelerations

2.1 Ship Motions

Paragraph 2.1.1 has been amended as follows.

2.1.1 Roll motion

The roll period T_θ, in *s*, to be taken as:

$$T_\theta = \frac{2.3\pi k_r}{\sqrt{g\,GM}}$$

The roll angle θ, in *deg*, to be taken as:

$$\cancel{\theta = \frac{9000(1.25-0.025T_B)f_p\ f_{BK}}{(B+75)\pi}} \qquad \underline{\theta = \frac{9000(1.25-0.025T_\theta)f_p\ f_{BK}}{(B+75)\pi}}$$

where:

f_p : Coefficient to be taken as:

$f_p = f_{ps}$ for strength assessment.

$f_p = f_{fa}(0.23 - 4\,f_T B \times 10^{-4})$ for fatigue assessment.

(Omitted)

Section 6 INTERNAL LOADS

1. Pressures Due to Liquids

1.2 Static Liquid Pressure

Paragraph 1.2.2 has been amended as follows.

1.2.2 Harbour/sheltered water operations

The static pressure, P_{ls} due to liquid in tanks and ballast holds for harbour/sheltered water operations, in kN/m^2, is to be taken as:

$P_{ls} = \rho_L \, g\left(z_{top} - z + h_{air}\right) + P_{drop}$ for ballast tanks

$P_{ls} = \rho_L \, g\left(z_{top} - z\right) + P_{PV}$ for cargo tanks filled with liquid cargo

$P_{ls} = \rho_L \, g\left(z_{top} - z + 0.5h_{air}\right)$ for <u>ballast holds with h_{air}=0 and for</u> other cases

5. Loads on Non-exposed Decks and Platforms

5.3 Concentrated Force due to Unit Load

Paragraph 5.3.1 has been amended as follows.

5.3.1

If a unit load is carried on an internal deck, the static and dynamic forces due to the unit load carried are to be considered <u>when a direct analysis is applied for stiffeners or primary supporting members such as in **Pt 1, Ch 6, Sec 5, 1.2** or **Pt 1, Ch 6, Sec 6, 3.3** respectively</u>.

Section 8 LOADING CONDITIONS

Table 12 has been amended as follows.

Table 12 FE Load combinations applicable to empty hold in alternate condition of *BC-A* (EA) - midship cargo hold region

No.	Description Reqt ref	Loading pattern Aft Mid Fore	Draught	$C_{BM\text{-}LC}$: % of perm. SWBM	$C_{SF\text{-}LC}$: % of perm. SWSF	Dynamic load case
(Omitted)						

(1) Loading pattern No. 1 with the cargo mass M_{Full} and the maximum cargo density as defined in **4.1.4** can be analysed in lieu of this loading pattern.

(2) Maximum cargo density as defined in **4.1.4** is to be used for calculation of dry cargo pressure.

(3) In case of no ballast hold, normal ballast condition with assuming M_{SW} = 100% (hog.) is to be analysed.

(4) Position of ballast hold is to be adjusted as appropriate.

(5) This condition is only required when this loading condition is included in the loading manual.

(6) Actual still water vertical bending moment, as given in the loading manual, may be used instead of design value.

(7) This condition is to be considered for the empty hold which is assigned as ballast hold, if any.

(8) For the mid-hold where $\cancel{x_{b-aft} < 0.5L_{CSR}}$ $\underline{x_{b-aft} \leq 0.5L_{CSR}}$ and $\cancel{x_{b-fwd} > 0.5L_{CSR}}$ $\underline{x_{b-fwd} \geq 0.5L_{CSR}}$, the shear force is to be adjusted to target value at aft bulkhead of the mid-hold.

(9) For the mid-hold where $\cancel{x_{b-aft} < 0.5L_{CSR}}$ $\underline{x_{b-aft} \leq 0.5L_{CSR}}$ and $\cancel{x_{b-fwd} > 0.5L_{CSR}}$ $\underline{x_{b-fwd} \geq 0.5L_{CSR}}$, the shear force is to be adjusted to target value at forward bulkhead of the mid-hold.

(10) This load combination is to be considered only for the mid-hold where $x_{b-aft} > 0.5L_{CSR}$ or $x_{b-fwd} < 0.5L_{CSR}$.

(11) The shear force is to be adjusted to target value at aft bulkhead of the mid-hold.

(12) The shear force is to be adjusted to target value at forward bulkhead of the mid-hold.

(13) This condition is only required when block loading condition is included in the loading manual.

Table 13 has been amended as follows.

Table 13 FE Load combinations applicable to loaded hold in alternate condition of *BC-A* (FA) - midship cargo hold region

No.	Description Reqt ref	Loading pattern Aft Mid Fore	Draught	C_{BM-LC} : % of perm. SWBM	C_{SF-LC} : % of perm. SWSF	Dynamic load case
(Omitted)						

(1) Loading pattern no. 1 with the cargo mass M_{Full} and the maximum cargo density as defined in **4.1.4** can be analysed in lieu of this loading pattern.

(2) Maximum cargo density as defined in **4.1.4** is to be used for calculation of dry cargo pressure.

(3) In case of no ballast hold, normal ballast condition with assuming M_{SW} = 100% (hog.) is to be analysed.

(4) Position of ballast hold is to be adjusted as appropriate.

(5) This condition is only required when block loading condition is included in the loading manual.

(6) Actual still water vertical bending moment, as given in the loading manual, may be used instead of design value.

(7) This condition is to be considered for the heavy cargo hold which is assigned as ballast hold, if any.

(8) For the mid-hold where $\cancel{x_{b-aft} < 0.5L_{CSR}}$ $\underline{x_{b-aft} \le 0.5L_{CSR}}$ and $\cancel{x_{b-fwd} > 0.5L_{CSR}}$ $\underline{x_{b-fwd} \ge 0.5L_{CSR}}$, the shear force is to be adjusted to target value at aft bulkhead of the mid-hold.

(9) For the mid-hold, where $\cancel{x_{b-aft} < 0.5L_{CSR}}$ $\underline{x_{b-aft} \le 0.5L_{CSR}}$ and $\cancel{x_{b-fwd} > 0.5L_{CSR}}$, $\underline{x_{b-fwd} \ge 0.5L_{CSR}}$ the shear force is to be adjusted to target value at forward bulkhead of the mid-hold.

(10) This load combination is to be considered only for the mid-hold, where $x_{b-aft} > 0.5L_{CSR}$ or $x_{b-fwd} < 0.5L_{CSR}$.

(11) The shear force is to be adjusted to target value at aft bulkhead of the mid-hold.

(12) The shear force is to be adjusted to target value at forward bulkhead of the mid-hold.

(13) This condition is only required when block loading condition is included in the loading manual.

Table 14 has been amended as follows.

Table 14 FE Load combinations applicable for *BC-B* & *BC-C* - midship cargo hold region

No.	Description Reqt ref	Loading pattern Aft Mid Fore	Draught	$C_{BM\text{-}LC}$: % of perm. SWBM	$C_{SF\text{-}LC}$: % of perm. SWSF	Dynamic load case
(Omitted)						

(1) Applicable to *BC-B* only.

(2) For *BC-B* ships, the loading pattern no. 1 with the cargo mass M_{Full} and the maximum cargo density as defined in **4.1.3** can be analysed in lieu of this loading pattern.

(3) Maximum cargo density as defined in **4.1.3** is to be used for calculation of dry cargo pressure.

(4) In case of no ballast hold, normal ballast condition with assuming M_{SW} = 100% (hog.) is to be analysed.

(5) Position of ballast hold is to be adjusted as appropriate.

(6) This condition is to be considered for the cargo hold which is assigned as ballast hold, if any.

(7) For the mid-hold where $\cancel{x_{b-aft} < 0.5L_{CSR}}$ $\underline{x_{b-aft} \le 0.5L_{CSR}}$ and $\cancel{x_{b-fwd} > 0.5L_{CSR}}$ $\underline{x_{b-fwd} \ge 0.5L_{CSR}}$, the shear force is to be adjusted to target value at aft bulkhead of the mid-hold.

(8) For the mid-hold where $\cancel{x_{b-aft} < 0.5L_{CSR}}$ $\underline{x_{b-aft} \le 0.5L_{CSR}}$ and $\cancel{x_{b-fwd} > 0.5L_{CSR}}$ $\underline{x_{b-fwd} \ge 0.5L_{CSR}}$, the shear force is to be adjusted to target value at forward bulkhead of the mid-hold.

(9) This load combination is to be considered only for the mid-hold where $x_{b-aft} > 0.5L_{CSR}$ or $x_{b-fwd} < 0.5L_{CSR}$.

(10) The shear force is to be adjusted to target value at aft bulkhead of the mid-hold.

(11) The shear force is to be adjusted to target value at forward bulkhead of the mid-hold.

Chapter 5 HULL GIRDER STRENGTH

Section 1 HULL GIRDER YIELDING STRENGTH

1. Strength Characteristics of Hull Girder Transverse Sections

1.2 Hull Girder Transverse Sections

Sub-paragraph 1.2.9(b) has been amended as follows.

1.2.9 Definitions of openings

The following definitions of opening are to be applied:

(a) Large openings are:

- Elliptical openings exceeding 2.5 *m* in length or 1.2 *m* in breadth.
- Circular openings exceeding 0.9 *m* in diameter.

(b) Small openings (i.e. ~~lightening~~ drain holes, etc.) are openings that are not large ones.

(c) Manholes

(d) Isolated openings are openings spaced not less than 1 *m* apart in the ship's transverse/vertical direction.

3. Hull Girder Shear Strength Assessment

3.5 Effective Net Thickness for Longitudinal Bulkheads between Cargo Tanks of Oil Tankers - Correction due to Loads from Transverse Bulkhead Stringers

Paragraph 3.5.1 has been amended as follows.

3.5.1

In way of transverse bulkhead stringer connections, within areas as specified in **Fig. 7**, the equivalent net thickness of plate, $t_{sti\text{-}k\text{-}n50}$ in *mm*, where the index *k* refers to the identification number of the stringer, is not to be taken greater than:

$$t_{sti-k-n50} = t_{sfi-n50}\left(1 - \frac{\tau_{sti-k}}{\tau_{i-perm}}\right)$$

where:

τ_{sti-k} : Shear stress in plate *i*, in N/mm^2, in the longitudinal bulkhead due to the stringer force in way of stringer *k*, taken as:

$$\tau_{sti-k} = \frac{Q_{st-k}}{l_{st-k}\, t_{sfi-n50}}$$

$t_{sfi-n50}$: Effective net plating thickness as defined in **3.4.1**, in *mm*, calculated at the transverse bulkhead for the height corresponding to the level of the stringer.

τ_{t-perm} : Permissible hull girder shear stress, in N/mm^2, for the plate *i*.

$$\tau_{i-perm} = 120/k$$

(Omitted)

Appendix 1 DIRECT CALCULATION OF SHEAR FLOW

1. Calculation Formula

1.2 Determinate Shear Flow

Paragraph 1.2.1 has been amended as follows.

1.2.1

The determinate shear flow, q_D in N/mm, at each location in the cross section can be obtained from the following line integration:

$$\cancel{q_D(S) = -\frac{1}{10^6 I_{y-n50}} \int_0^s (z - z_n) t_{n50} ds}$$

$$\underline{q_D(s) = -\frac{1}{10^6 I_{y-n50}} \int_0^s (z - z_n) t_{n50} ds}$$

where:

s :Coordinate value of running coordinate along the cross section, in m.

I_{y-n50}: Moment inertia of the cross section, in m^4.

t_{n50} : Net thickness of plating, in mm, or equivalent net thickness of corrugated plate as defined in **Ch 5, Sec1, 3.4.6**.

Paragraph 1.2.4 has been amended as follows.

1.2.4

Calculations of the determinate shear flow at bifurcation points can be calculated such as water flow calculations as shown in **Fig. ~~3~~<u>2</u>**.

1.4 Computation of Several Properties of the Cross Section

Paragraph 1.4.1 has been amended as follows.

1.4.1

Properties of the cross section can be obtained by the following formulae where the cross section is assumed as the assembly of line segments:

$$\ell = \sqrt{(y_k - y_i)^2 + (z_k - z_i)^2}$$

$$a_{n50} = 10^{-3} \ell t_{n50} \qquad A_{n50} = \sum a_{n50}$$

$$s_{y-n50} = \frac{a_{n50}}{2}(z_k + z_i) \qquad S_{y-n50} = \sum s_{y-n50}$$

$$\cancel{i_{y0-n50} = \frac{a_{n50}}{2}(z_k^2 + z_k z_i + z_i^2)} \; \underline{i_{y0-n50} = \frac{a_{n50}}{3}(z_k^2 + z_k z_i + z_i^2)} \qquad I_{y0-n50} = \sum i_{y0-n50}$$

where:

a_{n50}, A_{n50}: Area of the line segment and the cross section respectively, in m^2.

s_{y-n50}, S_{y-n50}: First moment of the line segment and the cross section about the baseline, in

m^3.

$I_{y0\text{-}n50}$, $I_{y0\text{-}n50}$: Moment inertia of the line segment and the cross section about the baseline, in m^4.

Paragraph 1.4.2 has been amended as follows.

1.4.2

The height of horizontal neutral axis, $z_{\cancel{G}n}$ in m, can be obtained as follows:

$$\cancel{z_G = \frac{S_{y-n50}}{A_{n50}}}$$

$$z_n = \frac{S_{y-n50}}{A_{n50}}$$

2. Example of Calculations for a Single Side Hull Cross Section

2.1 Cross Section Data

Paragraph 2.1.2 has been amended as follows.

2.1.2

The Z coordinate of horizontal neutral axis and the inertia moment about the neutral axis are calculated as follow:

$$\cancel{z_G = \frac{\sum S_{y-n50}}{\sum a_{n50}} = \frac{11.686}{1.416} = 8.255}$$

$$z_n = \frac{\sum S_{y-n50}}{\sum a_{n50}} = \frac{11.686}{1.416} = 8.255$$

$$I_{y-n50} = 2(\sum i_{y0-n50} - z_n^2 \sum a_{n50}) = 2(185.138 - 8.255^2 \times 1.416) = 177.34$$

Appendix 2 HULL GIRDER ULTIMATE CAPACITY

2. Incremental-iterative Method

2.3 Calculations of the Indeterminate Shear Flow

Paragraph 2.3.1 has been amended as follows.

2.3.1 Stiffened plate element and stiffener element

Stiffened plate element and stiffener element composing the hull girder transverse sections may collapse following one of the modes of failure specified in **Table 1**.

- Where the plate members are stiffened by non-continuous longitudinal stiffeners, the stress of the element is to be obtained in accordance with **2.3.3** to **2.3.8**, taking into account the non-continuous longitudinal stiffener. In calculating the total forces for checking the hull girder ultimate strength, the area of non-continuous longitudinal stiffener is to be assumed as zero.

~~In calculating the total forces for checking the hull girder ultimate strength, the area of non-continuous longitudinal stiffener is to be assumed as zero.~~

- Where the opening is provided in the stiffened plate element, the considered area of the stiffened plate element is to be obtained by deducting the opening area from the plating in calculating the total forces for checking the hull girder ultimate strength. The consideration of the opening is in accordance with the requirement in **Ch 5, Sec 1, 1.2.9**.

(Omitted)

Chapter 6 HULL LOCAL SCANTLING

Section 4 PLATING

2. Special Requirements

2.2 Bilge Plating

Paragraph 2.2.2 has been amended as follows.

2.2.2 Bilge plate thickness ~~within 0.4L_{CSR} amidships~~

(a) The net thickness of bilge plating is not to be taken less than the offered net thickness for the adjacent bottom shell or adjacent side shell plating, whichever is greater.

(b) The net thickness of ~~curved~~ rounded bilge plating, t, in *mm*, is not to be taken less than:

$$t = 6.45 \times 10^{-4} (P_{ex} s_b)^{0.4} R^{0.6}$$

where:

P_{ex} : Design sea pressure for the design load set SEA-1 as defined in **Ch 6, Sec 2, 2.1.3** calculated at the lower turn of the bilge, in kN/m^2.

R: Effective bilge radius in *mm*.

$$R = R_0 + 0.5(\Delta s_1 + \Delta s_2)$$

R_0 : Radius of curvature, in *mm*. See **Fig.1**.

Δs_1 : Distance between the lower turn of bilge and the outermost bottom longitudinal, in *mm*, see **Fig.1**. Where the outermost bottom longitudinal is within the curvature, this distance is to be taken as zero.

Δs_2 : Distance between the upper turn of bilge and the lowest side longitudinal, in *mm*, see **Fig.1**. Where the lowest side longitudinal is within the curvature, this distance is to be taken as zero.

s_b : Distance between transverse stiffeners, webs or bilge brackets, in *mm*.

(c) Longitudinally stiffened bilge plating is to be assessed as regular stiffened plating. The bilge thickness is not to be less than the lesser of the value obtained by **1.1.1** and **2.2.2(b)**. A bilge keel is not considered as an effective 'longitudinal stiffening' member ~~and unless other longitudinal stiffeners are fitted, this requirement has to be applied~~.

Paragraph 2.2.3 has been deleted.

2.2.3 ~~Bilge plate thickness outside 0.4L_{CSR} amidships~~(deleted)

~~For bilge plating outside 0.4LCSR amidships, the bilge plate thickness requirement in **2.2.2** is applicable. Special consideration is to be made in evaluation of support provided by the hull form and internal stiffening arrangements. Outside of 0.4LCSR amidships, the bilge plating thickness and arrangement are to comply with the requirements to side shell or bottom plating in the same region.~~

Section 5 STIFFENERS

1. Stiffeners subject to Lateral Pressure

1.1 Yielding Check

Paragraph 1.1.4 has been amended as follows.

1.1.4 Plate and stiffener of different materials

When the minimum specified yield stress of a stiffener exceeds the minimum specified yield stress of the attached plate by more than 35%, the following criterion is to be satisfied:

$$\cancel{R_{eH} \leq \left(R_{eH-P} - \frac{\sigma_S |\sigma_{hg}|}{\beta_S} \right) \frac{Z_P}{Z} + \frac{\alpha_s |\sigma_{hg}|}{\beta_S}}$$

$$\underline{R_{eH-S} \leq \left(R_{eH-P} - \frac{\sigma_S |\sigma_{hg}|}{\beta_S} \right) \frac{Z_P}{Z} + \frac{\alpha_s |\sigma_{hg}|}{\beta_S}}$$

(Omitted)

Chapter 7 DIRECT STRENGTH ANALYSIS

Section 2 CARGO HOLD STRUCTURAL STRENGTH ANALYSIS

4. Load Application

4.3 Hull Girder Loads

Paragraph 4.3.3 has been amended as follows.

4.3.3 Target hull girder shear force

The target hull girder vertical shear force at the aft and forward transverse bulkheads of the mid-hold, $Q_{targ\text{-}aft}$ and $Q_{targ\text{-}fwd}$, in kN, for a given FE load combination is taken as:

- $Q_{fwd} \geq Q_{aft}$:

$$Q_{targ-aft} = C_{SF-LC} \cdot Q_{sw-neg} - \Delta Q_{swa} + f_\beta \left|C_{QW}\right| Q_{wv-neg}$$

$$Q_{targ-fwd} = C_{SF-LC} \cdot Q_{sw-pos} + \Delta Q_{swf} + f_\beta \left|C_{QW}\right| Q_{wv-pos}$$

- $Q_{fwd} < Q_{aft}$:

$$Q_{targ-aft} = C_{SF-LC} \cdot Q_{sw-pos} + \Delta Q_{swa} + f_\beta \left|C_{QW}\right| Q_{wv-pos}$$

$$Q_{targ-fwd} = C_{SF-LC} \cdot Q_{sw-neg} - \Delta Q_{swf} + f_\beta \left|C_{QW}\right| Q_{wv-neg}$$

where:

Q_{fwd}, Q_{aft}: Vertical shear forces, in kN, due to the local loads respectively at the forward and aft bulkhead position of the mid-hold, as defined in **4.4.~~7~~<u>6</u>**.

$C_{SF\text{-}LC}$: Percentage of permissible still water shear force as given in **Ch 4, Sec 8**, for the FE load combination under consideration.

(Omitted)

4.4 Procedure to Adjust Hull Girder Shear Forces and Bending Moments

Paragraph 4.4.3 has been amended as follows.

4.4.3 Hull girder forces and bending moment due to local loads

With the local load distribution, the hull girder load longitudinal distributions are obtained by assuming the model is simply supported at model ends. The reaction forces at both ends of the model and longitudinal distributions of hull girder shear forces and bending moments induced by local loads at any longitudinal station are determined by the following formulae:

$$R_{V\_fore} = -\frac{\sum_i (x_i - x_{aft}) f_{vi}}{x_{fore} - x_{aft}} \qquad R_{V\_aft} = \sum_i f_{vi} + R_{V\_fore}$$

$$R_{H\_fore} = \frac{\sum_i (x_i - x_{aft}) f_{hi}}{x_{fore} - x_{aft}} \qquad R_{H\_aft} = -\sum_i f_{hi} + R_{H\_fore}$$

$$F_l = \sum_i f_{li}$$

$$Q_{V\_FEM}(x_j) = R_{V\_aft} - \sum_i f_{vi} \qquad \text{when} \quad x_i < x_j$$

$$\cancel{Q_{H\_FEM}(x_j) = R_{H\_aft} - \sum_i f_{hi}} \quad \underline{Q_{H\_FEM}(x_j) = R_{H\_aft} + \sum_i f_{hi}} \qquad \text{when} \quad x_i < x_j$$

$$M_{V\_FEM}(x_j) = (x_j - x_{aft}) R_{V\_aft} - \sum_i (x_j - x_i) f_{vi} \qquad \text{when} \quad x_i < x_j$$

$$\cancel{M_{H\_FEM}(x_j) = (x_j - x_{aft}) R_{H\_aft} - \sum_i (x_j - x_i) f_{hi}}$$

$$\underline{M_{H\_FEM}(x_j) = (x_j - x_{aft}) R_{H\_aft} + \sum_i (x_j - x_i) f_{hi}} \qquad \text{when} \quad x_i < x_j$$

(Omitted)

Table 11 has been amended as follows.

Table 11 Exceptions for Shear Stress Correction

Identification	Figure	Difference between modelled shear area and the net effective shear area in % of the ~~net effective~~ <u>modelled</u> shear area $\cancel{\frac{A_{FEM-n50} - A_{shr-n50}}{A_{shr-n50}} \cdot 100\%}$ $\underline{\frac{A_{FEM-n50} - A_{shr-n50}}{A_{FEM-n50}} \cdot 100\%}$	Reduction factor for yield criteria, C_r
(Omitted)			

Section 3 LOCAL STRUCTURAL STRENGTH ANALYSIS

6. Analysis Criteria

6.2 Acceptance Criteria

Paragraph 6.2.1 has been amended as follows.

6.2.1

Verification of stress results against the acceptance criteria is to be carried out in accordance with **6.1**.

The structural assessment is to demonstrate that the stress complies with the following criteria:

$\lambda_f \leq \lambda_{fperm}$

where:

λ_f : Fine mesh yield utilisation factor.

$$\cancel{\lambda_f = \frac{\sigma_{vm}}{R_y}} \quad \underline{\lambda_f = \frac{\sigma_{vm}}{R_Y}} \quad \text{or shell elements in general}$$

$$\cancel{\lambda_f = \frac{|\sigma_{axial}|}{R_y}} \quad \underline{\lambda_f = \frac{|\sigma_{axial}|}{R_Y}} \quad \text{for rod or beam elements in general}$$

(Omitted)

Chapter 8 BUCKLING

Section 3 PRESCRIPTIVE BUCKLING REQUIREMENTS

1. General

1.2 Equivalent Plate Panel

Paragraph 1.2.1 has been amended as follows.

1.2.1

In longitudinal stiffening arrangement, when the plate thickness varies over the width b, of a plate panel, the buckling check is to be performed for an equivalent plate panel width, combined with the smaller plate thickness, t_1. The width of this equivalent plate panel, b_{eq}, in mm, is defined by the following formula:

$$b_{eq} = \ell_1 + \ell_2 \left(\frac{t_1}{t_2} \right)^{1.5}$$

where:

ℓ_1 : Width of the part of the plate panel with the smaller <u>net</u> plate thickness, t_1, in *mm*, as defined in **Fig. 1**.

ℓ_2 : Width of the part of the plate panel with the greater <u>net</u> plate thickness, t_1, in *mm*, as defined in **Fig. 1**.

Title of Fig. 1 has been amended as follows.

Fig. 1 Plate Thickness Change over the <u>Width</u>

2. Hull Girder Stress

2.1 General

Paragraph 2.1.2 has been amended as follows.

2.1.2

The hull girder shear stresses, τ_{hg}, in N/mm^2, in the plate i are determined as follows:

$$\tau_{hg} = \frac{Q_{Tot}(x) q_{vi}}{t_{i-n50}} 10^3$$

where:

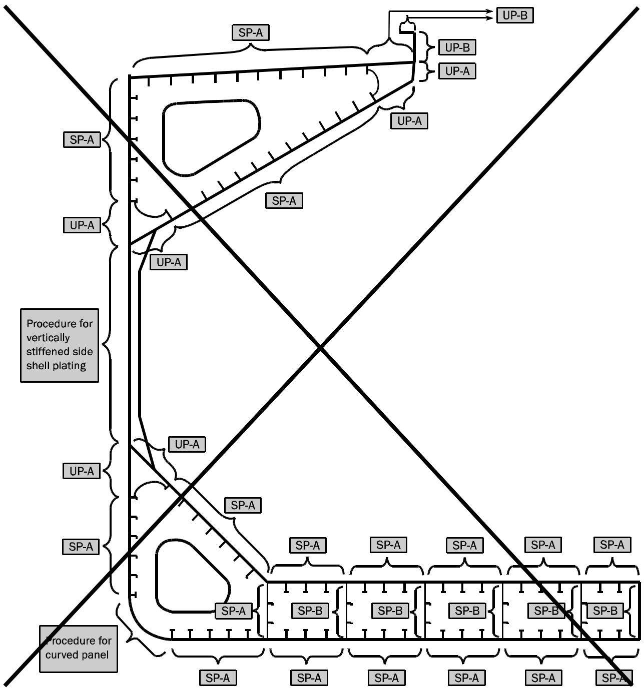
$Q_{Tot}(x)$: Total vertical shear force, in kN, at the ship longitudinal location x, taken as ~~the greater of the following values~~ <u>follows</u>:

(Omitted)

Section 4 BUCKLING REQUIREMENTS FOR DIRECT STRENGTH ANALYSIS

Fig. 5 has been amended as follows.

Fig. 5 Longitudinal Plates for Single Hull Bulk Carrier



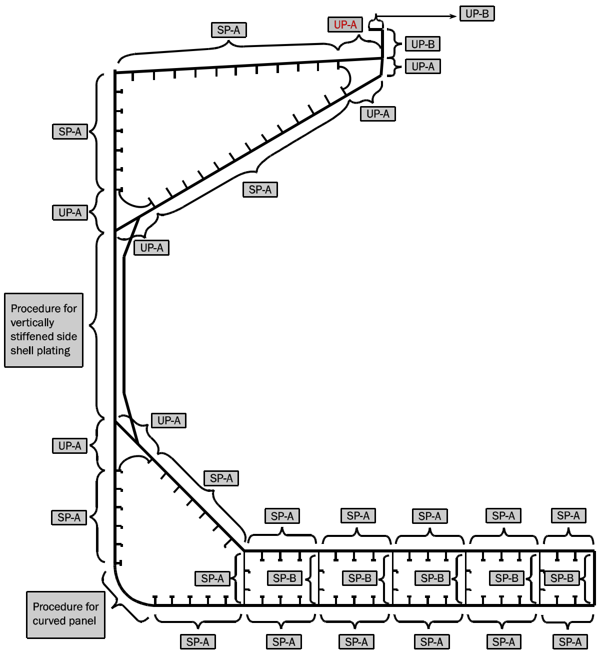
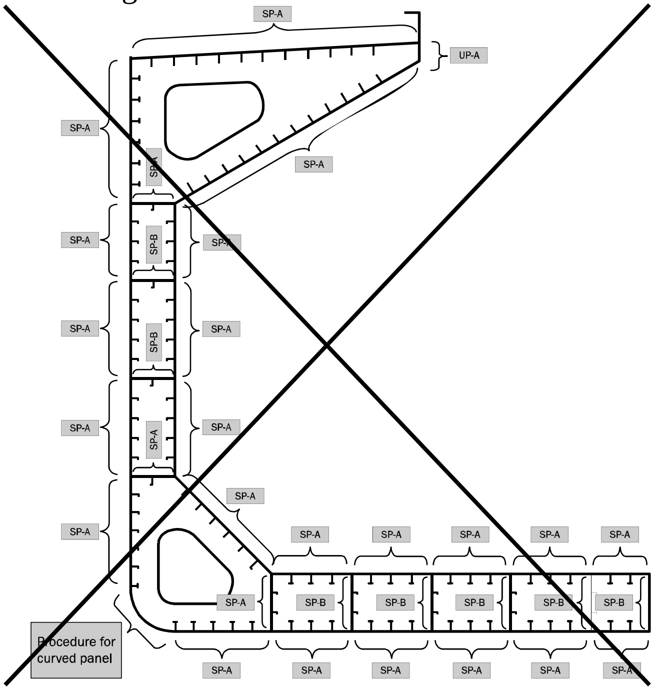
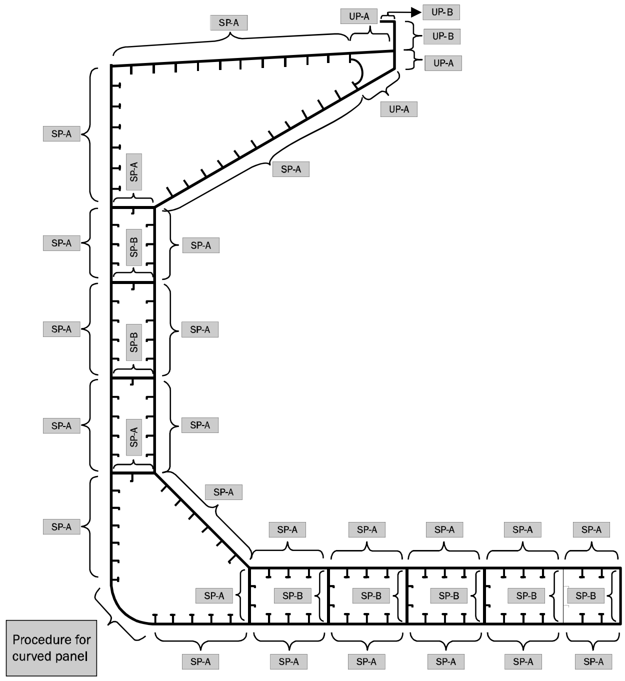


Fig. 7 has been amended as follows.

Fig. 7 Longitudinal Plates for Double Hull Bulk Carrier



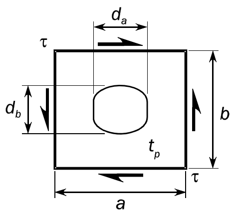
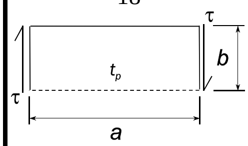


Section 5 BUCKLING CAPACITY

2. Buckling Capacity of Plates and Stiffeners

Table 3 has been amended as follows.

Table 3 Buckling Factor and Reduction Factor for Plane Plate Panels

Case	Stress ratio ψ	Aspect ratio α	Buckling factor K	Reduction factor C
17 	–		$\cancel{K_\tau = K_{\tau case11} r}$ $K_\tau = K_{\tau case15} r$ $\cancel{K_{\tau case11}}$ $K_{\tau case15}$ according to case ~~11~~15 r : opening reduction factor taken as: $r = \left(1 - \frac{d_a}{a}\right)\left(1 - \frac{d_b}{b}\right)$ with $\frac{d_a}{a} \le 0.7$ and $\frac{d_b}{b} \le 0.7$	$C_\tau = 1$ for $\lambda \le 0.84$ $C_\tau = \frac{0.84}{\lambda}$ for $\lambda > 0.84$
18 	–		$\cancel{K_\tau = 3^{0.5}(0.6 + 4/\alpha^2)}$ $K_\tau = \sqrt{3}(0.6 + 4/\alpha^2)$	$C_\tau = 1$ for $\lambda \le 0.84$ $C_\tau = \frac{0.84}{\lambda}$ for $\lambda > 0.84$
Note 1: Cases listed are general cases. Each stress component (σ_x, σ_y) is to be understood in local coordinates.				

2.3 Stiffeners

Paragraph 2.3.4 has been amended as follows.

2.3.4 Ultimate buckling capacity

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

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

where:

(Omitted)

c_{xa}: Coefficient to be taken as:

$$\cancel{c_{xa} = \left(\frac{\ell}{2s} + \frac{2s}{l}\right)^2} \quad c_{xa} = \left(\frac{\ell}{2s} + \frac{2s}{\ell}\right)^2 \quad \text{for} \quad \ell \ge 2s$$

$$c_{xa} = \left(1 + \left(\frac{\ell}{2s}\right)^2\right)^2 \quad \text{for} \quad \ell < 2s$$

(Omitted)

Table 6 has been amended as follows.

Table 6 Reduction Factors

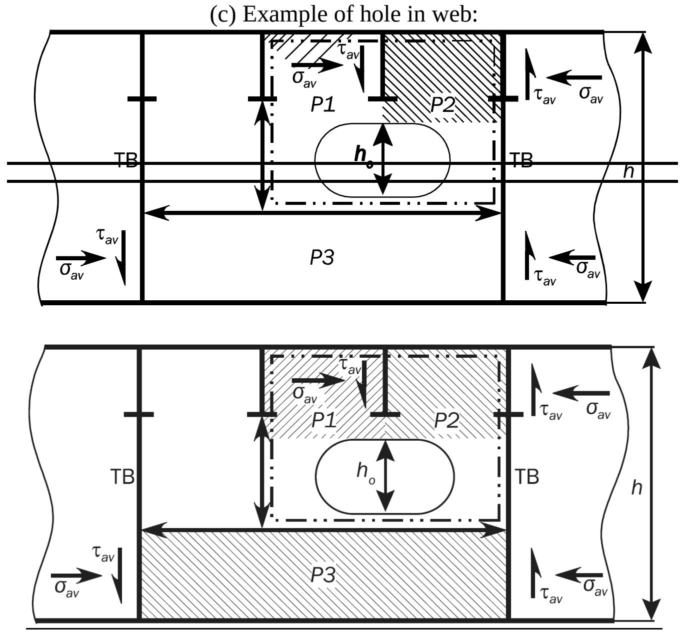
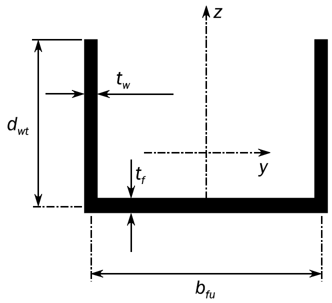
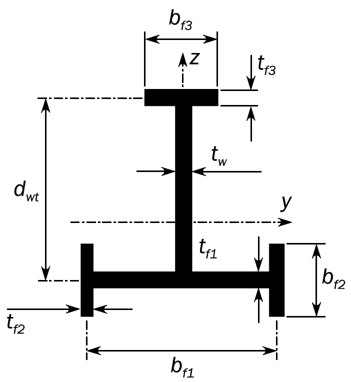
Configuration	C_x, C_y	C_τ	
		Opening modelled in PSM	Opening not modelled in PSM
(omitted)			
(c) Example of hole in web: 		Panels $P1$ and $P2$ are to be evaluated in accordance with **(a)**. Panel $P3$ is to be evaluated in accordance with **(b)**.	
Where: h : Height, in m, of the web of the primary supporting member in way of the opening. h_0: Height in m, of the opening measured in the depth of the web. τ_{av} *(web)*: Weighted average shear stress, in N/mm^2, over the web height h of the primary supporting member. Note 1: Web panels to be considered for buckling in way of openings are shown shaded and numbered $P1$, $P2$, etc.			

Table 7 has been amended as follows.

Table 7 Cross Sectional Properties

	$I_{sv-n50} = \frac{1}{3}\left(b_{fu}t_f^3 + 2d_{wt}t_w^3\right)10^{-4}$	cm^4
	$y_0 = 0$	cm
	$\cancel{z_0 = -\frac{d_{wt}^2 t_w 10^{-1}}{2d_{wt}t_w + b_f t_f} - \frac{0.5d_{wt}^2 t_w 10^{-1}}{d_{wt}t_w + b_{fu}t_f/6}}$ $z_0 = -\frac{d_{wt}^2 t_w 10^{-1}}{2d_{wt}t_w + b_{fu}t_f} - \frac{0.5d_{wt}^2 t_w 10^{-1}}{d_{wt}t_w + b_{fu}t_f/6}$	cm
	$c_{warp} = \frac{b_{fu}^2 d_{wt}^3 t_w (3d_{wt}t_w + 2b_{fu}t_f)}{12(6d_{wt}t_w + b_{fu}t_f)}10^{-6}$	cm^6
	(Omitted)	(Omitted)
	$\cancel{I_{f1} = \left(\frac{\left(b_{f1} - t_{f2}\right)^3 t_{f1}}{12} + \frac{b_{f2}t_{f2}b_{f1}^2}{12}\right)10^{-4}}$ $I_{f1} = \left(\frac{\left(b_{f1} - t_{f2}\right)^3 t_{f1}}{12} + \frac{b_{f2}t_{f2}b_{f1}^2}{2}\right)10^{-4}$	cm^4
	(Omitted)	(Omitted)

Note 1: All dimensions are in *mm*.
Note 2: Cross sectional properties are given for typical cross sections. Properties for other cross sections are to be determined by direct calculation.

Chapter 9 FATIGUE

Section 2 STRUCTURAL DETAILS TO BE ASSESSED

Table 4 has been amended as follows.

Table 4 Hot Spots for Welded Lower Hopper Knuckle Connection

Hot spot location	Procedure for calculation of hot spot stress
Hot spot 1: Inner bottom plate, on cargo tank side Hot spot 2: Hopper sloping plate, on cargo tank side	**Ch 9, Sec 5, 4.2**
Hot spot 3: Hopper web, outboard of side girder Hot spot 4: Double bottom floor, inboard the side girder Hot spot 5: Side girder	**Ch 9, Sec 5, 4.3**
Hot spot 6: Scarfing bracket to the inner bottom plate~~””.aa~~	**Ch 9, Sec 5, 3.1**, type “*b*”
(Omitted)	

Table 16 has been amended as follows.

Table 16 Hot Spots for Connection of Longitudinal Stiffener and Transverse Web Including Cut-outs and Lug Plates

Hot spot location	Procedure for calculation of hot spot stress
The critical hot spot has to be decided for each design in agreement with the Society. Typically the following three hot spot types are to be considered:	
Hot spot 1: Corners of the cut-out edge	**Ch 9, Sec 5, 3.~~1~~<u>2</u>**
Hot spot 2: Connection of transverse web/lug-plate to longitudinal stiffener web in way of slot Hot spot 3: Overlapping connection between transverse web and lug plate	**Ch 9, Sec 5, 3.1**, type “*b*”
(Omitted)	

Section 3 FATIGUE EVALUATION

3. Reference Stresses for Fatigue Assessment

3.1 Fatigue Stress Range

Paragraph 3.1.3 has been amended as follows.

3.1.3 Base material free edge

For base material free edge, the fatigue stress range, $\Delta\sigma_{FS,i(j)}$ in N/mm^2, is taken as the local stress range at free edge, $\Delta\sigma_{BS,i(j)}$, as defined in **Ch 9, Sec 1, 2.4** with correction factors:

$$\cancel{\Delta\sigma_{FS,i(j)} = K_{sf} \cdot f_{material} \cdot f_{mean,i(j)} \cdot f_{thick} \cdot \Delta\sigma_{BS,i(j)}}$$

$$\underline{\Delta\sigma_{FS,i(j)} = K_{sf} \cdot f_{material} \cdot f_{mean,i(j)} \cdot f_{thick} \cdot f_c \cdot \Delta\sigma_{BS,i(j)}}$$

where:

K_{sf} : Surface finishing factor for base material given in **4.2.3**.

$f_{material}$: Correction factor for material strength, taken as:

$$f_{material} = \frac{1200}{965 + R_{eH}}$$

$\Delta\sigma_{BS,i(j)}$: Local stress range, in N/mm^2, due to dynamic loads in load case (i) of loading condition (j) taken as:

$$\Delta\sigma_{BS,i(j)} = \left|\sigma_{BS,i1(j)} - \sigma_{BS,i2(j)}\right|$$

$\Delta\sigma_{BS,i1(j)}, \Delta\sigma_{BS,i2(j)}$: Local stress, in N/mm^2, in load case 'i1' and 'i2' of loading condition (j), obtained by very fine mesh FE analysis specified in **Ch 9, Sec 5**.

4. *S-N* Curves

4.1 Basic *S-N* Curves

Paragraph 4.1.4 has been amended as follows.

4.1.4 In-air environment

The basic design curves in-air environment shown in **Fig. 3** are represented by linear relationships between
log ($\Delta\sigma$) and log (N) as follows :

$$\log(N) = \log(K_2) - m \cdot \log(\Delta\sigma)$$

where:

$\cancel{\log(K_2) = \log(K_1) - 2\delta}$ $\underline{\log(K_2) = \log(K_1) - 2 \cdot \log(\delta)}$

K_1 : Constant related to mean *S-N* curve, as given in **Table 2**.

K_2 : Constant related to design *S-N* curve, as given in **Table 2**.

δ : Standard deviation of log (N), as given in **Table 2**.

$\Delta\sigma_q$: Stress range at $N = 10^7$ cycles related to design *S-N* curve, in N/mm^2, as given in **Table 2**.

Section 4 SIMPLIFIED STRESS ANALYSIS

4. Local Stiffener Stress

4.2 Stress due to Relative Displacement

Paragraph 4.2.4 has been amended as follows.

4.2.4 Oil tankers

The additional hot spot stress due to relative displacement for load case *i*1 and *i*2 of loading condition (*j*) for an oil tanker is to be accounted for either using finite element method as described in **4.2.6** or by applying a stress factor on the local dynamic stress component as described in the following:

$$\cancel{\sigma_{dD,ik(j)} = (K_d - 1)\cdot\left|\sigma_{LD,ik(j)}\right|} \quad \underline{\sigma_{dD,ik(j)} = (K_d - 1)\cdot\sigma_{LD,ik(j)}}$$

where:

$\sigma_{LD,ik(j)}$: Local dynamic stress defined in **4.1.1**.

K_d: Bending stress factor for longitudinal stiffeners caused by relative displacement between supports, shown on **Fig. 3**, as given in **Table 2**.

Paragraph 4.2.6 has been amended as follows.

4.2.6 Stress due to relative displacement derived using FE method

(Omitted)

$\sigma_{dFwd-a,ik(j)}$, $\sigma_{dAft-a,ik(j)}$, $\sigma_{dFwd-f,ik(j)}$, $\sigma_{dAft-f,ik(j)}$:

Additional stress at location '*a*' and '*f* ', in N/mm^2, due to the relative displacement between the transverse bulkhead including swash bulkhead or floors in way of stool and the forward (*Fwd*) and afterward (*Aft*) transverse web or floor respectively for load case *i*1 and *i*2 of loading condition (*j*), taken as:

(Omitted)

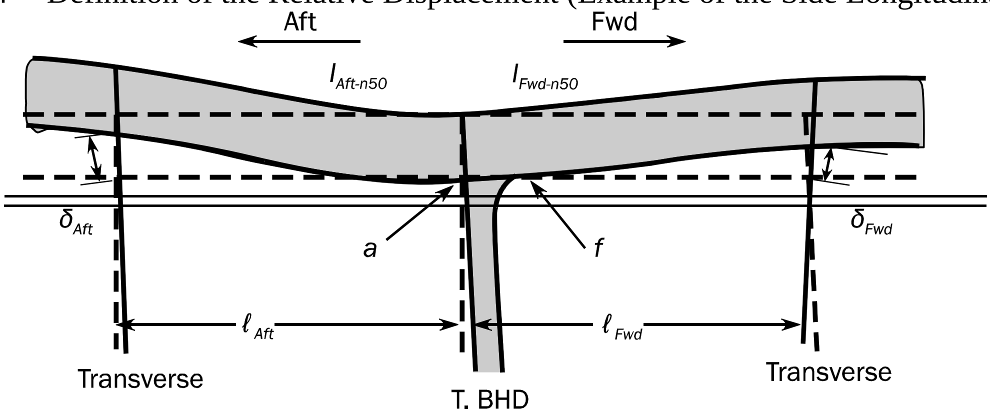
$$\cancel{\sigma_{dFwd-f,ik(j)} = \left[\frac{3.9\delta_{Fwd,ik(j)} EI_{Aft-n50} I_{Fwd-n50}}{Z_{Fwd-n50}\ell_{Fwd}\left(\ell_{Aft} I_{Fwd} + \ell_{Fwd} I_{Aft-n50}\right)}\left(1-1.15\frac{\left|x_{eFwd}\right|}{\ell_{Fwd}}\right) - \frac{0.9\delta_{Fwd,ik(j)} EI_{Fwd-n50}\left|x_{eFwd}\right|}{Z_{Fwd-n50}\ell_{Fwd}^3}\right]10^{-5}}$$

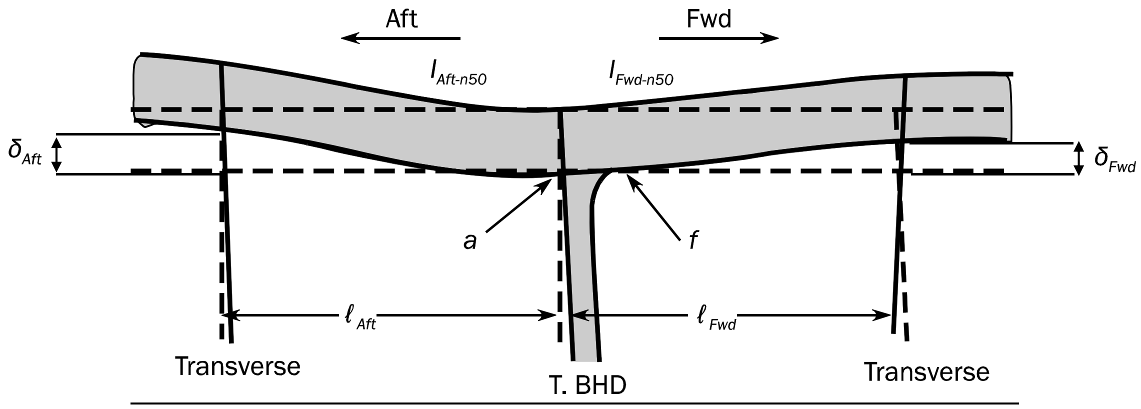
$$\underline{\sigma_{dFwd-f,ik(j)} = \left[\frac{3.9\delta_{Fwd,ik(j)} EI_{Aft-n50} I_{Fwd-n50}}{Z_{Fwd-n50}\ell_{Fwd}\left(\ell_{Aft} I_{Fwd-n50} + \ell_{Fwd} I_{Aft-n50}\right)}\left(1-1.15\frac{\left|x_{eFwd}\right|}{\ell_{Fwd}}\right) - \frac{0.9\delta_{Fwd,ik(j)} EI_{Fwd-n50}\left|x_{eFwd}\right|}{Z_{Fwd-n50}\ell_{Fwd}^3}\right]10^{-5}}$$

(Omitted)

Fig. 4 has been amended as follows.

Fig. 4 Definition of the Relative Displacement (Example of the Side Longitudinal)

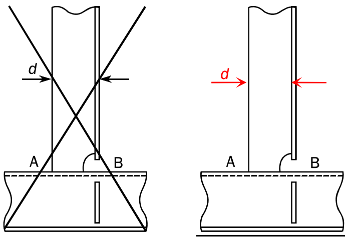
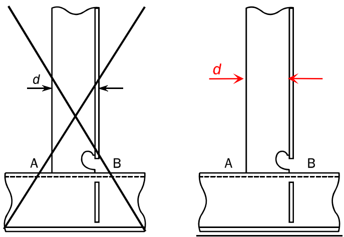
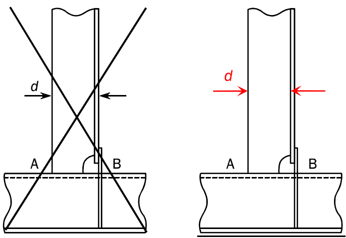




5. Stress Concentration Factors

Table 4 has been amended as follows.

Table 4 Stress Concentration Factors

ID	Connection type [2] [3]	Point '*A*'		Point '*B*'	
		K_a	K_b	K_a	K_b
1 [1]		1.28 for $d \le 150$ 1.36 for $150 < d \le 250$ 1.45 for $d > 250$	1.40 for $d \le 150$ 1.50 for $150 < d \le 250$ 1.60 for $d > 250$	1.28 for $d \le 150$ 1.36 for $150 < d \le 250$ 1.45 for $d > 250$	1.60
2 [1]		1.28 for $d \le 150$ 1.36 for $150 < d \le 250$ 1.45 for $d > 250$	1.40 for $d \le 150$ 1.50 for $150 < d \le 250$ 1.60 for $d > 250$	1.14 for $d \le 150$ 1.24 for $150 < d \le 250$ 1.34 for $d > 250$	1.27
(Omitted)					
25 [1]		1.28 for $d \le 150$ 1.36 for $150 < d \le 250$ 1.45 for $d > 250$	1.40 for $d \le 150$ 1.50 for $150 < d \le 250$ 1.60 for $d > 250$	1.14 for $d \le 150$ 1.24 for $150 < d \le 250$ 1.34 for $d > 250$	1.25 for $d \le 150$ 1.36 for $150 < d \le 250$ 1.47 for $d > 250$
(Omitted)					

5.3 Alternative Design

Title of Paragraph 5.3.1 has been amended as follows.

5.3.1 <u>Derivation of alternative stress concentration factors</u>
(Omitted)

Section 5 FINITE ELEMENT STRESS ANALYSIS

3. Hot Spot Stress for Details Different from Web-stiffened Cruciform Joints

3.3 Bent Hopper Knuckle

Paragraph 3.3.2 has been amended as follows.

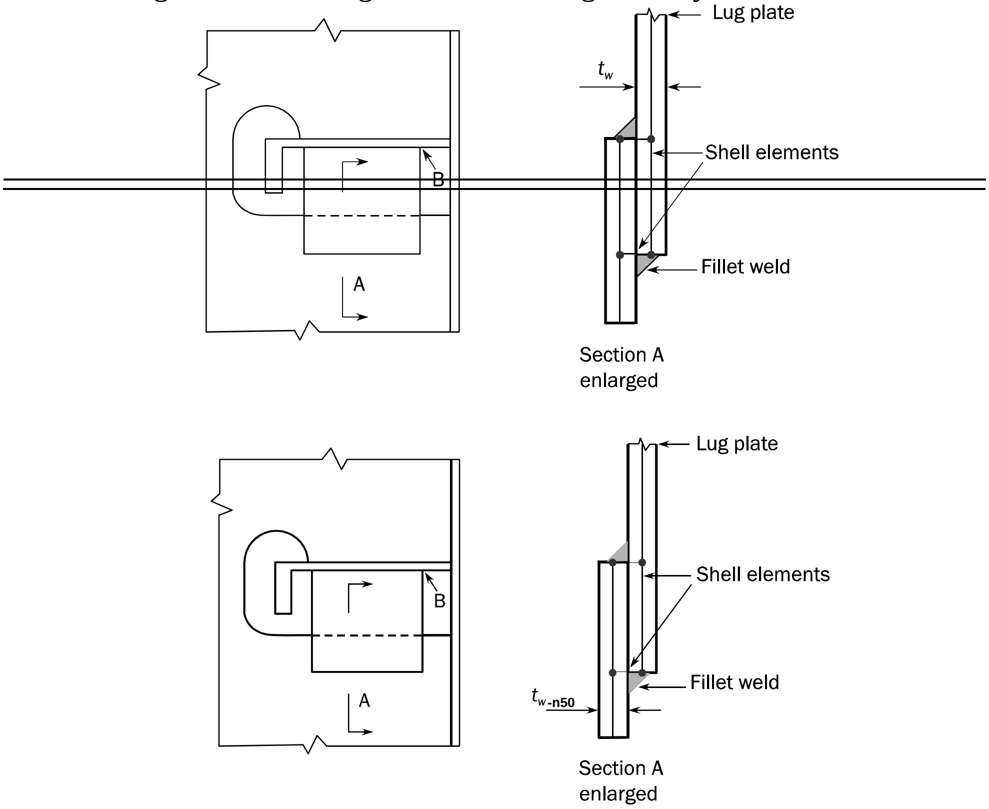
3.3.2

The procedure for calculation of hot spot stress at flange such as inner bottom /hopper sloping plate is the same that for web-stiffened cruciform joints as described in **4.2.1**. The procedure that applies for hot spots on the ballast tank side of the inner bottom/hopper plate in way of a bent hopper knuckle is in ~~principal~~ principle the same as that applied on the cargo tank side of the inner bottom plate for welded knuckle in **Fig. 18** and **Fig. 19**. The intersection line is taken at the mid-thickness of the joint assuming median alignment. The plate angle correction factor and the reduction of bending stress as applied for a web-stiffened cruciform joint in **4.2.2** are not to be applied for the bent hopper knuckle type.

Section 6 DETAIL DESIGN STANDARD

Fig. 2 has been amended as follows.

Fig. 2 Modelling of Eccentric Lug Plate by Shell Elements



6. Bulkhead Connection to Lower and Upper Stool

6.1 Design Standard J, K and L

Paragraph 6.1.2 has been amended as follows.

6.1.2

The welded connection of bulkhead to upper stool of bulk carriers are to be designed according to the design standard ~~M~~L, as shown in **Table 12**.

Table 10 has been amended as follows.

Table 10 Design Standard J – Transverse Bulkhead Connection Detail, Bulk Carrier (Ballast hold)

Connections of transverse bulkhead with lower stool	
(Omitted)	
Welding requirement	Full penetration welding is to be applied between lower stool top plates and the side plating of lower stools and corrugated bulkheads. Partial or full penetration welding is to be applied around gusset plates. However, full penetration welding is to be applied between lower stool top plates and gusset plates. ~~Partial or full penetration welding is to be applied between lower stool top plates and diaphragms/web rings.~~ Ensure start and stop of welding is as far away as practicable from the critical corners.

Table 12 has been amended as follows.

Table 12 Design Standard L – Transverse Bulkhead Connection Detail, Bulk Carrier (Ballast hold)

Connections of transverse bulkhead with sloped plate of upper stool	
(Omitted)	
Welding requirement	~~In the case of ballast holds:~~ ・ Partial or full penetration welding is to be applied between upper stool bottom plates and corrugation. ・ Fillet welding having minimum weld factor of 0.44 is to be applied between upper stool bottom plates and upper stool side plating. ・ Fillet welding having minimum weld factor of 0.44 is to be applied between upper stool bottom plates and diaphragms/web rings. Ensure start and stop of welding is as far away as practicable from the critical corners in all holds.

Chapter 10 OTHER STRUCTURES

Section 1 FORE PART

3. Structure subjected to Impact Loads

3.3 Bow Impact

Paragraph 3.3.4 has been amended as follows.

3.3.4 Side shell stiffeners

The side shell stiffeners within the strengthening area defined in **3.3.1** are to comply with the following criteria：

(a) The effective net plastic section modulus, Z_{pl}, in cm^3 in association with the effective plating to which it is attached, is not to be less than：

$$Z_{pl} = \frac{P_{FB}\, s\, \ell_{bdg}^{\ 2}}{f_{bdg}\, C_s\, R_{eH}}$$

where：

C_s : Permissible bending stress coefficient taken as：

C_s = 0.9 for acceptance criteria set AC-I.

(b) The net web thickness, t_w, in *mm*, is not to be less than：

$$t_w = \frac{P_{FB}\, s\, \ell_{shr}}{2 d_{shr}\, C_t\, \tau_{eH}}$$

where：

d_{shr} : Effective web depth of stiffener, in mm, as defined in **Ch 3, Sec 7, 1.4.3**.

C_t : Permissible shear stress coefficient taken as：

C_t = 1.0 for acceptance criteria set AC-I.

(c) The slenderness ratio is to comply with **Ch 8, Sec 2**.

~~(d) The minimum net thickness of breasthooks/diaphragm plates, t_w, in *mm*, is not to be less than：~~

$$\cancel{t_w = \frac{s}{70}\sqrt{\frac{R_{eH}}{235}}}$$

~~where：~~

~~s : Spacing of stiffeners on the web, as defined in **Ch 1, Sec 4, Table 5**, in *mm*. Where no stiffeners are fitted, s is to be taken as the depth of the web.~~

Section 4 TANKS SUBJECT TO SLOSHING

Symbols has been amended as follows.

Symbols

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

α_p: Correction factor for the panel aspect ratio to be taken as:

$$\alpha_p = 1.2 - \frac{b}{2.1a}$$ but not to be taken as greater than 1.0.

a: Length of plate panel, in *mm*, as defined in **Ch 3, Sec 7, ~~2.2.2~~2.1.1**.

b: Breadth of plate panel, in *mm*, as defined in **Ch 3, Sec 7, ~~2.2.2~~2.1.1**.

(Omitted)

Chapter 12 CONSTRUCTION

Section 3 DESIGN OF WELD JOINTS

2. Tee or Cross Joint

2.3 Intermittent Fillet Welds

Paragraph 2.3.4 has been amended as follows.

2.3.4 Size for one side continuous weld

The size for one side continuous weld is to be of fillet required by **2.5.2** for intermittent welding, where $\cancel{f_2}$ $\underline{f_3}$ factor is to be taken as 2.0.

Part 2 SHIP TYPES

Chapter 1 BULK CARRIERS

Section 3 HULL LOCAL SCANTLING

Symbols has been amended as follows.

Symbols

For symbols not defined in this section, refer to **Pt 1, Ch 1, Sec 4**.
(Omitted)
ℓ_{bdg} : Effective bending span, in *m*, as defined in **Pt 1, Ch 3, Sec 7, 1.1.2**.
(Omitted)

1. Cargo Hold Side Frames of Single Side Bulk Carriers

1.2 Lower Bracket of Side Frame

Paragraph 1.2.4 has been amended as follows.

1.2.4

(Omitted)

The web depth h_{LB} of lower bracket is to be measured from the intersection between the hopper tank sloping plating and the side shell plate, perpendicularly to the face plate of the lower bracket as shown in **Ch 1**, **Sec 2**, **Fig. 5**.

For the three side frames located immediately abaft the collision bulkhead, where the frames are strengthened in accordance with ~~**1.1.2**~~**1.1.3** and the offered t_{LB} is greater than 1.73 t_w, the t_{LB} applied in **1.2.4** may be taken as t'_{LB} given by:

(Omitted)

4. Allowable Hold Loading for *BC-A* & *BC-B* Ships in Flooded Conditions

4.1 Evaluation of Double Bottom Capacity and Allowable Hold Loading

Paragraph 4.1.2 has been amended as follows.

4.1.2 Floor shear strength

The floor shear strength, in *kN*, is to be taken as given in the following formulae:

- In way of the floor panel adjacent to the hopper tank:

$$S_{f1} = A_f \frac{\tau_A}{\eta_1} 10^{-3}$$

- In way of the openings in the outermost bay (i.e., that bay which is closer to the hopper tank):

$$S_{f2} = A_{f,h} \frac{\tau_A}{\eta_2} 10^{-3}$$

where:

A_f : Net sectional area, in mm^2, of the floor panel adjacent to the hopper tank.

$A_{f,h}$: Net sectional area, in mm^2, of the floor panels in way of the openings in the outermost bay (i.e., the bay which is closer to the hopper tank).

τ_A : ~~Net sectional area, in mm^2, of the floor panel adjacent to the hopper tank.~~ Allowable shear stress, in N/mm^2, to be taken as the lesser of:

$$\tau_A = 0.645 \frac{R_{eH}^{0.6}}{(s/t)^{0.8}} \quad \text{and} \quad \tau_A = \frac{R_{eH}}{\sqrt{3}}$$

For floors adjacent to the stools or transverse bulkheads, τ_A is taken as:

$$\frac{R_{eH}}{\sqrt{3}}$$

(Omitted)

Paragraph 4.1.3 has been amended as follows.

4.1.3 Girder shear strength

The girder shear strength, in kN, is to be taken as given in the following formulae:

(Omitted)

τ_A : Allowable shear stress, in N/mm^2, as defined in **4.1.2** where $t_{\cancel{N}}$ is the girder web net thickness.

(Omitted)

Paragraph 4.1.4 has been amended as follows.

4.1.4 Allowable hold loading

The allowable hold loading, in t, is to be taken as:

$$W = \rho_c V \frac{1}{F}$$

where:

(Omitted)

P : Pressure, in kN/m^2, to be taken as:

- For dry bulk cargoes, the lesser of:

$$P = \frac{Z + \rho g (z_F - 0.1D_1 - h_F)}{1 + \frac{\rho}{\rho_c}(perm - 1)}$$

$$P = Z + \rho g (z_F - 0.1D_1 - h_F \ perm)$$

- For steel mill products:

$$\cancel{P = \frac{Z + \rho g (z_F - 0.1D_1 - h_F)}{1 - \frac{\rho}{\rho_c}}} \quad \underline{P = \frac{Z + \rho g (z_F - 0.1D_1 - h_F)}{1 - \frac{\rho}{\rho_{st}}}}$$

<u>ρ_{st} : Density of steel, in t/m^3, to be taken as **7.8**.</u>

(Omitted)

Section 5 CARGO HATCH COVERS

5. Strength Check

5.4 Primary Supporting Members

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:

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

where:

η_{Plate} : Maximum plate utilisation factor calculated according to Method A, as defined in **Pt 1, Ch 8, Sec 5, 2.~~4~~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**.

5.5 Stiffeners and Primary Supporting Members of Variable Cross Section

Paragraph 5.5.1 has been amended as follows.

5.5.1

The net section modulus *Z*, in cm^3, of stiffeners and primary supporting members with a variable cross section is to be taken not less than the greater of the values given by the following formulae:

$Z = \cancel{X}\, Z_{CS}$

$$Z = \left(1 + \frac{3.2a - \psi - 0.8}{7\psi + 0.4}\right) Z_{CS}$$

where:

Z_{CS} : Net section modulus, in cm^3, for a constant cross section, complying with the checking criteria in **5.4.4**.

a : Coefficient taken equal to:

$$a = \frac{\ell_1}{\ell_0}$$

(Omitted)

ℓ_1 : Length of the variable section part, in *m*, as shown in **Fig. ~~1~~2**.

ℓ_0 : Span measured, in *m*, between end supports, as shown in **Fig. ~~1~~2**.

Z_1 : Net section modulus at end, in cm^3, as shown in **Fig. ~~1~~2**.

Z_0 : Net section modulus at mid-span, in cm^3, as shown in **Fig. ~~1~~2**.

(Omitted)

I_1 : Net moment of inertia at end, in cm^4, as shown in **Fig. ~~1~~2**.

I_0 : Net moment of inertia at mid-span, in cm^4, as shown in **Fig. ~~1~~2**.

Fig. ~~1~~2 Variable Cross Section Stiffener
(Omitted)

6. Hatch Coamings

6.2 Load Model

Paragraph 6.2.4 has been amended as follows.

6.2.4
For cargo holds intended for the carriage of ~~liquid cargoes~~ ballast water, the liquid internal pressures applied on hatch coaming is also to be determined according to **Pt 1, Ch 4, Sec 6**.

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. ~~2~~3** and **Fig. ~~3~~4**) are to be taken not less than:
(Omitted)

Fig. ~~2~~3 Coaming Stay (Example 1)
(Omitted)

Fig. ~~3~~4 Coaming Stay (Example 2)
(Omitted)

For other designs of coaming stays, such as those shown in **Fig. ~~4~~5** and **Fig. ~~5~~6**, 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. ~~4~~5 Coaming Stay (Example 3)
(Omitted)

Fig. ~~5~~6 Coaming Stay (Example 4)
(Omitted)

Chapter 2 OIL TANKERS

Section 3 HULL LOCAL SCANTLING

1. Primary Supporting Members in Cargo Hold Region

1.4 Girders in Double Bottom

Paragraph 1.4.2 has been amended as follows.

1.4.2 Net shear area of centre girders

For double bottom centre girders where no longitudinal bulkhead is fitted above, the net shear area, $A_{shr-n50}$ in cm^2, of the double bottom centre girder in way of the first bay from each transverse bulkhead and wash bulkhead, where fitted, is not to be less than:

$$A_{shr-n50} = \frac{8.5Q}{C_{t-pr}\tau_{eH}}$$

where:

Q: Design shear force, in kN, taken as:

$$\cancel{Q = 0.14 n_3 n_4 P \ell_{shr}^2}$$

$$\underline{Q = 0.21 n_1 n_2 P \ell_{shr}^2}$$

(Omitted)

2. Vertically Corrugated Bulkheads

2.2 Scantling Requirements

Paragraph 2.2.2 has been amended as follows.

2.2.2 Net web plating thickness over the height

The net web plating thickness of the lower 15% of the corrugation, t_w in mm, is to be taken as the greatest value calculated for all applicable design load sets, as given in **Pt 1, Ch 6, Sec 2, 2**, and given by the following. This requirement is not applicable to corrugated bulkheads without a lower stool.

$$t_w = \frac{1000|Q_{cg}|}{d_{cg} C_{t-cg} \tau_{eH}}$$

where:

(Omitted)

P_l: Design pressure given in ~~Table 1~~**<u>Pt 1, Ch 6, Sec2, Table 1</u>** for the design load set being considered, calculated at the lower end of the corrugation, in kN/m^2.

P_u: Design pressures given in ~~Table 1~~**<u>Pt 1, Ch 6, Sec2, Table 1</u>** for the design load set being considered, calculated at the upper end of the corrugation, in kN/m^2.

(Omitted)

Paragraph 2.2.4 has been amended as follows.

2.2.4 Net section modulus over the height

The net section modulus at the lower and upper ends and at the mid length of the corrugation ($\ell_{cg}/2$) of a unit corrugation, Z_{cg} are to be taken as the greatest value calculated for all applicable design load sets, as given in **Pt 1, Ch 6, Sec 2, 2** and given by the following.

$$Z_{cg} = \frac{1000 M_{cg}}{C_{s-cg} R_{eH}}$$

where:

(Omitted)

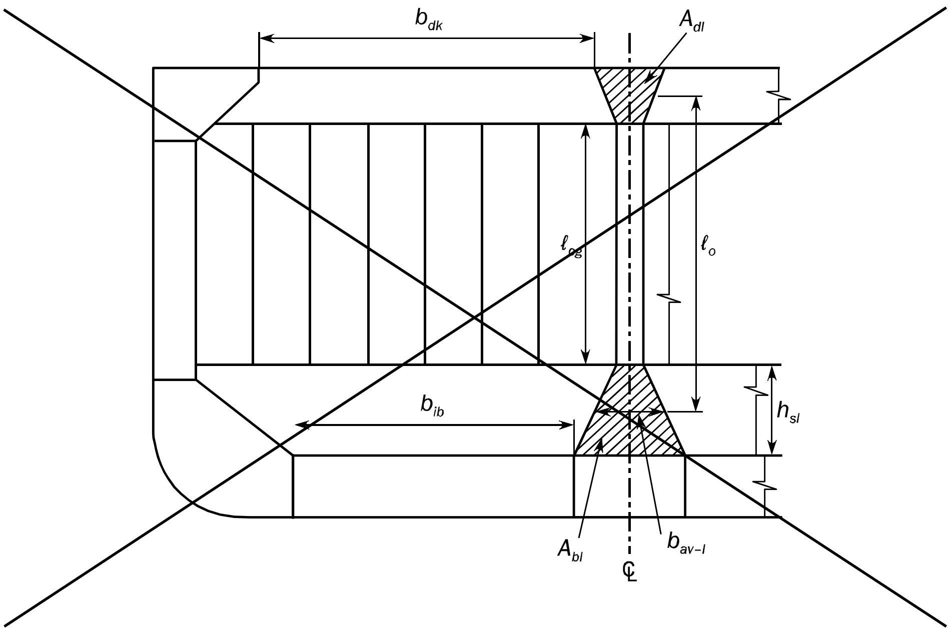
P_l, P_u : Design pressure given in ~~Table 1~~ **Pt 1, Ch 6, Sec 2, Table 1** for the design load set being considered, calculated at the lower and upper ends of the corrugation, respectively, in kN/m^2:

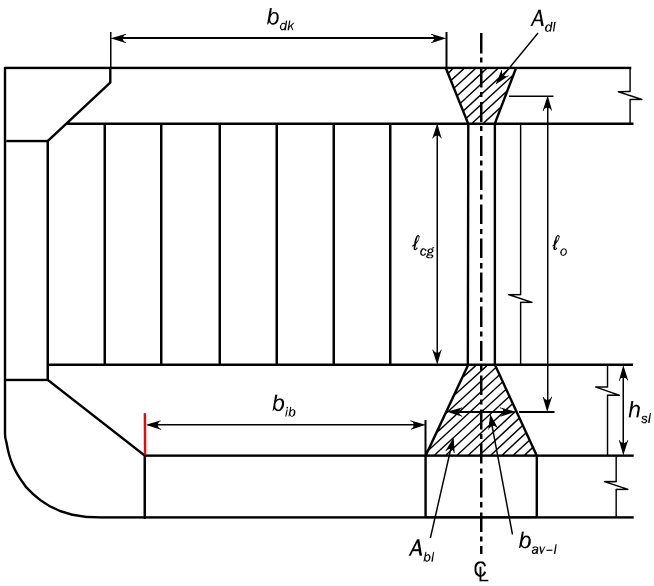
- For transverse corrugated bulkheads, the pressures are to be calculated at a section located at b_{tk} / 2 from the longitudinal bulkheads of each tank.
- For longitudinal corrugated bulkheads, the pressures are to be calculated at the ends of the tank, i.e. the intersection of the forward and aft transverse bulkheads and the longitudinal bulkhead.

(Omitted)

Fig. 4 has been amended as follows.

Fig. 4 Definition of Parameters for Corrugated Bulkhead
(Tankers with Longitudinal Bulkhead at Centreline)





EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 July 2015.

2. Notwithstanding the amendments to the Rules, the current requirements 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.

Note:
This Procedural Requirement applies from 1 July 2009.