Common Structural Rules for Bulk Carriers and Oil Tankers, 1 January 2021, Corrigenda 1

Amended Rules

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

Reason for Amendment

IACS periodically makes Rule Changes or Corrigenda as a part of the maintenance of its Common Structural Rules for Bulk Carriers and Oil Tankers (CSR-BC&OT).

Since Corrigenda are primarily intended to correct editorial errors, they are to be applied retroactively to the date of entry into force of the rules in the relevant year edition. However, since it takes time to go through the entire rule change process for incorporation into the NK Rules, the Society has provided a rationale provision, with amendment dated 30 June 2016, so that Corrigenda adopted by IACS are, in principle, applicable from their effective dates.

Corrigenda 1 related to the 1 January 2021 edition of the CSR-BC&OT was published by IACS in January 2022. Relevant requirements are, therefore, amended in accordance with Corrigenda 1.

In addition, differences in paragraph numbering between CSR-BC&OT and ClassNK Rules which occurred when incorporating previous Rule Changes are corrected to ensure consistency with the CSR.

Outline of Amendment

(1) Amends relevant requirements in accordance with Corrigenda 1.
(2) Amends the numbering of paragraphs, figures and tables to be consistent with the CSR-BC&OT.

"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 3 VERIFICATION OF COMPLIANCE

2. Documents to be Submitted

2.2.1 Plans and supporting calculations are to be submitted for approval

Table 1 has been amended as follows.

Table 1 Plans and Supporting Calculation to be Submitted for Approval

Plan or supporting calculation	Containing also information on
(Omitted)	(Omitted)
Sea chests, stabiliser recesses, etc.	-
~~Plan of manholes~~	-
Plan of access to and escape from spaces	-
(Omitted)	(Omitted)

Paragraph 2.2.2 has been amended as follows.

2.2.2 Plans to be submitted for information

In addition to those in **2.2.1**, the following plans are to be submitted to the Society for information:

(a) General arrangement.
(b) Capacity plan, indicating the volume and position of the centre of gravity of all compartments and tanks.
(c) Lines plan, when deemed necessary by the Society.
(d) Hydrostatic curves.
(e) Lightweight distribution.
(f) Docking plan.
(g) Arrangement of lifting appliances
(h) Plan of manholes

Section 4 SYMBOLS AND DEFINITIONS

2. Symbols

2.1 Ship's Main Data

2.1.1

Unless otherwise specified, symbols regarding ship's main data and their units used in these Rules are those defined in **Table 2**.

Table 2 has been amended as follows.

Table 2 Ship's Main Data

Symbol	Meaning	Units
(Omitted)	(Omitted)	(Omitted)
T_{BAL-H}	Heavy ballast draught at midship	*m*
T_{BAL-E}	Emergency ballast draught or gale ballast draught at midship	*m*
(Omitted)	(Omitted)	(Omitted)

3. Definitions

3.1 Principal Particulars

Paragraph 3.1.9 has been amended as follows.

3.1.9 Lightweight

The lightweight is the ship displacement, in *t*, complete in all respects, but without cargo, consumable~~,~~ stores, ~~passengers and~~ crew and their effects, and without any liquids on board except that machinery and piping fluids, such as lubricants and hydraulics, are at operating levels.

3.8 Glossary

3.8.1 Definitions of Terms

Table 7 has been amended as follows.

Table 7 Definition of Terms

Terms	Definition
(Omitted)	(Omitted)
Corrugation	Plating arranged in a corrugated fashion, shedder and gusset plates excluded.
(Omitted)	(Omitted)

Chapter 2 GENERAL ARRANGEMENT DESIGN

Section 2 SUBDIVISION ARRANGEMENT

1. Watertight Bulkhead Arrangement

Paragraph 1.2 has been deleted.

~~**1.2 (Deleted)**~~

Section 3 COMPARTMENT ARRANGEMENT

Paragraphs 4, 5 and 6 have been deleted.

~~**4. (Deleted)**~~

~~**5. (Deleted)**~~

~~**6. (Deleted)**~~

Paragraph 7 has been amended as follows.

~~7~~4. Ballast Tanks

~~7~~4.1 Capacity and Disposition of Ballast Tanks

~~7~~4.1.1

All ships are to have ballast tanks of sufficient capacity that the ship may operate safely on ballast voyage. The capacity of ballast is to be at least such that, in any ballast condition at any part of the voyage, including the conditions consisting of lightweight plus ballast only, the ship's draught and trim can meet the requirements defined in:

- For oil tankers, **Ch 4, Sec 8, 3.1**.
- In addition, for oil tankers, the moulded draught amidships, T_{mid} ~~(~~, in m~~)~~, excluding any hogging or sagging correction, is not to be less than:
  $T_{mid} = 2.0 + 0.02$ ~~L_{CSR}~~ L_{LL}
- For bulk carriers, **Ch 4, Sec 8, 4.1**.

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 1 MATERIALS

2. Hull Structural Steel

2.3 Steel Grades

Table 5 has been amended as follows.

Table 5 Minimum Material Grades for Ships with Length Exceeding 250 *m*

Structural member category (1)	Material grade
~~Shear~~ Sheer strake at strength deck	Grade *E*/*EH* within 0.4L_{CSR} amidships
Stringer plate in strength deck	Grade *E*/*EH* within 0.4L_{CSR} amidships
Bilge strake	Grade *D*/*DH* within 0.4L_{CSR} amidships

(1) Single strakes required to be of Grade *D*/*DH* or Grade *E*/*EH* as shown in the above table and within 0.4L_{CSR} amidships are to have breadths not less than 800+5 L_{CSR} (*mm*), need not be greater than 1,800 (*mm*), unless limited by the geometry of the ship's design.

Section 6 STRUCTURAL DETAIL PRINCIPLES

2. General Principles

2.3 Connection of Longitudinal Members Not Contributing to the Hull Girder Longitudinal Strength

Paragraph 2.3.1 has been amended as follows.

2.3.1

Where the hull girder stress at the strength deck or at the bottom as defined in **Ch 5, Sec 1, 2.2.2** is higher than the permissible stress as defined in **Ch 5, Sec 1, 2.2.1** for normal strength steel, longitudinal members not contributing to the hull girder longitudinal strength and welded to the strength deck or bottom plating and ~~bilge strake~~ bilge plating, such as longitudinal hatch coamings, gutter bars, strengthening of deck openings, bilge keel, are to be made of steel with the same specified minimum yield stress as the strength deck or bottom structure steel.

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

(Omitted)

For connections similar to item **(b)** in **Fig. 3**, but not lapped, the bracket arm length is to comply with

$\ell_{bkt} \geq \underline{2.0} h_{stf}$

(Omitted)

5. Intersection of Stiffeners and Primary Supporting Members

5.2 Connection of Stiffeners to PSM

Paragraph 5.2.4 has been deleted, and Paragraphs 5.2.5 to 5.2.7 have been renumbered to Paragraphs 5.2.4 to 5.2.6 respectively.

~~5.2.4 (deleted)~~

~~5.2.5~~5.2.4

Where a backing bracket is fitted in addition to the PSM web stiffener, it is to be aligned with the web stiffener. The arm length of the backing bracket is not to be less than the depth of the web stiffener. The net cross sectional area through the throat of the bracket is to be included in the calculation of A_w as shown in **Fig.9**.

~~5.2.6~~5.2.5

Lapped connections of PSM web stiffeners or tripping brackets to stiffeners are not permitted in the cargo hold region.

~~5.2.7~~5.2.6

Where built-up stiffeners have their face plate welded to the side of the web, a symmetrical arrangement of connection to the PSM is to be fitted. This may be achieved by fitting backing brackets on the opposite side of the PSM or bulkhead. In way of the cargo hold region, the PSM web stiffener and backing brackets are to be butt welded to the intersecting stiffener web.

Paragraph 5.2.8 has been amended as follows.

~~5.2.8~~5.2.7

Where the web stiffener of the PSM is parallel to the web of the intersecting stiffener, but not connected to it, the offset PSM web stiffener is to be located in close proximity to the slot edge as shown in **Fig. 10**. The ends of the offset web stiffeners are to be suitably tapered and softened.

~~Locations where the web stiffener of the PSM are not connected to the intersecting stiffeners as well as the detail arrangements are to be specially considered on the basis of their ability to transmit load with equivalent effectiveness to that of **5.2.2** through **5.2.7**. Details of calculations made and/or testing procedures and results are to be submitted.~~

Paragraph 5.2.9 has been renumbered to 5.2.8.

~~5.2.9~~5.2.8

The size of the fillet welds is to be calculated according to **Ch 12, Sec 3, 2.5** based on the weld factors given in **Table 2**. For the welding in way of the shear connection the size is not to be less than that required for the PSM web plate for the location under consideration.

7. Double Bottom Structure

7.5 Bilge Keel

Paragraph 7.5.3 has been amended as follows.

7.5.3 Ground bars

Bilge keels are not to be welded directly to the shell plating. A ground bar, or doubler, is to be fitted on the shell plating as shown in **Fig. 18** and **Fig. 19**. In general, the ground bar is to be continuous. The gross thickness of the ground bar is not to be less than the gross thickness of the ~~bilge strake~~ bilge plating or 14 *mm*, whichever is the lesser.

10. Bulkhead Structure

10.5 Non-tight Bulkheads

Paragraph 10.5.2 has been amended as follows.

10.5.2 Non-tight bulkheads not acting as pillars

In general, the maximum spacing of stiffeners fitted on non-tight bulkheads not acting as pillars is to be:

- 0.9 *m*, for transverse bulkheads.
- Two frame spacings, with a maximum of 1.5 *m*, for longitudinal bulkheads.

The net thickness of bulkhead stiffener, in *mm*, is not to be less than:

$$t = 3 + 0.015L_2$$

The depth of bulkhead stiffener of flat bar type is in general not to be less than 1/12 of stiffener length.

A smaller depth of stiffener may be accepted based on calculations showing compliance with ~~**Ch 6, Sec 5**~~ **Ch 10, Sec 4, 2.2** and **Ch 8**.

Section 7 STRUCTURAL IDEALISATION

Symbols has been amended as follows.

Symbols

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

φ_w: Angle, in *deg*, between the stiffener or primary supporting member web and the attached plating, see **Fig. 14** for stiffener and **Ch 10, Sec 1, Fig. 5** for primary supporting member. φ_w is to be taken equal to 90 *deg* if the angle is ~~greater than or equal to~~ between 75 and 105 *deg* including 75 and 105 *deg*.

(Omitted)

1. Structural Idealisation of Stiffeners and Primary Supporting Members

1.4 Geometrical Properties of Stiffeners and Primary Supporting Members

Paragraphs 1.4.3 and 1.4.4 have been amended as follows.

1.4.3 Effective shear depth of stiffeners

The effective shear depth of stiffeners, d_{shr}, in *mm*, is to be taken as:

$$d_{shr} = \left(h_{stf} - 0.5t_{c-stf} + t_p + 0.5t_{c-pl}\right)\sin\varphi_w$$

where:

h_{stf} : Height of stiffener, in *mm*, as defined in **Ch 3**, **Sec 2**, **Fig.2**.

t_p : Net thickness of the stiffener attached plating, in *mm*, as defined in **Ch 3**, **Sec 2**, **Fig. 2**.

t_{c-stf} : Corrosion addition, in *mm*, of considered stiffener as given in **Ch 3**, **Sec 3**.

t_{c-pl} : Corrosion addition, in *mm*, of attached plate of the stiffener considered as given in **Ch 3**, **Sec 3**.

~~φ_w: Angle, in *deg*, as defined in **Fig. 14**. φ_w is to be taken as 90 *degrees* if the angle is greater than or equal to 75 *degrees*.~~

1.4.4 Elastic net section modulus and net moment of inertia of stiffeners

The elastic net section modulus, Z, in cm^3 and the net moment of inertia, I, in cm^4 of stiffeners, is to be taken as:

$$Z = Z_{stf}\sin\varphi_w$$

$$I = I_{st}\sin^2\varphi_w$$

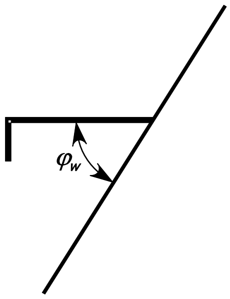
where:

Z_{stf} : Net section modulus of the stiffener, in cm^3, considered perpendicular to its attached plate, i.e. with φ_w = 90 *deg*.

I_{st} : Net moment of inertia of the stiffener, in cm^4, considered perpendicular to its attached plate, i.e. with φ_w = 90 *deg*.

~~φ_w : Angle, in *deg*, as defined in **Fig. 14**. φ_w is to be taken as 90 degrees if the angle is greater than or equal to 75 degrees.~~

Fig. 14 Angle between Stiffener Web and Attached Plating



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:

$$Z_{pl} = \frac{f_w h_w^2 t_w}{2000} + \frac{(2\gamma - 1) A_f h_{f-ctr}}{1000} \quad \text{for } 75° \le \varphi_w \le \cancel{90°}\ \underline{105°}$$

$$Z_{pl} = \frac{f_w h_w^2 t_w \sin\varphi_w}{2000} + \frac{(2\gamma - 1) A_f \left(h_{f-ctr}\sin\varphi_w - b_{f-ctr}\cancel{\cos\varphi_w}\underline{|\cos\varphi_w|}\right)}{1000} \quad \text{for } \varphi_w < 75° \ \underline{\text{or } \varphi_w > 105°}$$

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 $L2$ profile 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.

$b_{f\text{-}ctr}$: Distance from mid thickness of stiffener web to the centre of the flange area:
- $b_{f\text{-}ctr} = 0.5\,(b_f - t_w)$ for rolled angle profiles and bulb profiles.
- $b_{f\text{-}ctr} = 0$ for *T* profiles.

$h_{f\text{-}ctr}$: Height of stiffener measured to the mid thickness of the flange:
- $h_{f\text{-}ctr} = h_w + 0.5\, t_f$ for profiles with flange of rectangular shape and for bulb profiles.

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**.

Paragraph 1.4.7 has been amended as follows.

1.4.7 Primary supporting member web not perpendicular to attached plating

Where the primary supporting member web is not perpendicular to the attached plating, the actual net shear area, in cm^2, and the actual net section modulus, in cm^2, can be obtained from the following formulae:

- Actual net shear area:

  $A_{sh-n50} = A_{sh-0-n50} \sin\varphi_w$ ~~for $\varphi_w < 75°$~~

  ~~$A_{sh-n50} = A_{sh-0-n50}$ for $75° \le \varphi_w \le 90°$~~

- Actual net section modulus:

  $Z_{n50} = Z_{perp-n50} \sin\varphi_w$ ~~for $\varphi_w < 75°$~~

  ~~$Z_{n50} = Z_{perp-n50}$ for $75° \le \varphi_w \le 90°$~~

where:

$A_{sh-0-n50}$: Actual net shear area, in cm^2, of the primary supporting member assumed to be perpendicular to the attached plating, to be taken equal to:

$$A_{sh-0-n50} = \left(\sout{h_w}\, \underline{h_{eff}} + t_{f-n50} + t_{p-n50}\right) \; t_{w-n50} 10^{-2}$$

$Z_{perp-n50}$: Actual section modulus, in cm^3, with its attached plating of the primary supporting member assumed to be perpendicular to the attached plating.

3. Stiffeners

3.2 Load Calculation Points

Paragraph 3.2.2 has been amended as follows.

3.2.2 *LCP* for hull girder bending stress

The load calculation point for the hull girder bending stresses is defined as follows:

- For prescriptive yielding verification according to **Ch 6** and **Ch 10, Sec 4**:
  - At the middle of the full length, ℓ, of the considered stiffener.
  - At the reference point given in **Fig. 23**.
- For prescriptive buckling requirements according to **Ch 8**:
  - At the middle of the full length, ℓ, of the considered stiffener.
  - At the intersection point between the stiffener and its attached plate.

Chapter 4 LOADS

Section 6 INTERNAL LOADS

1. Pressures Due to Liquids

1.5 Dynamic Pressure in Flooded Conditions

Paragraph 1.5.1 has been amended as follows.

1.5.1 Dynamic pressure in flooded compartments

The dynamic pressure, P_{fd}, in kN/m^2, for watertight boundaries of flooded compartments is to be taken as:

$$P_{fd} = f_\beta \rho \left[a_Z(z_{0FD} - z) + f_{ull-l}\, a_X\,(x_0 - x) + f_{ull-t}\, a_Y\,(y_0 - y)\right]$$

where:

z_{0FD} : Z coordinate of the effective reference point, in m, for a flooded compartment taken as:

When $z_{FD} > z_0$, $z_{0FD} = z_0$

When $z_{FD} \leq z_0$, $z_{0FD} = z_{FD}$

f_{ull-l}, f_{ull-t} : Longitudinal and transverse acceleration correction factors:

When z_{FD} ~~$>$~~$\leq$ z_0, f_{ull-l} and f_{ull-t} are to be taken as defined in **1.3.1**.

When z_{FD} ~~$\leq$~~$\geq$ z_0, $f_{ull-l} = 1.0$ and $f_{ull-t} = 1.0$.

6. Sloshing Pressures in Tanks

6.3 Sloshing Pressure due to Longitudinal Liquid Motion

Paragraph 6.3.2 has been amended as follows.

6.3.2 Effective sloshing length

The effective sloshing length, ℓ_{slh}, in m, is to be taken as defined in **Table 11**.

Table 11 Effective Sloshing Length ℓ_{slh}

Type of transverse bulkhead	ℓ_{slh}
Transverse tight bulkheads	$\ell_{slh} = \dfrac{(1 + n_{WT}\,\alpha_{WT})(1 + f_{wf}\,\alpha_{wf})\ell_{tk-h}}{(1 + n_{WT})(1 + f_{wf})}$
Transverse wash bulkheads	$\ell_{slh} = \dfrac{[1 + (n_{WT} - 1)\alpha_{WT}](1 + f_{wf}\,\alpha_{wf})\ell_{tk-h}}{(1 + n_{WT})(1 + f_{wf})}$

where:

n_{WT} : Number of transverse wash bulkheads in the tank.

α_{WT} : Transverse wash bulkhead coefficient, to be taken as (see **Fig. 11**):

$$\alpha_{WT} = \frac{A_{OWT}}{A_{tk-t-h}}$$

For tanks with changing shape along the length and/or with wash bulkhead of different shape the transverse wash bulkhead coefficient, α_{WT}, may be taken as the weighted average of all wash bulkhead locations in the tank given as:

$$\alpha_{WT} = \frac{\sum_{i=1}^{n_{WT}} \frac{A_{OWT_i}}{A_{tk-t-h_i}}}{n_{WT}}$$

α_{wf} : Transverse web frame coefficient, to be taken as (see **Fig. 12**):

$$\alpha_{wf} = \frac{A_{O-wf-h}}{A_{tk-t-h}}$$

For tanks with changing shape along the length and/or with web frames of different shape the transverse web frame coefficient, α_{wf}, may be taken as the weighted average of all web frame locations in the tank given as:

$$\alpha_{wf} = \frac{\sum_{i=1}^{n_{wf}} \frac{A_{O-wf-h_i}}{A_{tk-t-h_i}}}{n_{wf}}$$

A_{OWT}: Total area of openings, in m^2, in the transverse section in way of the wash bulkhead below the considered filling height.

A_{tk-t-h}: Total transverse cross sectional area, in m^2, of the tank below the considered filling height.

A_{O-wf-h}: Total area of openings, in m^2, in the transverse section in way of the web frame below the considered filling height.

f_{wf} : Factor to account for number of transverse web frames and transverse wash bulkheads in the tank, to be taken as:

$$f_{wf} = \frac{n_{wf}}{1 + n_{WT}}$$

n_{wf} : Number of transverse web frames, excluding wash bulkheads, in the tank.

ℓ_{tk-h}: Length of cargo tank, in m, at considered filling height.

6.4 Sloshing Pressure due to Transverse Liquid Motion

Paragraph 6.4.2 has been amended as follows.

6.4.2 Effective sloshing breadth

The effective sloshing breadth, b_{slh}, in m, is to be taken as in **Table 12**, but not less than $0.3B$.

Table 12 Effective Sloshing Breadth b_{slh}

Type of longitudinal bulkhead	b_{slh}
Longitudinal tight bulkheads	$b_{slh} = \frac{(1 + n_{WL}\,\alpha_{WL})(1 + f_{grd}\,\alpha_{grd})b_{tk-h}}{(1 + n_{WL})(1 + f_{grd})}$
Longitudinal wash bulkheads	$b_{slh} = \frac{[1 + (n_{WL} - 1)\alpha_{WL}](1 + f_{grd}\,\alpha_{grd})b_{tk-h}}{(1 + n_{WL})(1 + f_{grd})}$

where:

n_{WL} : Number of longitudinal wash bulkheads in the tank.

α_{WL} : Longitudinal wash bulkhead coefficient:

$$\alpha_{WL} = \frac{A_{OWL}}{A_{tk-L-h}}$$

For tanks with changing shape along the breadth and/or with wash bulkhead of different shape the longitudinal wash bulkhead coefficient, α_{WL}, may be taken as the weighted average of all wash bulkhead locations in the tank given as:

$$\alpha_{WL} = \frac{\sum_{i=1}^{n_{WL}} \frac{A_{OWL_i}}{A_{tk-L-h_i}}}{n_{WL}}$$

α_{grd} : Girder coefficient, to be taken as:

$$\alpha_{grd} = \frac{A_{O-grd-h}}{A_{tk-L-h}}$$

For tanks with changing shape along the breadth and/or with girder of different shape the girder coefficient, α_{grd}, may be taken as the weighted average of all girder locations in the tank given as:

$$\alpha_{grd} = \frac{\sum_{i=1}^{n_{grd}} \frac{A_{O-grd-h_i}}{A_{tk-L-h_i}}}{n_{grd}}$$

A_{OWL} : Total area of openings, in m^2, in the longitudinal section in way of the wash bulkhead below the considered filling height.

A_{tk-L-h} : Total longitudinal cross sectional area, in m^2, of the tank below the considered filling height.

$A_{O-grd-h}$:Total area of openings, in m^2, in the longitudinal section in way of the web frame below the considered filling height.

f_{grd} : Factor to account for number of longitudinal girders and longitudinal wash bulkheads in the tank, to be taken as:

$$f_{grd} = \frac{n_{grd}}{1 + n_{WL}}$$

n_{grd} : Number of longitudinal girders, excluding longitudinal wash bulkheads, in the tank.

b_{tk-h} : Breadth of cargo tank, in m, at considered filling height.

7. Design Pressure for Tank Testing

7.1 Definition

Table 13 has been amended as follows.

Table 13 Design Testing Load Height z_{ST}

Compartment	z_{ST}
Double bottom tanks [1]	The greater of the following: $z_{ST} = z_{top} + h_{air}$ $z_{ST} = z_{bd}$
Hopper side tanks, topside tanks, double side tanks, fore and aft peaks used as tank	The greater of the following: $z_{ST} = z_{top} + h_{air}$ $z_{ST} = z_{top} + 2.4$
Tank bulkheads, deep tanks, fuel oil bunkers	The greater of the following: $z_{ST} = z_{top} + h_{air}$ $z_{ST} = z_{top} + 2.4$ $z_{ST} = z_{top} + 0.1\ P_{PV}$
Ballast hold	$z_{ST} = z_h + 0.9$
Chain locker ~~(if aft of collision bulkhead)~~	$z_{ST} = z_c$
Independent tanks	The greater of the following: $z_{ST} = z_{top} + h_{air}$ $z_{ST} = z_{top} + 0.9$
Ballast ducts	Testing load height corresponding to ballast pump maximum pressure

where:

z_{bd} : Z coordinate, in m, of the bulkhead deck.

z_h : Z coordinate, in m, of the top of hatch coaming.

z_c : Z coordinate, in m, of the top of the chain pipe.

(1) For double bottom tanks connected with hopper side tanks, topside tanks or double side tanks, z_{ST} corresponding to "Hopper side tanks, topside tanks, double side tanks, fore and aft peaks used as tank, cofferdams" is applicable.

Section 8 LOADING CONDITIONS

4. Bulk Carriers

4.1 Specific Design Loading Condition

Paragraph 4.1.4 has been amended as follows.

4.1.4 Cargo loading condition for *BC-A*

As required for *BC-B*, plus:

At least one cargo loaded condition with specified holds empty, with cargo density $3.0 t/m^3$, and the same filling ratio (cargo mass/hold cubic capacity) in all loaded cargo holds at scantling draught with all ballast tanks empty.

The combination of specified empty holds is to be indicated with the additional service feature {~~h~~*Holds a, b, … may be empty*}.

In such cases where the design cargo density applied is different from $3.0 t/m^3$, the maximum density of the cargo that the ship is allowed to carry is to be indicated in the loading manual. If the maximum density is less than $3.0 t/m^3$ then the additional service feature {~~h~~*Holds a, b, … may be empty with maximum cargo density x.y* t/m^3} is to be indicated as defined in **Ch 1**, **Sec 1**, **3.2.1**.

4.2 Design Load Combinations for Direct Strength Analysis

Paragraph 4.2.1 has been amended as follows.

4.2.1 Applicable general loading patterns

The following loading patterns are to be applied:

(a) Any cargo hold carrying M_{Full} with fuel oil tanks in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom in way of the cargo hold being empty, at scantling draught.

(b) Any cargo hold carrying minimum 50 % of M_H, with all double bottom tanks and all fuel oil tanks in way of the cargo hold being empty, at scantling draught.

(c) Any cargo hold taken empty, with all double bottom tanks and all fuel oil tanks in way of the cargo hold being empty, at the deepest ballast draught. Where a topside and double bottom tank are permanently connected as a common tank, the following conditions are to be considered:

- The topside and double bottom tank empty,
- The topside and double bottom tank full.

Paragraph 4.2.2 has been amended as follows.

4.2.2 Multiport conditions

The following multiport conditions are applicable to all types of bulk carriers except when the service feature {*no MP*} is assigned:

(a) Any cargo hold carrying M_{Full} with fuel oil tanks in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67 % of scantling draught.

(b) Any cargo hold taken empty with all double bottom tanks and all fuel oil tanks in way of the cargo hold being empty, at 83 % of scantling draught.

(c) Any two adjacent cargo holds carrying M_{Full} with the next holds being empty, with fuel oil tanks in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67 % of the scantling draught. This requirement to the mass of the cargo and fuel oil ~~in double bottom~~ tanks in way of the cargo hold applies also to the condition where the adjacent hold is filled with ballast.

(d) Any two adjacent cargo holds being empty with the next holds being full, with all double bottom tanks and fuel oil tanks in way of the cargo hold being empty, at 75 % of scantling draught.

Paragraph 4.2.3 has been amended as follows.

4.2.3 Alternate conditions

The following alternate conditions are applicable to *BC-A* only:

(a) Cargo holds which are intended to be empty at scantling draught, being empty with all double bottom tanks and fuel oil tanks in way of the cargo hold also being empty.

(b) Cargo holds which are intended to be loaded with high density cargo, carrying M_{HD} plus 10 % of M_H, in the partially filled condition with highest density according to **Ch 4**, **Sec 6**, **Table 1**. The fuel oil tanks in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom being empty in way of the cargo hold, at scantling draught.

(c) Cargo holds which are intended to be loaded with high density cargo, carrying M_{HD} plus 10 % of M_H in the full condition with lowest density according to **Ch 4**, **Sec 6**, **Table 1**. The fuel oil tanks in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom being empty in way of the cargo hold, at scantling draught.

(d) If the ship is intended to operate in alternate block load condition, any two adjacent cargo holds are to be loaded with the next holds being empty, carrying 10 % of M_H in each hold in addition to the maximum cargo load according to that design loading condition, with fuel oil tanks in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom in way of the cargo hold being empty, at scantling draught. In operation the maximum allowable mass is to be limited to the maximum cargo load according to the design loading conditions.

Paragraph 4.2.4 has been amended as follows.

4.2.4 Heavy ballast condition

The following condition applies to ballast holds only:

- Cargo holds which are designed as ballast water holds, being 100 % full of ballast water including hatchways, with all double bottom tanks and fuel oil tanks in way of the cargo hold being 100 % full, at any heavy ballast draught. For ballast holds adjacent to topside wing, hopper and double bottom tanks, it shall be strengthwise acceptable that the ballast holds are filled when the topside wing, hopper stool and double bottom tanks are empty.

Paragraph 4.2.5 has been amended as follows.

4.2.5 Additional harbour condition for all bulk carriers

The following additional harbour conditions apply to all bulk carriers:

(a) At reduced draught during loading and unloading in harbour, the maximum allowable mass in a cargo hold may be increased by 15 % of the maximum mass allowed at the scantling draught in seagoing condition, but is not to exceed the mass allowed at scantling draught in the seagoing condition. The minimum required mass may be reduced by the same amount.

(b) Any single cargo hold holding the maximum allowable seagoing mass at 67 % of scantling draught, in harbour condition with fuel oil tanks in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom in way of the cargo hold being empty.

(c) Any two adjacent cargo holds carrying M_{Full} with the next holds being empty, with fuel oil tanks ~~in the double bottom~~ in way of the cargo hold, if any, being 100 % full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67 % of scantling draught, in harbour condition.

Chapter 5 HULL GIRDER STRENGTH

Section 1 HULL GIRDER YIELDING STRENGTH

3. Hull Girder Shear Strength Assessment

3.4 Effective Net Thickness for Longitudinal Bulkheads between Cargo Tanks of Oil Tankers

Paragraph 3.4.6 has been amended as follows.

3.4.6 Equivalent net thickness of corrugation

The equivalent net thickness, in *mm*, of the corrugation of vertical and horizontal corrugated bulkheads, $t_{cor\text{-}n50}$, to be used for the calculation of the effective net shear area of $A_{3\text{-}n50}$ in **Table 7** and for the unit shear flow, is given as follows:

$$t_{cor-n50} = \frac{t_{W-gr} + t_{f-gr}}{2} \frac{s_C}{c+a} - 0.5 t_C$$

where:

t_{W-gr}: Gross corrugation web thickness, in *mm*.

t_{f-gr}: Gross corrugation flange thickness, in *mm*.

s_C: Projected length of one corrugation, in *mm*, as defined in **Ch 3, Sec 6, Fig. 21**.

c: Breadth of corrugation web, in *mm*, as defined in **Ch 3, Sec 6, Fig. 21**.

a: Breadth of corrugation flange, in *mm*, as defined in **Ch 3, Sec 6, Fig. 21**.

Chapter 6 HULL LOCAL SCANTLING

Section 4 PLATING

1. Plating subjected to Lateral Pressure

1.2 Plating of Corrugated Bulkheads

Paragraph 1.2.1 has been amended as follows.

1.2.1 Cold, hot formed and built up corrugations

The net thicknesses, t in mm, of the web and flange plates of corrugated bulkheads are not to be taken less than the greatest value calculated for all applicable design load sets, as defined in **Ch 6, Sec 2, 2.1.3**, given by:

$$t = 0.0158 b_p \sqrt{\frac{|P|}{C_{CB} R_{eH}}}$$

where:

b_p: Breadth of plane corrugation plating:

$b_p = \alpha b_{f-cg}$ for flange plating, in mm, as defined in **Ch 3, Sec 6, Fig. 21**.

$b_p = c b_{w-cg}$ for web plating, in mm, as defined in **Ch 3, Sec 6, Fig. 21**.

C_{CB}: Permissible bending stress coefficient for corrugated bulkhead plating taken equal to:

- For acceptance criteria set AC-S for transverse corrugated bulkheads and vertically corrugated longitudinal bulkheads.
  $C_{CB} = 0.75$
- For acceptance criteria set AC-SD for transverse corrugated bulkheads and vertically corrugated longitudinal bulkheads.
  $C_{CB} = 0.90$
- For horizontally corrugated longitudinal bulkheads, without being greater than $C_{CB-\max}$.

$$C_{CB} = \beta_{CB} - \alpha_{CB} \frac{|\sigma_{hg}|}{R_{eH}}$$

β_{CB}: Coefficient as defined in **Table 2**.

α_{CB}: Coefficient as defined in **Table 2**.

$C_{CB-\max}$: Maximum permissible bending stress coefficient as defined in **Table 2**.

2. Special Requirements

2.2 Bilge Plating

Paragraph 2.2.1 has been amended as follows.

2.2.1 Definition of bilge ~~area~~ plating

The definition of bilge ~~area~~ plating is given in **Ch 1, Sec 4, 3.8.1**.

2.4 Sheer Strake

Paragraph 2.4.2 has been amended as follows.

2.4.2 Welded sheer strake

The net thickness of a welded sheer strake is not to be less than the offered net thickness of the adjacent ~~2*m* width~~ side plating, provided this adjacent side plating is located entirely within the top wing tank or double side tank as the case may be.

Chapter 8 BUCKLING

Section 1 GENERAL

3. Definitions

3.2 Buckling Utilisation Factor

Paragraph 3.2.2 has been amended as follows.

3.2.2

For combined loads, the utilisation factor, η_{act}, is to be defined as the ratio of the equivalent applied ~~equivalent~~ stress and the corresponding buckling capacity, as shown in **Fig. 1**, and is to be taken as:

$$\eta_{act} = \frac{W_{act}}{W_u} = \frac{1}{\gamma_c}$$

where:

W_{act} : Equivalent ~~A~~applied ~~equivalent~~ stress, in *N/mm*^{2}~~:~~, the actual applied stress are given in **Sec 3** and **Sec 4** respectively for buckling assessment by prescriptive and direct strength analysis.

~~$W_{act} = \sqrt{\sigma_x^2 + \sigma_y^2 + \tau^2}$ for plate~~

~~$W_{act} = \sigma_a + \sigma_b + \sigma_w$ for stiffener~~

W_u : Equivalent buckling capacity, in *N/mm*^{2}, ~~to be taken as:~~ for plates and stiffeners, their respective buckling or ultimate capacities are given in **Sec 5**.

~~$W_u = \sqrt{\sigma_{cx}^2 + \sigma_{cy}^2 + \tau_c^2}$ for plate~~

~~$W_u = \frac{R_{eH\_S}}{S}$ for stiffener~~

γ_c : Stress multiplier factor at failure.

For each typical failure mode, the corresponding capacity of the panel is calculated by applying the actual stress combination and then increasing or decreasing the stresses proportionally until collapse.

Fig. 1 illustrates the buckling capacity and the buckling utilisation factor of a structural member subject to σ_x and σ_y stresses.

Section 2 SLENDERNESS REQUIREMENTS

3. Stiffeners

3.1 Proportions of Stiffeners

Paragraph 3.1.3 has been amended as follows.

3.1.3 Bending stiffness of stiffeners

The net moment of inertia, in cm^4, of the stiffener with the effective width of attached plate, s_{eff}, about the neutral axis parallel to the attached plating is not to be less than the minimum value given by:

$$I_{st} \geq C\ell^2 A_{eff} \frac{R_{eH}}{235}$$

where:

A_{eff} : Net sectional area of stiffener including effective attached plate, s_{eff}, in cm^2.

R_{eH} : Specified minimum yield stress of the material of the attached plate, in N/mm^2.

C : Slenderness coefficient taken as:

$C = 1.43$ for longitudinal stiffeners including sniped stiffeners.

$C = 0.72$ for other stiffeners.

5. Brackets

5.1 Tripping Brackets

Paragraph 5.1.1 has been amended as follows.

5.1.1 Unsupported flange length

The unsupported length of the flange of the primary supporting member, in m, i.e. the distance between tripping brackets, is not to be greater than:

$$S_b = b_f C \sqrt{\frac{A_{f-n50}}{\left(A_{f-n50} + \frac{A_{w-n50}}{3}\right)} \left(\frac{235}{R_{eH}}\right)}$$, but need not be less than S_{b-min}.

where:

b_f : Flange breadth of primary supporting members, in mm.

C : Slenderness coefficient taken as:

$C = 0.022$ for symmetrical flanges.

$C = 0.033$ for asymmetrical flanges.

A_{f-n50} : Net cross sectional area of flange, in cm^2.

A_{w-n50} : Net cross sectional area of the web plate, in cm^2.

R_{eH} : Specified minimum yield stress of the PSM material, in N/mm^2.

S_{b-min} : Minimum unsupported flange length taken as:

$S_{b-\min} = 3.0m$ for ~~the cargo tank/hold region, on~~ tank/hold boundaries or ~~the~~ hull envelope including external decks.

$S_{b-\min} = 4.0m$ for other areas.

6. Other Structures

6.2 Edge Reinforcement in way of Openings

Paragraph 6.2.1 has been amended as follows.

6.2.1 Depth of edge stiffener

When fitted as shown in **Fig. 2**, the depth of web, h_w in *mm*, of edge stiffeners in way of openings is not to be less than:

$$h_w = C\ell\sqrt{\frac{R_{eH}}{235}}$$ or 50 *mm*, whichever is greater.

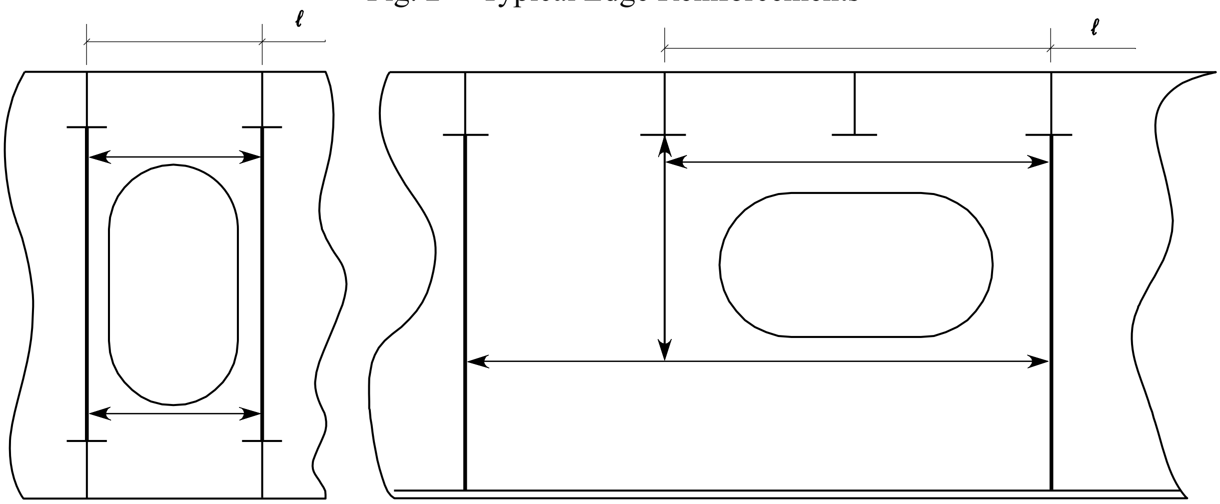
C : Slenderness coefficient taken as:

$$C = 50$$

R_{eH} : Specified minimum yield stress of the edge stiffener material, in N/mm^2.

ℓ : Length of edge stiffener in way of opening, in m, as defined in **Fig. 2**.

Fig. 2 Typical Edge Reinforcements



Section 3 PRESCRIPTIVE BUCKLING REQUIREMENTS

1. General

1.1 Scope

Paragraph 1.1.1 has been amended as follows.

1.1.1

This section applies to plate panels including curved plate panels and stiffeners subject to hull girder compression and shear stresses. In addition the following structural members subject to compressive stresses are to be checked:

- ~~Corrugation of transverse vertically corrugated bulkhead.~~
- Corrugation of longitudinal corrugated bulkhead.
- Strut.
- Pillar.
- Cross tie.

3. Buckling Criteria

Paragraph 3.4 has been amended as follows.

3.4 Vertically Corrugated ~~Transverse and~~ Longitudinal Bulkheads

3.4.1

The shear buckling strength of vertically corrugated ~~transverse and~~ longitudinal bulkheads is to satisfy the following criterion:

$\eta_{Shear} \leq \eta_{all}$

where:

η_{Shear}: Maximum shear corrugated bulkhead utilisation factor.

$$\eta_{Shear} = \frac{\tau_{bhd}}{\tau_c}$$

τ_{bhd}: Hull girder ~~S~~shear stress, in *N/mm*^{2}, in the longitudinal bulkhead ~~taken~~ as defined in **2.1.2**

- ~~For longitudinal bulkheads: hull girder shear stress defined in **2.1.2**~~
- ~~For transverse bulkheads: shear stress in the corrugation defined in **Pt 2, Ch 1, Sec 3, 3.2.1.**~~

τ_c : Shear critical stress, in *N/mm*^{2}, as defined in **Ch 8**, **Sec 5**, **2.2.3**.

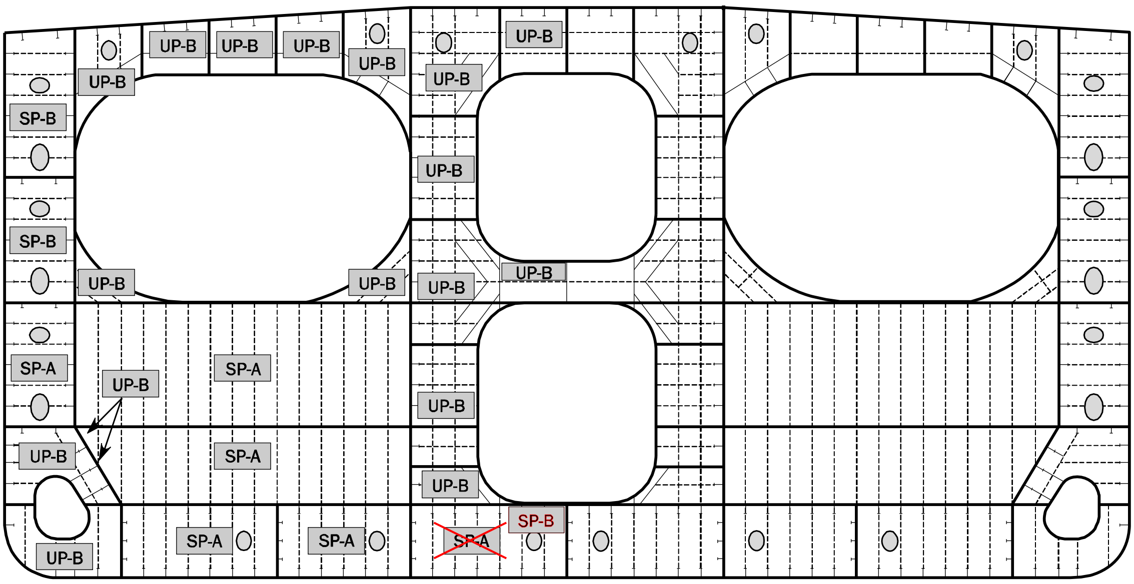
Section 4 BUCKLING REQUIREMENTS FOR DIRECT STRENGTH ANALYSIS

2. Stiffened and Unstiffened Panels

2.2 Stiffened Panels

Fig.4 has been amended as follows.

Fig. 4 Cross Tie



3. Corrugated Bulkhead

3.2 Reference stress

Paragraph 3.2.4 has been amended as follows.

3.2.4

Where more than one plate thicknesses are used for flange <u>or web</u> panel, maximum stress is to be obtained for each thickness range and to be checked with the buckling criteria for each thickness.

Section 5 BUCKLING CAPACITY

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

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

For stiffened panels fitted with U-type stiffeners, stiffener spacing *s* is taken as:

$s = b_1 + b_2$

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

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

$N_y = c\sigma_y t_p$

L_{B1}: Stiffener span, in *mm*, equal to spacing between primary supporting members, i.e. $L_{B1} = \ell$. For vertically stiffened side shell of single side skin bulk carriers, $L_{B1} = 0.8\ell$.

L_{B2}: Width of the stiffened panel, in *mm*, taken as 6 times of the stiffener spacing, i.e. 6*s*.

n: Number of half waves along the direction perpendicular to the stiffener axis. The factor $\gamma_{GEB,bi}$ is to be minimized with respect to the wave parameter *n*, i.e. to be taken as the smallest value larger than zero.

K_{tran}: Coefficient taken as 0.9.

c: Factor taking into account the stresses in the attached plating acting perpendicular to the stiffener axis:

$c = 0.5(1 + \Psi)$ for $0 \leq \Psi \leq 1$

$c = \frac{1}{2(1 - \Psi)}$ for $\Psi < 0$

Ψ: Edge stress ratio for case 2 according to **Table 3**.

$\sigma_{x,av}$: Average stress for both plate and stiffener with Poisson correction, taken as:

$\sigma_{x,av} = \sigma_x - \nu \underline{c} \sigma_y A_s/(A_p + A_s) \geq 0$ for $\sigma_x > 0$ and $\sigma_y > 0$

$\sigma_{x,av} = \sigma_x$ for $\sigma_x \leq 0$ and $\sigma_y \leq 0$

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

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

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

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

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

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

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**.

Paragraph 2.1.3 has been amended as follows.

2.1.3

The stress multiplier factor $\gamma_{GEB,\tau}$ for the stiffened panel subjected to pure shear load is taken as:

$$\gamma_{GEB,\tau} = \frac{\sqrt[4]{D_{11}^3 D_{22}}}{(L_{B1}/2)^2\, N_{xy}}\left[8.125 + 5.64\sqrt{\frac{(D_{12}+D_{33})^2}{D_{11}D_{22}}} - 0.6\frac{(D_{12}+D_{33})^2}{D_{11}D_{22}}\right] \text{ for } D_{11}D_{22} \geq (D_{12}+D_{33})^2$$

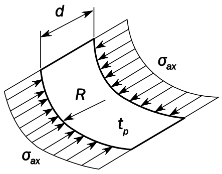
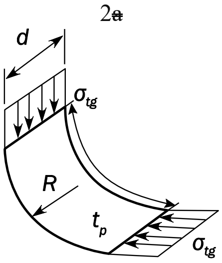
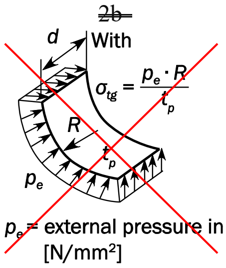
$$\gamma_{GEB,\tau} = \frac{\sqrt{2D_{11}(D_{12}+D_{33})}}{(L_{B1}/2)^2\, N_{xy}}\left[8.3 + 1.525\frac{D_{11}D_{22}}{(D_{12}+D_{33})^2} - 0.493\frac{D_{11}^2 D_{22}^2}{(D_{12}+D_{33})^4}\right] \text{ for } D_{11}D_{22} < (D_{12}+D_{33})^2$$

where:

$N_{xy} = \tau \not{t}\, \underline{t_p}$

Table 4 has been amended as follows.

Table 4 Buckling and Reduction Factor for Curved Plate Panel with $R/t_p \leq 2500$

Case	Aspect ratio	Buckling factor K	Reduction factor C
1 	$\frac{d}{R} \leq 0.5\sqrt{\frac{R}{t_p}}$	$K = 1 + \frac{2}{3}\frac{d^2}{Rt_p}$	For general application: $C_{ax} = 1$ for $\lambda \leq 0.25$ $C_{ax} = 1.233 - 0.933\lambda$ for $0.25 < \lambda \leq 1$ $C_{ax} = 0.3/\lambda^3$ for $1 < \lambda \leq 1.5$ $C_{ax} = 0.2/\lambda^2$ for $\lambda > 1.5$ For curved single fields, e.g. bilge ~~strake~~ plating, which are bounded by plane panels as shown in **Ch 6, Sec 4, Fig.1**: $C_{ax} = \frac{0.65}{\lambda^2} \leq 1.0$
	$\frac{d}{R} > 0.5\sqrt{\frac{R}{t_p}}$	$K = 0.267\frac{d^2}{Rt_p}\left[3 - \frac{d}{R}\sqrt{\frac{t_p}{R}}\right] \geq 0.4\frac{d^2}{Rt_p}$	
2~~a~~  ~~2b~~ 	$\frac{d}{R} \leq 1.63\sqrt{\frac{R}{t_p}}$	$K = \frac{d}{\sqrt{Rt_p}} + 3\frac{(Rt_p)^{0.175}}{d^{0.35}}$	For general application: $C_{tg} = 1$ for $\lambda \leq 0.4$ $C_{tg} = 1.274 - 0.686\lambda$ for $0.4 < \lambda \leq 1.2$ $C_{tg} = \frac{0.65}{\lambda^2}$ for $\lambda > 1.2$ For curved single fields, e.g. bilge ~~strake~~ plating, which are bounded by plane panels as shown in **Ch 6, Sec 4, Fig.1**: $C_{ax} = \frac{0.8}{\lambda^2} \leq 1.0$
	$\frac{d}{R} > 1.63\sqrt{\frac{R}{t_p}}$	$K = 0.3\frac{d^2}{R^2} + 2.25\left(\frac{R^2}{dt_p}\right)^2$	
(omitted)			

Paragraph 2.2.7 has been amended as follows.

2.2.7 Applied normal and shear stresses to plate panels

The normal stresses, σ_x and σ_y, in *N/mm*^{2}, to be applied for the overall stiffened panel capacity and the plate panel capacity calculations, as given in **2.1.1** and **2.2.1** respectively, are to be taken as follows:

- For FE analysis, the reference stresses as defined in **Ch 8**, **Sec 4**, **2.4**.
- For prescriptive assessment of the overall stiffened panel capacity and the plate panel capacity, the axial or transverse compressive stresses calculated according to **Ch 8**, **Sec 3**, **2.2.1**, at load calculation points of the considered stiffener or the considered elementary plate panel, as defined in **Ch 3, Sec 7, 3** and **Ch 3**, **Sec 7**, **2**, respectively. However, in case of transverse stiffening arrangement, the transverse compressive stress used for the assessment of the overall stiffened panel capacity is to be taken as the compressive stress calculated at load calculation points of the stiffener attached plating, as defined in **Ch 3, Sec 7, 2.**
- For grillage analysis where the stresses are obtained based on beam theory, the stresses taken as:

$$\sigma_x = \frac{\sigma_{xb} + \nu\sigma_{yb}}{1 - \nu^2}$$

$$\sigma_y = \frac{\sigma_{yb} + \nu\sigma_{xb}}{1 - \nu^2}$$

where:

σ_{xb}, σ_{yb}: Stress, in *N/mm*^{2}, from grillage beam analysis respectively along *x* or *y* axis of the ~~attached~~ plate ~~of girders~~ attached to the PSM web.

The shear stress τ, in *N/mm*^{2}, to be applied for the overall stiffened panel capacity and the plate panel capacity calculations, as given in **2.1.1** and **2.2.1** respectively, are to be taken as follows:

- For FE analysis, the reference shear stresses as defined in **Ch 8**,**Sec 4**, **2.4**.
- For prescriptive assessment of the plate panel capacity, the shear stresses calculated according to **Ch 8**, **Sec 3**, **2.2.1**, at load calculation points of the considered elementary plate panel, as defined in **Ch 3**, **Sec 7**, **2**.
- For prescriptive assessment of the overall stiffened panel capacity, the shear stresses calculated according to **Ch 8**, **Sec 3**, **2.2.1**, at the following load calculation point:
  - At the middle of the full span, ℓ, of the considered stiffener.
  - At the intersection point between the stiffener and its attached plating.
- For grillage beam analysis, $\tau = 0$ in the ~~attached~~ plate ~~of girders~~ attached to the PSM web.

Chapter 10 OTHER STRUCTURES

Section 1 FORE PART

3. Structure subjected to Impact Loads

3.3 Bow Impact

Paragraph 3.3.6 has been amended as follows.

3.3.6 Primary supporting members

(Omitted)

(g) The net web thickness of each primary supporting member, t_w, in *mm* including decks/bulkheads ~~in way of~~ directly welded to the side shell is not to be less than:

$$t_w = \frac{P_{FB} b_{BI}}{\sin\varphi_W \sigma_{cr}}$$

Where:

φ_W : Angle, in *deg*, between the primary supporting member web and the shell plate, see **Fig. 5**.

σ_{cr} : Critical buckling stress in compression of the web of the primary supporting member or deck/bulkhead panel in way of the applied load given by **Ch 8, Sec 5, 2.2.3**, in N/mm^2. In the calculation, both σ_x and σ_y given in **Ch 8, Sec 5, 2.2.3** are to be considered and UP-B is to be applied.

Section 3 AFT PART

3. Stern Frames

3.1 General

Paragraph 3.1.2 has been amended as follows.

3.1.2

Cast steel and fabricated stern frames are to be strengthened by adequately spaced horizontal plates with gross thickness not less than 80 % of required thickness for stern frames, t_1 , as defined in **Table 1** or **Table 2**. Abrupt changes of section are to be avoided in castings; all sections are to have adequate tapering radius.

3.2 Propeller Posts

Paragraph 3.2.2 has been deleted, and Paragraph 3.2.3 has been renumbered to Paragraph 3.2.2.

~~3.2.2 DELETED~~

~~DELETED~~

~~3.2.3~~3.2.2 Propeller shaft bossing

In single screw ships, the thickness of the propeller shaft bossing, included in the propeller post, is not to be less than 60 % of the dimension b required in **3.2.1** for bar propeller posts with a rectangular section.

Chapter 12 CONSTRUCTION

Section 3 DESIGN OF WELD JOINTS

2. Tee or Cross Joint

2.4 Partial or Full Penetration Welds

Paragraph 2.4.6 has been amended as follows.

2.4.6 Locations required for partial penetration welding

Partial penetration welding as defined in **2.4.2**, is to be used in the following locations. (see examples in **Fig. 3**):

(a) Connection of hopper sloping plate to longitudinal bulkhead (inner hull) or horizontal girder in double side space.
(b) End connection of longitudinal/transverse bulkhead primary supporting member including buttress structure to the double bottom and both end connections of backing bracket, where it is fitted.
(c) Corrugated bulkhead lower stool supporting floors to inner bottom.
(d) Corrugated bulkhead gusset and shedder plates.
(e) Lower 15 % of the length of built-up corrugation of vertical corrugated bulkheads
(f) Structural elements in double bottom below bulkhead primary supporting members and stool plates, except in way of **2.4.5(i)**.
(g) Lower hopper plate to inner bottom.
(h) Horizontal stringers on bulkheads in way of their bracket toe and the heel.

2.5 Weld Size Criteria

Table 2 has been amended as follows.

Table 2 Weld Factors for Different Structural Members

<table>
<tr><th rowspan="2">Hull area</th><th colspan="4">Connection</th><th rowspan="2">f_{weld}</th></tr>
<tr><th colspan="2">Of</th><th colspan="2">To</th></tr>
<tr><td colspan="6">(Omitted)</td></tr>
<tr><td rowspan="6">Deck</td><td rowspan="3">Strength deck</td><td rowspan="2">$t_{as\text{-}built} \geq 13$</td><td colspan="2">Side shell plating within 0.6L_{CSR} midship</td><td>PPW (3)</td></tr>
<tr><td colspan="2">Elsewhere</td><td>0.48</td></tr>
<tr><td>$t_{as\text{-}built} < 13$</td><td colspan="2">Side shell plating</td><td>0.48</td></tr>
<tr><td colspan="2" rowspan="2">Other deck</td><td colspan="2">Side shell plating</td><td>0.38</td></tr>
<tr><td colspan="2">Stiffeners</td><td>0.20</td></tr>
<tr><td colspan="2">Hatch coamings</td><td>Deck plating</td><td>Longitudinal hatch coaming at corners of hatchways on a length of 15 % of the hatch coaming height</td><td>FPW (4) (1)</td></tr>
<tr><td colspan="6">(Omitted)</td></tr>
<tr><td rowspan="4">Machinery space</td><td colspan="2">Centre girder</td><td colspan="2">Keel and inner bottom</td><td>0.48</td></tr>
<tr><td colspan="2">Floor</td><td colspan="2">Centre girder and engine foundation girder</td><td>0.48</td></tr>
<tr><td colspan="2">Engine foundation girders</td><td colspan="2">Top plate ~~and primary hull structure~~ of main engine bed and inner bottom plate, where applicable</td><td>PPW (3)</td></tr>
<tr><td colspan="2">Floors and girders</td><td colspan="2">Inner bottom and shell plate</td><td>0.38</td></tr>
<tr><td rowspan="2">Superstructure and deckhouse</td><td colspan="2">External bulkhead (first and second tier erections)</td><td colspan="2">Deck, external bulkhead</td><td>0.48</td></tr>
<tr><td colspan="2">External bulkheads and internal bulkheads</td><td colspan="2">Elsewhere</td><td>0.20</td></tr>
</table>

(1) f_{weld} =0.43 for hatch coaming other than in cargo holds.

(2) Continuous welding.

(3) PPW: Partial penetration welding in accordance with **2.4.2**. When one side partial penetration weld is adopted, f_{weld} = 0.48 is to be used for the fillet.

(4) FPW: Full penetration welding in accordance with **2.4.2**.

(5) Bulkheads of superstructure and deckhouse are to be considered in the row corresponding to ”Superstructure and deck house”.

Table 3 has been amended as follows.

Table 3 Weld Factors for Miscellaneous Fittings and Equipment

Item		Connection to	f_{weld}
Hatch cover	Primary supporting members	~~Watertight/oil-tight joints~~ At ends (10% of span) of PSM	0.48 (1)
		Elsewhere	0.24
	Stiffeners	At ends ~~of stiffeners~~	0.38 (2)
		Elsewhere	~~0.24~~0.20
Mast, derrick post, crane pedestal, etc.		Deck / Underdeck reinforced structure	0.43
Deck machinery seat		Deck	0.24
Mooring equipment seat		Deck	0.43
Ring for access hole type cover		Anywhere	0.43
Stiffening of side shell doors and weathertight doors		Anywhere	0.24
Frames of shell and weathertight doors		Anywhere	0.43
Coaming of ventilator and air pipe		Deck	0.43
Ventilators, etc., fittings		Anywhere	0.24
~~Ventilators, air pipes, etc., coaming to deck~~		~~Deck~~	~~0.43~~
Scupper and discharge		Deck	0.55
Bulwark stay		Deck	0.24
Bulwark plating		Deck	0.43
Guard rail, stanchion		Deck	0.43
Cleats and fittings		Hatch coaming and hatch cover	0.24 (3)

(1) For bulk carrier hatch covers f_{weld} = 0.38 ~~for watertight joints~~

(2) For bulk carrier hatch covers f_{weld} = 0.24 at ends of stiffeners

(3) Minimum weld factor. Where $t_{as\text{-}built}$ >11.5 *mm* l_{leg} need not exceed $0.62t_{as\text{-}built}$. Penetration welding may be required depending on design.

Chapter 13 SHIP IN OPERATION – RENEWAL CRITERIA

Section 2 ACCEPTANCE CRITERIA

1. General

1.2 Definition

Paragraph 1.2.1 has been amended as follows.

1.2.1 Deck zone

The deck zone includes all the following items contributing to the hull girder strength:

- For bulk carriers: elements above or crossed by the $0.9D$ level line above the baseline such as:
  - Strength deck plating.
  - Deck stringer.
  - Sheer strake.
  - Side shell plating.
  - Inner hull and other longitudinal bulkhead plating, if any.
  - Topside tank sloped plating, including horizontal and vertical strakes.
  - Longitudinal stiffeners, girders and stringers connected to the above mentioned plating.
- For oil tankers: elements above or crossed by the $0.9D$ level line above the baseline such as:
  - Strength deck plating.
  - Deck stringer.
  - Sheer strake.
  - Inner hull and other plane longitudinal bulkheads upper most strake.
  - Topside tank sloped plating, including horizontal and vertical strakes.
  - Longitudinal upper stool.
  - Longitudinal stiffeners, girders and stringers connected to the above mentioned plating.

Paragraph 1.2.2 has been amended as follows.

1.2.2 Bottom zone

The bottom zone includes the following items contributing to the hull girder strength:

- For bulk carriers: elements up to the upper level of the hopper sloping plating or up to and including the inner bottom plating if there is no hopper tank:
  - Keel plate.
  - Bottom plating.
  - Bilge plating.
  - Bottom girders.
  - Inner bottom plating.
  - Hopper tank sloping plating, and horizontal plating, if any.

- Longitudinal stiffeners connected to the above mentioned plating.
- Side shell plating.
- Plane longitudinal bulkheads lower strake.
- Longitudinal stiffeners connected to the above mentioned plating.

- For oil tankers:
  - Keel plate.
  - Bottom plating.
  - Bilge plating.
  - Plane Longitudinal bulkheads lower strake.
  - Bottom girders.
  - Inner bottom plating.
  - Hopper tank sloping plating, and horizontal plating, if any.
  - Side shell plating.
  - Longitudinal lower stool.
  - Longitudinal stiffeners connected to the above mentioned plating.

Part 2 SHIP TYPES

Chapter 1 BULK CARRIERS

Section 3 HULL LOCAL SCANTLING

Symbols has been amended as follows.

Symbols

(Omitted)

SCW : Plate width, in *mm*, taken as the width of the corrugation flange ~~c~~ b_{f-cg} or the web ~~c~~ b_{w-cg}, whichever is greater, see **Pt 1**, **Ch 3**, **Sec 6**, **Fig. 21**.

~~*SC*~~ *Scg* : Half pitch, in *mm*, of the corrugation flange as defined in **Pt 1**, **Ch 3**, **Sec 6**, **Fig. 21**.

3. Transverse Vertically Corrugated Watertight Bulkheads Separating Cargo Holds in Flooded Condition

3.2 Bending, Shear and Buckling Check

Paragraph 3.2.1 has been amended as follows.

3.2.1 Bending capacity and shear capacity

The bending capacity and the shear capacity of the corrugations of transverse watertight corrugated bulkheads separating cargo holds are to comply with the following formulae:

$$0.5W_{LE} + W_M \geq \frac{M}{0.95R_{eH}} 10^3$$

$$\tau \leq \frac{R_{eH}}{2}$$

where:

M : Bending moment in a corrugation, in *kNm*, taken as:

$$M = \frac{F_R \ell_C}{8}$$

F_R : Resultant force, in *kN*, given in **Pt 1**, **Ch 4**, **Sec 6**, **3.1.7**.

ℓ_C : Span of the corrugations, in *m*, as given in **Pt 1**, **Ch 3**, **Sec 6**, **10.4.5**.

W_{LE} : Net section modulus, in cm^3, of one half pitch corrugation, to be calculated at the lower end of the corrugations according to **3.3**, not to be taken greater than:

$$W_{LE,M} = W_G + \frac{Q\, h_G 10^3 - 0.5h_G^2\, s_C\, P_R}{R_{eH}}$$

W_G : Net section modulus, in cm^3, of one half pitch corrugation, to be calculated in way of the upper end of shedder or gusset plates, as applicable, according to **3.3**.

Q : Shear force, in *kN*, at the lower end of a corrugation, to be taken as:

$$Q = 0.8F_R$$

h_G : Height, in *m*, of shedders or gusset plates, as applicable as shown in **Fig. 4** to **Fig. 6**.

P_R : Resultant pressure, in *kN/m*^{2}, to be calculated in way of the middle of the shedders or gusset plates, as applicable, according to **Pt 1**, **Ch 4**, **Sec 6**, **3.1.7**.

W_M : Net section modulus, in *cm*^{3}, of one half pitch corrugation, to be calculated at the mid-span of corrugations according to **3.3** without being taken greater than 1.15 W_{LE}.

τ : Shear stress, in *N/mm*^{2}, in the corrugation to be taken as:

$$\tau = 10 \frac{Q}{A_{shr}}$$

A_{shr} : Net shear area, in *cm*^{2}, of one half pitch corrugation. The calculated net shear area is to consider possible reduced shear efficiency due to non-straight angles between the corrugation webs and flanges. In general, the reduced shear area may be obtained by multiplying the web sectional area by sin ~~φ~~ ϕ.

~~φ~~ ϕ : Angle between the web and the flange, see **Pt 1**, **Ch 3**, **Sec 6**, **Fig. 21**.

The net section modulus of the corrugations in the upper part of the bulkhead, as defined in **Fig. 3**, is not to be taken less than 75% of that of the middle part complying with this requirement and **Pt 1**, **Ch 6**, **Sec 4**, **1.2**, corrected for different minimum yield stresses.

Paragraph 3.2.2 has been amended as follows.

3.2.2 Shear buckling check of the bulkhead corrugation webs

The shear stress τ, calculated according to **3.2.1**, is to comply with the following formula:

$$\tau \le \tau_C$$

where:

τ_C : Critical shear buckling stress, in *N/mm*^{2}, to be taken as:

$$\tau_C = \tau_E \quad \text{for} \quad \tau_E \le \frac{R_{eH}}{2\sqrt{3}}$$

$$\tau_C = \frac{R_{eH}}{\sqrt{3}}\left(1 - \frac{R_{eH}}{4\sqrt{3}\tau_E}\right) \quad \text{for} \quad \tau_E > \frac{R_{eH}}{2\sqrt{3}}$$

τ_E : Euler shear buckling stress, in *N/mm*^{2}, to be taken as:

$$\tau_E = 0.9 k_t\, E \left(\frac{t_w}{\cancel{c}\, b_{w-cg}}\right)^2$$

k_t : Coefficient, to be taken equal to 6.34.

t_w : Net thickness, in *mm*, of the corrugation webs.

~~c~~ b_{w-cg} : Width, in *mm*, of the corrugation webs as shown in **Pt 1**, **Ch 3**, **Sec 6**, **Fig. 21**.

Title of paragraph 3.3 has been amended as follows.

3.3 Net Section Modulus ~~at the Lower End~~ of the Corrugations

Paragraph 3.3.1 has been amended as follows.

3.3.1 Effective flange width

The net section modulus ~~at the lower end~~ of the corrugations is to be calculated with the compression flange having an effective flange width b_{eff} not larger than the following formula:

$$b_{eff} = C_E \cancel{a} \underline{b_{f-cg}}$$

where:

C_E : Coefficient to be taken equal to:

$$C_E = \frac{2.25}{\beta} - \frac{1.25}{\beta^2} \text{ for } \beta > 1.25$$

$$C_E = 1.0 \text{ for } \beta \leq 1.25$$

β : Coefficient to be taken equal to:

$$\beta = \frac{\cancel{a}\underline{b_{f-cg}}}{t_f}\sqrt{\frac{R_{eH}}{E}}$$

$\cancel{a}\underline{b_{f-cg}}$: Width, in *mm*, of the corrugation flange as shown in **Pt 1**, **Ch 3**, **Sec 6**, **Fig. 21**.

t_f :Net flange thickness, in *mm*.

Paragraph 3.3.3 has been amended as follows.

3.3.3 Effective shedder plates

Provided that effective shedder plates are fitted as shown in **Fig. 4**, when calculating the section modulus at the lower end of the corrugations (Sections '1' in **Fig. 4**), the net area, in cm^2, of flange plates may be increased by I_{SH} to be taken as:

$$I_{SH} = 2.5 \cdot 10^{-3} \cancel{a}\underline{b_{f-cg}}\sqrt{t_f\, t_{SH}} \text{ without being taken greater than } 2.5 \cancel{a}\underline{b_{f-cg}} t_f 10^{-3}$$

where:

$\cancel{a}\underline{b_{f-cg}}$: Width, in *mm*, of the corrugation flange as shown in **Pt 1**, **Ch 3**, **Sec 6**, **Fig. 21**.

t_{SH} : Net shedder plate thickness, in *mm*.

t_f : Net flange thickness, in *mm*.

Effective shedder plates are those which:

- are not knuckled,
- are welded to the corrugations and the lower stool top plate according to **Pt 1**, **Ch 12**,
- are fitted with a minimum slope of 45 degrees, their lower edge being in line with the lower stool side plating,
- have net thickness not less than 75% of the net required for the corrugation flanges,
- have material properties not less than those required for the flanges.

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 4.1.4 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:

ρ_C : Density of the dry bulk cargo, in t/m^3, as defined **Pt 1**, **Ch 4**, **Sec 6**, **2.3.3**.

V : Volume, in m^3, occupied by the cargo up to the level h_B.

F : Coefficient to be taken as:

$F = 1.1$ in general

$F = 1.05$ for steel mill products.

h_B : Level of cargo, in *m*, to be taken as:

$$h_B = \frac{P}{\rho_c g}$$

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:

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

ρ_{st} : Density of steel, in t/m^3, to be taken as 7.85.

D_1 : Distance, in *m*, from the baseline to the freeboard deck at side amidships.

h_F : Inner bottom flooded height, in *m*, measured vertically with the ship in the upright position, from the inner bottom to the flooded level z_F.

z_F : Flooded level, in *m*, as defined in **Pt 1**, **Ch 4**, **Sec 6**, ~~**3.1.3**~~ **3.2.3**.

$perm$: Permeability of cargo, which need not be taken greater than 0.3.

Z : Pressure, in kN/m^2, to be taken as the lesser of:

$$Z = \frac{C_H}{A_{DB,H}}$$

$$Z = \frac{C_E}{A_{DB,E}}$$

C_H : Shear capacity of the double bottom, in *kN*, to be calculated according to **4.1.1**, considering, for each floor, the lesser of the shear strengths S_{f1} and S_{f2} as defined in **4.1.2** and, for each girder, the lesser of the shear strengths S_{g1} and S_{g2} as defined in **4.1.3**.

$A_{DB,H}$: Area, in m^2, taken as:

$$A_{DB,H} = \sum_{i=1}^{n} S_i\, B_{DB,i}$$

C_E : Shear capacity of the double bottom, in kN, to be calculated according to **4.1.1**, considering, for each floor, the shear strength S_{f1} as defined in **4.1.2** and, for each girder, the lesser of the shear strengths S_{g1} and S_{g2} as defined in **4.1.3**.

$A_{DB,E}$: Area, in m^2, taken as:

$$A_{DB,E} = \sum_{i=1}^{n} S_i (B_{DB} - s)$$

n : Number of floors between stools or transverse bulkheads, if no stool is fitted.

S_i : Space of i-th floor, in m.

$B_{DB,i}$: Length, in m, to be taken equal to:

$B_{DB,i} = B_{DB} - s$ for floors for which $S_{f1} < S_{f2}$

$B_{DB,i} = B_{DB,h}$ for floors for which $S_{f1} \geq S_{f2}$

B_{DB} : Breadth, in m, of double bottom between the hopper tanks as shown in **Fig. 8**.

$B_{DB,h}$: Distance, in m, between the two openings considered as shown in **Fig. 8**.

s : Spacing, in m, of inner bottom longitudinal ordinary stiffeners adjacent to the hopper tanks.

Section 4 HULL LOCAL SCANTLINGS FOR BULK CARRIERS L_{CSR}<150M

Symbols has been amended as follows.

Symbols

(Omitted)

ϕ : ~~Major diameter~~ <u>Depth</u> of the openings <u>in parallel to web depth of primary support members</u>, in *m*.

(Omitted)

3. Transverse Corrugated Bulkheads of Ballast Holds

3.2 Net Section Modulus

Paragraph 3.2.1 has been amended as follows.

3.2.1

The net section modulus Z, in cm^3, of corrugated bulkhead of ballast holds, subjected to lateral pressure are not to be less than the values obtained from the following formula:

$$Z = K \frac{P \sout{s_C} \underline{s_{cg}} \ell^2}{f_{bdg}\, C_s\, R_Y}$$

where:

K : Coefficient given in **Table 1** and **Table 2**, according to the type of end connection. When d_H < 2.5 d_0, both section modulus per half pitch of corrugated bulkhead and section modulus of lower stool at inner bottom are to be calculated.

P : Design pressure for the design load set as defined in **Pt 1, Ch 6, Sec 2, Table 1** and calculated at the load calculation point defined in **Pt 1, Ch 3, Sec 7, 3.2**, in kN/m^2.

~~s_C~~ <u>s_{cg}</u> : Half pitch length, in *mm*, of the corrugation, as defined in **Pt 1, Ch 3, Sec 6, Fig. 21**.

ℓ : Length, in *m*, between the supports, as indicated in **Fig. 1**.

C_s: Coefficient defined in **Pt 1, Ch 6, Sec 5, 1.1.2**.

f_{bdg} : Coefficient defined in **Pt 1, Ch 6, Sec 5, 1.1.2**.

The effective width of the corrugation flange in compression is to be considered according to **Ch 1, Sec 3, 3.3.1** when the net section modulus of corrugated bulkhead is calculated.

4. Primary Supporting Members

4.2 Design Load Sets

4.2.2 Loading conditions

Table 3 has been amended as follows.

Table 3 Design Load Sets for Primary Supporting Members in Cargo Hold Region

Item	Design load set	Load component	Draught	Design load	Loading condition
Bulk cargo hold assigned as ballast hold	*WB*-4	$P_{in} - P_{ex}$ (1)	T_{BAL-H} ~~(3)~~	*S*+*D*	Heavy ballast condition
	WB-6	P_{in}	-	*S*	Harbour/test condition
Bulk cargo hold	*BC*-11	$P_{in} - P_{ex}$ (1)	T_{SC}	*S*+*D*	Cargo loading condition
	BC-12	$P_{in} - P_{ex}$ (1)	-	*S*	Harbour condition
Compartments not carrying liquids	*FD*-1 (2)	P_{in}	T_{SC}	*S*+*D*	Flooded condition
	FD-2 (2)	P_{in}		*S*	Flooded condition

(1) P_{ex} is to be considered for external shell only.

(2) *FD*-1 and *FD*-2 are not applicable to external shell.

~~(3) Minimum draught among heavy ballast conditions is to be used.~~

Section 5 CARGO HATCH COVERS

2. Arrangements

Paragraph 2.1 has been deleted, and 2.2 has been renumbered to 2.1.

~~**2.1 (Deleted)**~~

2.~~2~~1 Hatch Covers

2.~~2~~1.1

The stiffeners and primary supporting members of the hatch covers are to be continuous over the breadth and length of the hatch covers, as far as practical. When this is impractical, sniped end connections are not to be used and appropriate arrangements are to be adopted to ensure sufficient load carrying capacity.

2.~~2~~1.2

The spacing of primary supporting members parallel to the direction of stiffeners is not to be greater than 1/3 of the span of primary supporting members.

2.~~2~~1.3

The breadth of the primary supporting member face plate is not to be less than 40 % of their depth for laterally unsupported spans greater than 3 *m*. Tripping brackets attached to the face plate may be considered as a lateral support for primary supporting members.

The face plate outstand is not to exceed 15 times the gross face plate thickness.

2.~~2~~1.4

Efficient retaining arrangements are to be provided to prevent translation of the hatch cover under the action of the longitudinal and transverse forces exerted by cargoes on the cover, if any. These retaining arrangements are to be located in way of the hatch coaming side brackets.

2.~~2~~1.5

The width of each bearing surface for hatch covers is to be at least 65 *mm*.

Paragraph 2.3 has been amended as follows.

2.~~3~~2 Hatch Coamings

2.~~3~~2.1

Coamings, stiffeners and brackets are to be capable of withstanding the local forces in way of the clamping devices and handling facilities necessary for securing and moving the hatch covers as well as those due to cargo stowed on the latter.

2.~~3~~2.2

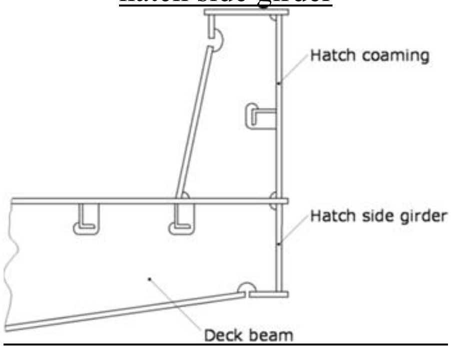
Special attention is to be paid to the strength of the fore transverse coaming of the forward hatch and to the scantlings of the closing devices of the hatch cover on this coaming.

2.~~3~~2.3

Longitudinal coamings are to be vertically extended at least to the lower edge of deck beams, or hatch side girders below deck are to be fitted in line with longitudinal coamings. Extended coaming plates are to be flanged or fitted with face bars or half-round bars at the level of lower edge of the deck beams. **Fig. 1** gives an example.

- Where they are not part of continuous deck girders, the lower edge of longitudinal coamings including below deck structures as an extension measure above are to extend for at least two frame spaces beyond the end of the hatch openings.
- Where ~~longitudinal coamings~~ they are part of continuous deck girders, their scantlings are to be as required in **Pt 1, Ch 6, Sec 6** and **Pt 1, Ch 8, Sec 3**.

Fig. 1 Example of extension to lower edge of deck beams of longitudinal coaming by fitting a hatch side girder



2.~~3~~2.4

A web frame or a similar structure is to be provided below the deck in line with the transverse coaming. Transverse coamings are to extend below the deck and to be connected with the web frames.

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 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.

It is also applicable for hatch covers fitted with U-type stiffeners as shown in **Fig. ~~1~~2**. The stresses in all structural members are to be determined by a finite element analysis with the modelling requirements as described in **5.6.1**.

It is to be checked that stresses of all structural members comply with the yield strength assessment requirement in **5.6.2** and the buckling strength assessment as described in **5.2.3**, **5.3.4**, **5.4.6**, **5.6.3** and **5.6.4**.

Fig.1 has been renumbered Fig.2.

Fig. ~~1~~2 Example of Hatch Cover Fitted with U-Type Stiffener
(Omitted)

5.3 Stiffeners

Paragraph 5.3.3 has been amended as follows.

5.3.3 Net section modulus and net shear sectional area

The net section modulus Z, in cm^3, and the net shear sectional area A_{shr}, in cm^2, of a stiffener subject to lateral pressure are to be taken not less than given by the following formulae:

$$Z = \frac{(F_S P_S + F_W P_W)\, s \cdot \ell_s^2}{f_{bc}\, \sigma_a} \quad \cancel{10^3}$$

$$A_{shr} = \frac{5(F_S P_S + F_W P_W)\, s\ell_s}{\tau_a} \underline{10^{-3}}$$

where:

ℓ_s: Stiffener span, in *m*, to be taken as the spacing, in m, of primary supporting members or the distance between a primary supporting member and the edge support, as applicable. When brackets are fitted at both ends of all stiffener spans, the stiffener span may be reduced by an amount equal to 2/3 of the minimum brackets arm length, but not greater than 10% of the gross span, for each bracket.

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:

$Z = Z_{CS}$

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

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:

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

ψ : Coefficient taken equal to:

$$\psi = \frac{Z_1}{Z_0}$$

ℓ_1 : Length of the variable section part, in *m*, as shown in **Fig. ~~2~~3**.

ℓ_0 : Span measured, in *m*, between end supports, as shown in **Fig. ~~2~~3**.

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

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

Moreover, the net moment of inertia, in cm^4, 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:

$$I = I_{CS}$$

$$I = \left[1 + 8\alpha^3 \left(\frac{1 - \varphi}{0.2 + \sqrt{\varphi}}\right)\right] I_{CS}$$

where:

I_{CS} : Net moment of inertia, in cm^4, with a constant cross section complying with **5.4.5**.

φ : Coefficient taken equal to:

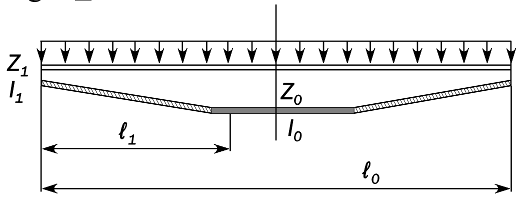
$$\varphi = \frac{I_1}{I_0}$$

I_1 : Net moment of inertia at end, in cm^4, as shown in **Fig. ~~2~~3**.

I_0 : Net moment of inertia at mid-span, in cm^4, as shown in **Fig. ~~2~~3**.

The use of these formulae is limited to the determination of the strength of stiffeners and primary supporting members in which abrupt changes in the cross section do not occur along their length.

Fig. ~~2~~3 Variable Cross Section Stiffener



6. Hatch Coamings

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. ~~5~~6** and **Fig. ~~6~~7**) are to be taken not less than:

$$Z = \frac{s_C\, P_C\, H_C^2}{1.9 R_{eH}}$$

$$t_w = \frac{s_C\, P_C\, H_C}{0.5\, h\, R_{eH}}$$

where:

H_C : Stay height, in m.

s_C : Stay spacing, in mm.

h : Stay depth, in mm, at the connection with deck.

Fig. ~~5~~6 Coaming Stay (Example 1)
(Omitted)

Fig. ~~6~~7 Coaming Stay (Example 2)
(Omitted)

For calculating of offered section modulus of coaming stays, the face plate area may be taken into account only when it is welded with full penetration welds to the deck plating and provided with adequate under deck structure supporting the coaming stay in the deck structure.

For other designs of coaming stays, such as those shown in **Fig. ~~7~~8** and **Fig. ~~8~~9**, 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:

$$\sigma \leq 0.95\, R_{eH}$$

$$\tau \leq 0.5 R_{eH}$$

Fig. ~~7~~8 Coaming Stay (Example 3)
(Omitted)

Fig. ~~8~~9 Coaming Stay (Example 4)
(Omitted)

Chapter 2 OIL TANKERS

Section 2 STRUCTURAL DESIGN PRINCIPLES

1. Corrosion Protection

1.2 Internal Cathodic Protection Systems

Paragraph 1.2.2 has been amended as follows.

1.2.2

Permanent magnesium or magnesium alloy anodes in tanks ~~made of, or alloyed with magnesium~~ are not acceptable, except in tanks solely intended for water ballast that are not adjacent to cargo tanks.

Impressed current systems are not to be used in cargo tanks due to the development of chlorine and hydrogen that can result in an explosion.

Aluminium anodes are accepted, however, in tanks with liquid cargo with flash point below 60°C and in adjacent ballast tanks, aluminium anodes are to be located so a kinetic energy of not more than 275 J is developed in the event of their loosening and becoming detached.

Section 4 HULL OUTFITTING

1. Supporting Structures for Components Used in Emergency Towing Arrangements

1.6 Scantling Requirements

Paragraph 1.6.3 has been amended as follows.

1.6.3 Permissible stresses

For the design load given in **1.5.2**, the shear stresses and normal stresses, including bending stresses induced in the supporting structure and welds, in way of strong-points and fairleads, are not to be exceed the permissible values given below based on the gross thickness of the structure:

- Normal stress, $1.00R_{eH}$.
- Shear stress, $0.58R_{eH}$.

Allowable buckling utilization factor is to be used as given in **Pt 1, Ch 8, Sec 1, Table 1**, for static and dynamic load scenario, *S*+*D*. Buckling assessment method is to be used according to **Pt 1, Ch 8, Sec 4, 2**.