17-393

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 2017 AMENDMENT NO.2

Rule No.92 25 December 2017
Resolved by Technical Committee on 26 July 2017

ClassNK
NIPPON KAIJI KYOKAI

Rule No.92 25 December 2017
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 2 RULE PRINCIPLES

Table 1 has been amended as follows.

Table 1 Load Scenarios and Corresponding Rule Requirements

Operation	Load type	Design load scenario ~~(specified in **Ch 4, Sec 7**)~~	Acceptance criteria ~~(specified in **Ch 6** and **Ch 7**)~~
Seagoing operations			
Transit	Static and dynamic loads in heavy weather	$S + D$	AC-SD
	Impact loads in heavy weather	Impact (I)	AC-I
	Internal sloshing loads	Sloshing (SL)	AC-S
	Cyclic wave loads	Fatigue (F)	-
BWE by flow through or sequential methods	Static and dynamic loads in heavy weather	$S + D$	AC-SD
Harbour and sheltered operations			
Loading, unloading and ballasting	Typical maximum loads during loading, unloading and ballasting operations	S	AC-S
Tank testing	Typical maximum loads during tank testing operations	S	AC-S
Special conditions in harbour	Typical maximum loads during special operations in harbour, e.g. propeller inspection afloat or dry-docking loading conditions	S	AC-S
Accidental condition			
Flooded conditions	Typically maximum loads on internal watertight subdivision structure in accidental flooded conditions	A	AC-SD AC-S

Section 5 LOADING MANUAL AND LOADING INSTRUMENTS

2. Loading Manuals

2.3 Requirements Specific to Bulk Carriers

Paragraph 2.3.2 has been amended as follows.

2.3.2

The loading manual is to describe:

- Envelope results and permissible limits of still water bending moments and shear forces in the ~~hold~~ flooded conditions according to **Ch 4, Sec 4**,
- The cargo hold(s) or combination of cargo holds that might be empty at full draught. If no cargo hold is allowed to be empty at full draught, this is to be clearly stated in the loading manual,
- Maximum allowable and minimum required mass of cargo and double bottom contents of each hold as a function of the draught at mid-hold position as defined in **Ch 4, Sec 8, 4.3**,
- Maximum allowable and minimum required mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds. This mean draught may be calculated by averaging the draught of the two mid-hold positions as defined in **Ch 4, Sec 8, 4.3**,
- Maximum allowable tank top loading together with specification of the nature of the cargo for cargoes other than bulk cargoes,
- Maximum allowable load on deck and hatch covers. If the ship is not approved to carry load on deck or hatch covers, this is to be clearly stated in the loading manual,
- Maximum rate of ballast change together with the advice that a load plan is to be agreed with the terminal on the basis of the achievable rates of change of ballast.

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 6 STRUCTURAL DETAIL PRINCIPLES

10. Bulkhead Structure

10.4 Corrugated Bulkheads

Paragraph 10.4.2 has been amended as follows.

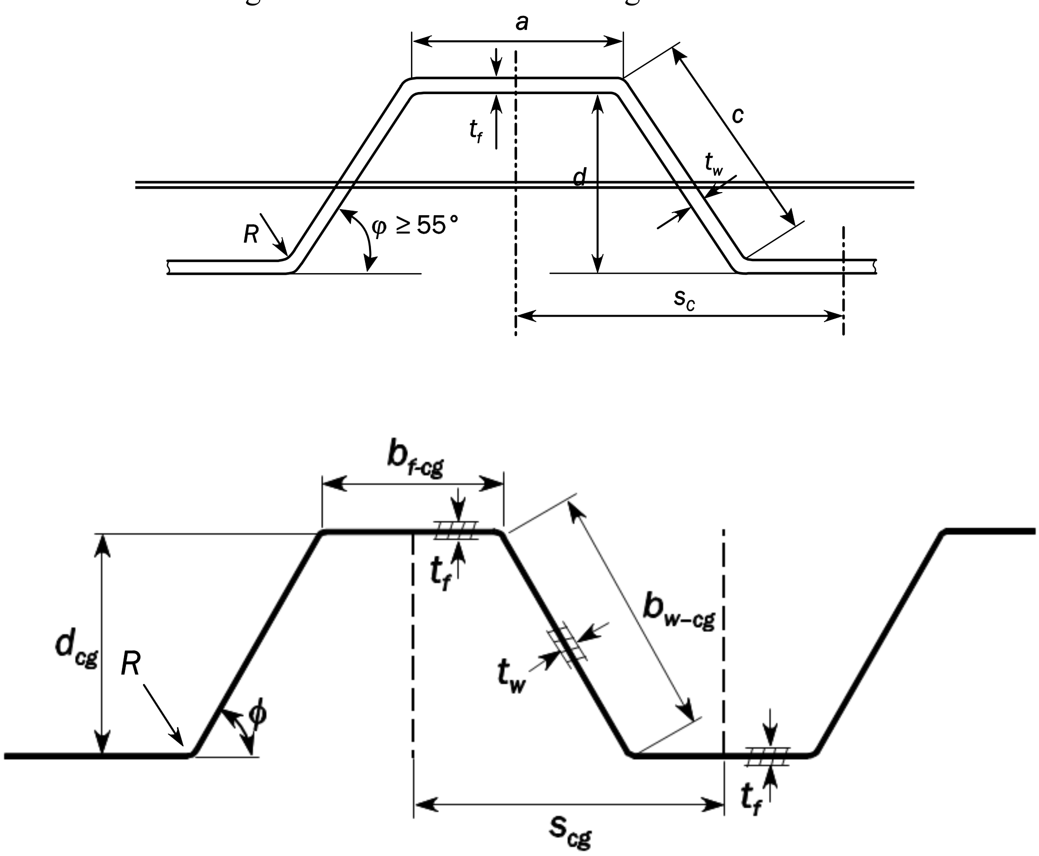
10.4.2 Construction

The main dimensions ~~a~~ $\underline{b_{f\text{-}cg}}$, R, ~~c~~ $\underline{b_{w\text{-}cg}}$, ~~$d$~~ $\underline{d_{cg}}$, t_f, t_w, ~~s_C~~ $\underline{s_{cg}}$ of corrugated bulkheads are defined in **Fig. 21**.

The corrugation angle ~~φ~~ $\underline{\phi}$ is not to be less than 55 degrees.

When welds in a direction parallel to the bend axis are provided in the zone of the bend, the welding procedures are to be submitted to the Society for approval.

Fig. 21 Dimensions of a Corrugated Bulkhead



Paragraph 10.4.3 has been amended as follows.

10.4.3 Corrugated bulkhead depth

The depth of the corrugation, ~~d~~ $\underline{d_{cg}}$, in *mm*, is not to be less than:

$$\cancel{d = \frac{1000\ell_c}{C}}$$

$$\underline{d_{cg} = \frac{1000\ell_c}{C}}$$

where:

ℓ_c : Mean span of considered corrugation, in *m*, as defined in **10.4.5**.

C : Coefficient to be taken as:

C = 15 for tank and water ballast cargo hold bulkheads.

C = 18 for dry cargo hold bulkheads.

Paragraph 10.4.4 has been amended as follows.

10.4.4 Actual section modulus of corrugations

The net section modulus of a corrugation may be obtained, in cm^3, from the following formula:

$$\cancel{Z = \left[\frac{d(3at_f + ct_w)}{6}\right]10^{-3}}$$

$$\underline{Z = \left[\frac{d_{cg}(3b_{f-cg}t_f + b_{w-cg}t_w)}{6}\right]10^{-3}}$$

where:

t_f, t_w : Net thickness of the plating of the corrugation, in *mm*, shown in **Fig. 21**.

~~d~~ $\underline{d_{cg}}$, ~~a~~ $\underline{b_{f\text{-}cg}}$, ~~$c$~~ $\underline{b_{w\text{-}cg}}$: Dimensions of the corrugation, in *mm*, shown in **Fig. 21**.

Where the web continuity is not ensured at ends of the bulkhead, the net section modulus of a corrugation is to be obtained, in cm^3, from the following formula:

$$\cancel{Z = 0.5at_f d 10^{-3}}$$

$$\underline{Z = 0.5b_{f-cg}t_f d_{cg}10^{-3}}$$

Chapter 4 LOADS

Section 4 HULL GIRDER LOADS

Symbols has been amended as follows.

Symbols

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

x : X coordinate, in m, of the calculation point with respect to the reference coordinate system defined in **Ch 4, Sec 1, 1.2.1**.

C_w : Wave coefficient, ~~in *m*,~~ to be taken as:

$$C_w = 10.75 - \left(\frac{300 - L_{CSR}}{100}\right)^{1.5} \quad \text{for } \cancel{90 \le L_{CSR} \le 300} \ \underline{90\,m \le L_{CSR} \le 300\,m}$$

$$C_w = 10.75 \quad \text{for } \cancel{300 < L_{CSR} \le 350} \ \underline{300\,m < L_{CSR} \le 350\,m}$$

$$C_w = 10.75 - \left(\frac{L_{CSR} - 350}{150}\right)^{1.5} \quad \text{for } \cancel{350 < L_{CSR} \le 500} \ \underline{350\,m < L_{CSR} \le 500\,m}$$

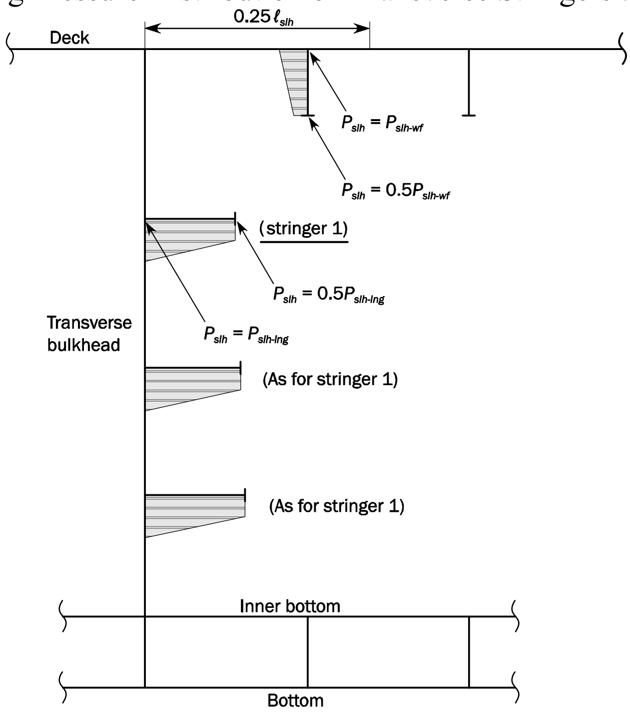
(Omitted)

Section 6 INTERNAL LOADS

6. Sloshing Pressures in Tanks

Fig.13 has been amended as follows.

Fig. 13 Sloshing Pressure Distribution on Transverse Stringers and Web Frames



6.4 Sloshing Pressure due to Transverse Liquid Motion

Paragraph 6.4.3 has been amended as follows.

6.4.3 Sloshing pressure in way of longitudinal bulkheads

The sloshing pressure in way of longitudinal bulkheads including wash bulkheads due to transverse liquid motion, $P_{slh\text{-}t}$, in kN/m^2, for a particular filling level, is to be taken as:

$$P_{slh-t} = 7\rho_{slh}\, g\, f_{slh}\left(\frac{b_{slh}}{B} - 0.3\right)GM^{0.75}$$

where:

b_{slh} : Effective sloshing breadth defined in **6.4.2**.

GM : Metacentric height, given in **Ch 4, Sec 3, 2.1.1**.
For the calculation of sloshing pressure in ballast tanks the ‘ballast condition’ is to be used for oil tankers and the ‘normal ballast condition’ for bulk carriers.
For the calculations of sloshing pressure in cargo tanks of oil tankers, the ‘partial load condition’ is to be used.

<u>f_{slh} : Coefficient defined in **6.3.3**.</u>

Fig.14 has been amended as follows.

Fig. 14 Sloshing Pressure Distribution on Longitudinal Stringers and Girders

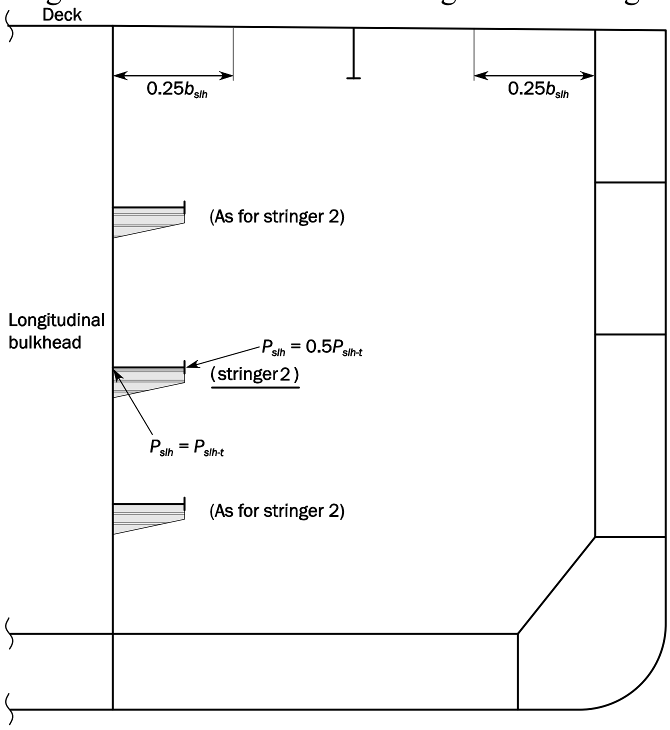


Table 13 has been amended as follows.

Table 13 Design Testing Load Height z_{ST}

Compartment	z_{ST}
(Omitted)	
Hopper side tanks, topside tanks, double side tanks, fore and aft peaks used as tank~~, cofferdams~~	The greater of the following: $z_{ST} = z_{top} + h_{air}$ $z_{ST} = z_{top} + 2.4$
(Omitted)	

Section 8 LOADING CONDITIONS

3. Oil Tankers

3.1 Specific Design Loading Conditions

Paragraph 3.1.1 has been amended as follows.

3.1.1 Seagoing conditions

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

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

((b) to (e) are omitted.)

4. Bulk Carriers

4.1 Specific Design Loading Condition

Paragraph 4.1.1 has been amended as follows.

4.1.1 Seagoing conditions

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

(a) Cargo loading conditions as defined in **4.1.2** to **4.1.4**.

(b) Heavy ballast condition where the ballast tanks may be full, partially full or empty. Where ballast tanks are partially full, the conditions in **2.2.1** are to be complied with. The propeller immersion ℓ/D_p is to be at least 60%. The trim is to be by the stern and is not to exceed $0.015L_{\cancel{CSR}\ \underline{LL}}$. The moulded forward draught is not to be taken less than the smaller of $0.03L_{CSR}$ or 8 m.

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 3.4.3 has been amended as follows.

3.4.3 Shear force correction for a ship with a centreline longitudinal bulkhead

For ships with a centreline longitudinal bulkhead, the shear force correction in way of transverse bulkhead, δQ_3, in *kN*, is to be obtained from the following formula:

$$\delta Q_3 = 0.5 K_3 F_{db}$$

where:

F_{db}: Maximum resulting force on the double bottom in a tank, in *kN*, as defined in **3.4.5**.

K_3: Correction factor, to be taken equal to:

$$K_3 = 0.4\left(1 - \frac{1}{1+n}\right) - f_3$$

n: Number of floors between transverse bulkheads.

f_3: Shear force distribution factor, as defined in **Table** ~~5~~7.

Paragraph 3.4.4 has been amended as follows.

3.4.4 Shear force correction for a ship with two longitudinal bulkheads between the cargo tanks

For ships with two longitudinal bulkheads between the cargo tanks, the shear force correction, δQ_3 in *kN*, is to be obtained from the following formula:

$$\delta Q_3 = 0.5 K_3 F_{db}$$

where:

F_{db}: Maximum resulting force on the double bottom in a tank, in *kN*, as defined in **3.4.5**.

K_3: Correction factor, to be taken equal to:

$$K_3 = 0.5\left(1 - \frac{1}{1+n}\right)\left(\frac{1}{r+1}\right) - f_3$$

where:

n: Number of floors between transverse bulkheads.

r: Ratio of the part load carried by the wash bulkheads and floors from longitudinal bulkhead to the double side taken as:

$$r = \frac{1}{\left[\dfrac{A_{3-n50}}{A_{1-n50} + A_{2-n50}} + \dfrac{2\times10^4 b_{80}(n_S + 1)A_{3-n50}}{\ell_{tk}(n_S A_{T-n50} + R)}\right]}$$

ℓ_{tk}: Length of cargo tank, between transverse bulkheads in the side cargo tank, in *m*.

b_{80}: 80% of the distance from longitudinal bulkhead to the inner hull longitudinal bulkhead, in *m*, at tank mid length.

$A_{T\text{-}n50}$: Net shear area of the transverse wash bulkhead, including the double bottom floor directly below, in the side cargo tank, in cm^2, taken as the smallest area in a vertical section.

$A_{1\text{-}n50}$, $A_{2\text{-}n50}$, $A_{3\text{-}n50}$: Net areas, as defined in **Table ~~5~~7**, in m^2.

f_3: Shear force distribution factor, as defined in **Table ~~5~~7**.

n_S: Number of wash bulkheads in the side cargo tank.

R: Total efficiency of the transverse primary supporting members in the side tank in cm^2.

$$R = \left(\frac{n - n_S}{2} - 1\right)\frac{A_{Q-n50}}{\gamma}$$

$$\gamma = 1 + \frac{300 {b_{80}}^2 A_{Q-n50}}{I_{psm-n50}}$$

$A_{Q\text{-}n50}$: Net shear area, in cm^2, of a transverse primary supporting member in the wing cargo tank, taken as the sum of the net shear areas of floor, cross ties and deck transverse webs. The net shear area is to be calculated at the mid span of the members.

$I_{psm\text{-}n50}$: Net moment of inertia for transverse primary supporting members, in cm^4, in the wing cargo tank, taken as the sum of the moments of inertia of transverses and cross ties. The net moment of inertia is to be calculated at the mid span of the member including an attached plate width equal to the primary supporting member spacing.

Paragraph 3.4.5 has been amended as follows.

3.4.5 Vertical force on double bottom

The maximum vertical resulting force on the double bottom in a tank, F_{db} is in no case to be less than that given by the minimum conditions given in **Table ~~6~~5**.

The maximum resulting force on the double bottom in a tank, F_{db} in *kN*, is to be taken as:

$$F_{db} = g\left|W_{CT} + W_{CTBT} - \rho b_2 \ell_{tk} T_{mean}\right|$$

where:

W_{CT}: Weight of cargo, in tonnes, as defined in **Table ~~7~~6**.

W_{CWBT}: Weight of ballast, in tonnes, as defined in **Table ~~7~~6**.

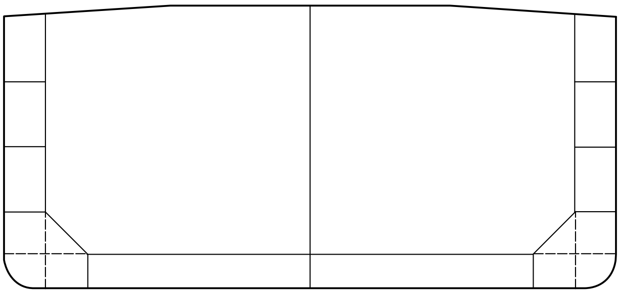
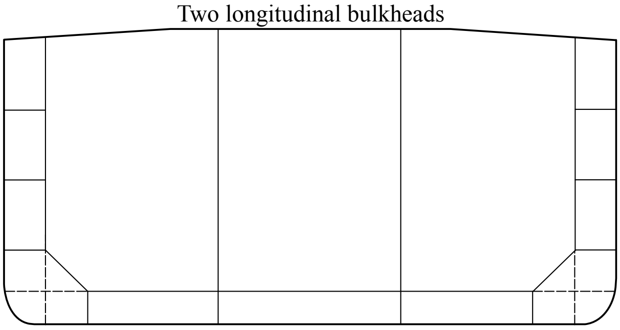
b_2: Breadth, in *m*, as defined in **Table ~~7~~6**.

ℓ_{tk}: Length of cargo tank, in *m*.

T_{mean}: Draught at the mid length of the tank for the loading condition considered, in *m*.

Table 5 has been renumbered to Table 7, and Table 6 and Table 7 have been renumbered to Table 5 and Table 6.

Table ~~5~~7 Shear Force Distribution Factor for Oil Tanker

Hull configuration	f_3 factor
One centreline bulkhead 	$f_3 = 0.504 - 0.076\dfrac{A_{1-n50}}{A_{2-n50}} - 0.156\dfrac{A_{2-n50}}{A_{3-n50}}$
Two longitudinal bulkheads 	$f_3 = 0.353 - 0.049\dfrac{A_{1-n50}}{A_{2-n50}} - 0.095\dfrac{A_{2-n50}}{A_{3-n50}}$

where:
$A_{1\text{-}n50}$, $A_{2\text{-}n50}$, $A_{3\text{-}n50}$:
Net projected area onto the vertical plane based on net thickness, t_{n50}, of the side shell, inner hull or the longitudinal bulkhead respectively, at one side of the section under consideration.
The area $A_{1\text{-}n50}$ includes the net plating area of the side shell, including the bilge.
The area $A_{2\text{-}n50}$ includes the net plating area of the inner hull, including the hopper side and the outboard girder under.
The Area $A_{3\text{-}n50}$ includes the net plating area of the longitudinal bulkheads, including the double bottom girders in line. The area $A_{3\text{-}n50}$ for the centreline bulkhead is not to be reduced for symmetry around the centreline. When the longitudinal bulkhead is made with corrugation,
$A_{3\text{-}n50}$ is to consider the equivalent net thickness of the corrugation as defined in **3.4.6**.

Table ~~6~~5 Minimum Conditions for Double Bottom

Structural configuration	Positive/negative force, F_{db}	Minimum condition
Ships with centreline bulkhead	Max positive net vertical force, F_{db+}	$0.9T_{sc}$and empty cargo tanks and ballast tanks
	Max negative net vertical force, F_{db-}	$0.6T_{sc}$and full cargo tanks and empty ballast tanks
Ships with two longitudinal bulkheads	Max positive net vertical force, F_{db+}	$0.9T_{sc}$and empty cargo tanks and ballast tanks
	Max negative net vertical force, F_{db-}	$0.6T_{sc}$and full centre cargo tank and empty ballast tanks

Table ~~7~~6 Design Conditions for Double Bottom

Structural configuration	W_{CT}	W_{CWBT}	b_2
Ships with centreline bulkhead	Weight of cargo in cargo tanks, in tonnes, using a minimum density of 1.025 t/m^3.	Weight of ballast between port and starboard inner sides, in *t*.	Maximum breadth between port and starboard inner sides at mid length of tank, in *m*, as shown in **Fig.6**.
Ships with two longitudinal bulkheads	Weight of cargo in the centre tank, in tonnes, using a minimum density of 1.025 t/m^3.	Weight of ballast below the centre cargo tank, in *t*.	Maximum breadth of the centre cargo tank at mid length of tank, in *m*, as shown in **Fig.6**.

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.

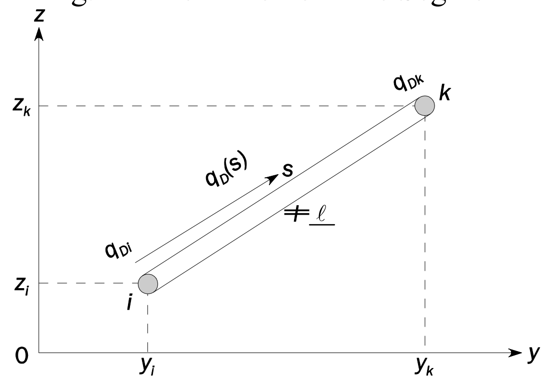
3.5.1

In way of transverse bulkhead stringer connections, within areas as specified in **Fig. ~~7~~8**, 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:
(Omitted)

Appendix 1 DIRECT CALCULATION OF SHEAR FLOW

Fig. 1 has been amended as follows.

Fig. 1 Definition of Line Segment



Appendix 2 HULL GIRDER ULTIMATE CAPACITY

Symbols has been amended as follows.

Symbols

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

$I_{y\text{-}n50}$: Moment of inertia, in m^4, of the hull transverse section around its horizontal neutral axis, to be calculated according to **Ch 5, Sec 1**.

$Z_{B\text{-}n50}$, $Z_{D\text{-}n50}$: Section moduli, in m^3, at bottom and deck, respectively, defined in **Ch 5, Sec 1**.

R_{eHs} : Minimum yield stress, in N/mm^2, of the material of the considered stiffener.

R_{eHp} : Minimum yield stress, in N/mm^2, of the material of the considered plate.

$A_{s\text{-}n50}$: Net sectional area, in cm^2, of stiffener, without attached plating.

$A_{p\text{-}n50}$: Net sectional area, in cm^2, of attached plating.

z_i : z coordinate, in m, of centre of gravity of the i-th element.

Chapter 7 DIRECT STRENGTH ANALYSIS

Section 2 CARGO HOLD STRUCTURAL STRENGTH ANALYSIS

4. Load Application

4.4 Procedure to Adjust Hull Girder Shear Forces and Bending Moments

Paragraph 4.4.8 has been amended as follows.

4.4.8 Procedure to adjust vertical and horizontal bending moments for midship cargo hold region

In case the target vertical bending moment needs to be reached, an additional vertical bending moment is to be applied at both ends of the cargo hold FE model to generate this target value in the mid-hold of the model. This end vertical bending moment is given as follows:

$$M_{v-end} = M_{v-targ} - M_{v-peak}$$

where:

(Omitted)

$M_{lineload}$: Vertical bending moment, in kNm, at position x, due to application of vertical line loads at frames according to method 2, to be taken as:

$$M_{lineload} = -(x - x_{aft})F - \sum_i (x - x_i)\delta w_i \qquad \text{when } x_i < x$$

F : Reaction force, in kN, at model ends due to application of vertical loads to frames as defined in **Table 7**.

x : X-coordinate, in m, of frame in way of the mid-hold.

δw_i : vertical load, in kN, at web frame station i applied to generate required shear force.

$\underline{\delta w_i = -\delta w_1}$ <u>when frame *i* is within after hold</u>

$\underline{\delta w_i = \delta w_2}$ <u>when frame *i* is within mid-hold</u>

$\underline{\delta w_i = -\delta w_3}$ <u>when frame *i* is within forward hold</u>

In case the target horizontal bending moment needs to be reached, an additional horizontal bending moment is to be applied at the ends of the cargo tank FE model to generate this target value within the mid-hold. The additional horizontal bending moment is to be taken as:

(Omitted)

4.5 Procedure to Adjust Hull Girder Torsional Moments

Paragraph 4.5.2 has been amended as follows.

4.5.2 Torsional moment due to local loads

Torsional moment, in kNm, at longitudinal station i due to local loads, $M_{T\text{-}FEMi}$ in kNm, is determined by the following formula (see **Fig. 20**):

$$M_{T-FEMi} = \sum_k \left[f_{hik} \left(z_{ik} - z_r \right) \right] - \sum_k \left(f_{vik} \; y_{ik} \right)$$

where:

$M_{T\text{-}FEMi}$: Lumped torsional moment, in kNm, due to local load at longitudinal station i.

z_r : Vertical coordinate of torsional reference point, in m:
For bulk carrier, $z_r = 0$.
For oil tanker, $z_r = z_{sc}$, shear centre at the middle of the mid-hold.

f_{hik} : Horizontal nodal force, in kN, of node k at longitudinal station i.

f_{vik} : Vertical nodal force, in kN, of node k at longitudinal station i.

y_{ik} : Y-coordinate, in m, of node k at longitudinal station i.

z_{ik} : Z-coordinate, in m, of node k at longitudinal station i.

$M_{T\text{-}FEM0}$: Lumped torsional moment, in kNm, due to local load at aft end of the FE model (forward end for foremost cargo hold model), taken as:

$$\cancel{M_{T-FEM0} = \sum_k \left[f_{h0k} \left(z_{0k} - z_r \right) \right] - \sum_k \left(f_{v0k} \; y_{0k} \right) + R_{H\_fwd} \cdot \left(z_{ind} - z_r \right)}$$

$$\underline{M_{T-FEM0} = -\sum_k \left[f_{h0k} \left(z_{0k} - z_r \right) \right] + \sum_k \left(f_{v0k} \; y_{0k} \right) + R_{H\_fwd} \cdot \left(z_{ind} - z_r \right)}$$

for foremost cargo hold model

$$M_{T-FEM0} = \sum_k \left[f_{h0k} \left(z_{0k} - z_r \right) \right] - \sum_k \left(f_{v0k} \; y_{0k} \right) + R_{H\_aft} \cdot \left(z_{ind} - z_r \right)$$

for the other cargo hold models

R_{H_fwd} : Horizontal reaction forces, in kN, at the forward end, as defined in **4.4.3**.

R_{H_aft} : Horizontal reaction forces, in kN, at the aft end, as defined in **4.4.3**.

z_{ind} : Vertical coordinate, in m, of independent point as defined in **2.5.3**.

Chapter 8 BUCKLING

Section 2 SLENDERNESS REQUIREMENTS

5. Brackets

5.3 Edge Reinforcement

Paragraph 5.3.1 has been amended as follows.

5.3.1 Edge reinforcements of bracket edges

The depth of stiffener web, h_w in *mm*, of edge stiffeners in way of bracket edges is not to be less than:

$$\cancel{h_w = C\ell_b \sqrt{\frac{R_{eH}}{235}}} \quad \underline{h_w = \frac{C\ell_b}{1000}\sqrt{\frac{R_{eH}}{235}}}$$ or 50 *mm*, whichever is greater.

where:

C : Slenderness coefficient taken as:

$C = 75$ for end brackets.

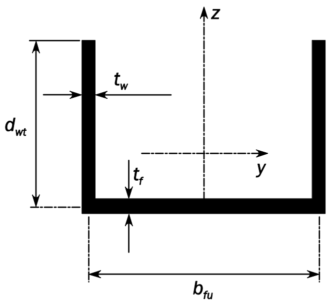
$C = 50$ for tripping brackets.

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

Section 5 BUCKLING CAPACITY

Table 7 has been amended as follows.

Table 7 Cross Sectional Properties

<table>
<tr><td colspan="3">(Omitted)</td></tr>
<tr><td rowspan="4">
</td><td>$\cancel{I_{sv-n50} = \frac{1}{3}\left(b_{fu}t_f^3 + 2d_{wt}t_w^3\right)10^{-4}}$
$\underline{I_{sv} = \frac{1}{3}\left(b_{fu}t_f^3 + 2d_{wt}t_w^3\right)10^{-4}}$</td><td>$cm^4$</td></tr>
<tr><td>$y_0 = 0$</td><td>cm</td></tr>
<tr><td>$z_0 = -\frac{d_{wt}^2 t_w 10^{-1}}{2d_{wt}t_w + b_{fu}t_f} - \frac{0.5d_{wt}^2 t_w 10^{-1}}{d_{wt}t_w + b_{fu}t_f/6}$</td><td>$cm$</td></tr>
<tr><td>$c_{warp} = \frac{b_{fu}^2 d_{wt}^3 t_w (3d_{wt}t_w + 2b_{fu}t_f)}{12(6d_{wt}t_w + b_{fu}t_f)}10^{-6}$</td><td>$cm^6$</td></tr>
<tr><td colspan="3">(Omitted)</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

Chapter 9 FATIGUE

Section 1 GENERAL CONSIDERATIONS

Table 3 has been amended as follows.

Table 3 Fraction of Time for Each Loading Condition of Bulk Carriers

Ship length	Loading conditions	$\alpha_{(j)}$	
		BC-A	*BC-B*, *BC-C*
$L_{CSR} < 200\ m$	Homogeneous	0.60	0.70
	Alternate	0.10	-
	Normal ballast(1)	0.15	0.05
	Heavy ballast(1)	0.15	0.25
$L_{CSR} \geq 200\ m$	Homogeneous	0.25	0.50
	Alternate	0.25	-
	Normal ballast	0.20	0.20
	Heavy ballast	0.30	0.30

(1) For *BC-B* and *BC-C* without heavy ballast cargo hold, fraction of time $\alpha_{(j)}$ for normal ballast is 0.30 and for heavy ballast 0.

Section 3 FATIGUE EVALUATION

3. Reference Stresses for Fatigue Assessment

3.2 Mean Stress Effect

Paragraph 3.2.1 has been amended as follows.

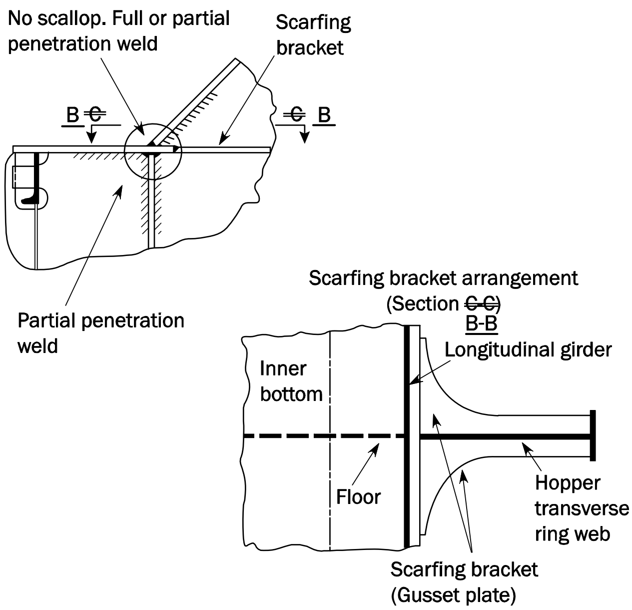
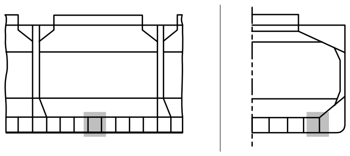
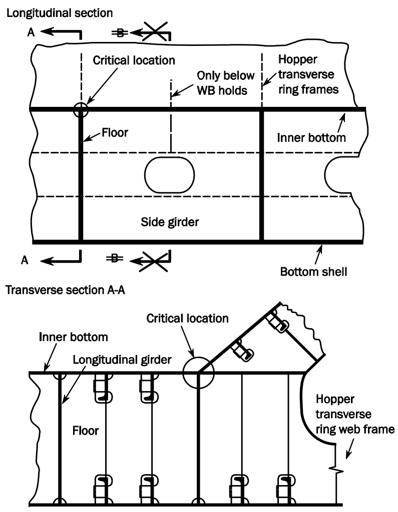
3.2.1 Correction factor for mean stress effect
(Omitted)

$\sigma_{mean,i(j)}$: Fatigue mean stress, in N/mm^2, for base material calculated according to **3.2.2** or welded joint calculated according to ~~**3.2.2**~~, **3.2.3** or **3.2.4** as applicable.

Section 6 DETAIL DESIGN STANDARD

Table 5 has been amended as follows.

Table 5 Design Standard E – Hopper Knuckle Connection Detail, Welded, Bulk Carrier

<table>
<tr><td colspan="2">Connections of floors in double bottom tanks to hopper tanks
Welded knuckle connection of hopper tank sloping plating to inner bottom plating</td></tr>
<tr><td>Critical areas</td><td rowspan="4">a) Improvement at the knuckles

</td></tr>
<tr><td></td></tr>
<tr><td>Critical locations</td></tr>
<tr><td>
</td></tr>
<tr><td colspan="2">(Omitted)</td></tr>
</table>

Chapter 10 OTHER STRUCTURES

Section 1 FORE PART

2. Structural Arrangement

2.1 Floors and Bottom Girders

Paragraph 2.1.2 has been amended as follows.

2.1.2 Bottom girders

A supporting structure is to be provided at the centreline either by extending the centreline girder to the stem or by providing a deep girder or centreline bulkhead.

Where a centreline girder is fitted, the minimum depth and thickness is not to be less than that required for the depth of the double bottom in the neighbouring cargo ~~tank~~ hold region, and the upper edge is to be stiffened.

In case of transverse framing, the spacing of bottom girders is not to exceed 2.5 *m*.

In case of longitudinal framing, the spacing of bottom girders is not to exceed 3.5 *m*.

3. Structure subjected to Impact Loads

3.2 Bottom Slamming

Paragraph 3.2.7 has been amended as follows.

3.2.7 Primary supporting members

((a) is omitted.)

(b) Simplified calculation of slamming shear force

For simple arrangements of primary supporting members, where the grillage ~~affect~~ effect may be ignored, the shear force, Q_{SL}, in *kN*, is given by :

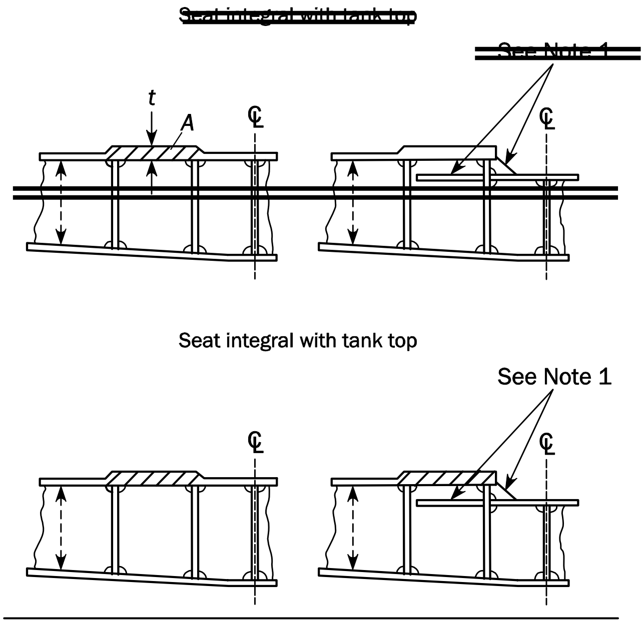
$$Q_{SL} = f_{pt}\ f_{dist}\ F_{SL}$$

((c) and (d) are omitted.)

Section 2 MACHINERY SPACE

Fig. 1 has been amended as follows.

Fig. 1 Machinery Foundations Type 1



Section 3 AFT PART

3. Stern Frames

3.1 General

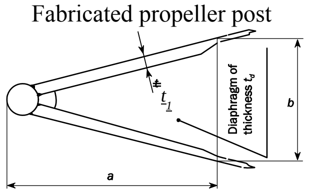
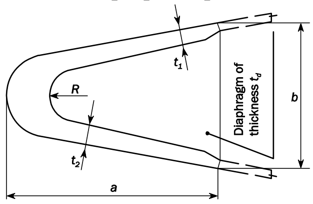
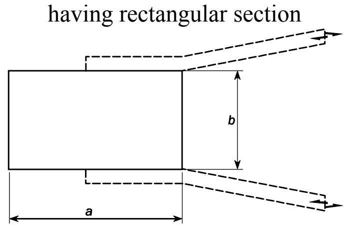
Paragraph 3.1.2 has been amended as follows.

3.1.2

Cast steel and fabricated stern frames are to be strengthened by adequately spaced 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.

Table 1 has been amended as follows.

Table 1 Single Screw Ships - Gross Scantlings of Propeller Posts

Gross scantlings of propeller posts, in *mm*	Fabricated propeller post 	Cast propeller post 	Bar propeller post, cast or forged, having rectangular section 
a	$50L_1^{1/2}$	$33L_1^{1/2}$	$10\sqrt{7.2L_{CSR} - 256}$
b	$35L_1^{1/2}$	$23L_1^{1/2}$	$10\sqrt{4.6L_{CSR} - 164}$
t_1	$2.5L_1^{1/2}$	$3.2L_1^{1/2}$	-
t_2	-	$4.4L_1^{1/2}$	-
t_d	$1.3L_1^{1/2}$	$2.0L_1^{1/2}$	-
R	-	50 *mm*	-

3.3 Connections

Paragraph 3.3.4 has been amended as follows.

3.3.4 Connection with centre ~~keelson~~ girder

Where the stern frame is made of cast steel, the lower part of the stern frame is to be fitted, as far as practicable, with a longitudinal web for connection with the centre ~~keelson~~ girder.

Section 4 TANKS SUBJECT TO SLOSHING

1. General

1.3 Application of Sloshing Pressure

Paragraph 1.3.5 has been amended as follows.

1.3.5 Application of design sloshing pressure due to transverse liquid motion

The design sloshing pressure due to transverse liquid motion, $\cancel{P_{shl-t}}$ $\underline{P_{slh-t}}$, as defined in **Ch 4, Sec 6, 6.4.3**, is to be applied to the following members as shown in **Fig. 2**.

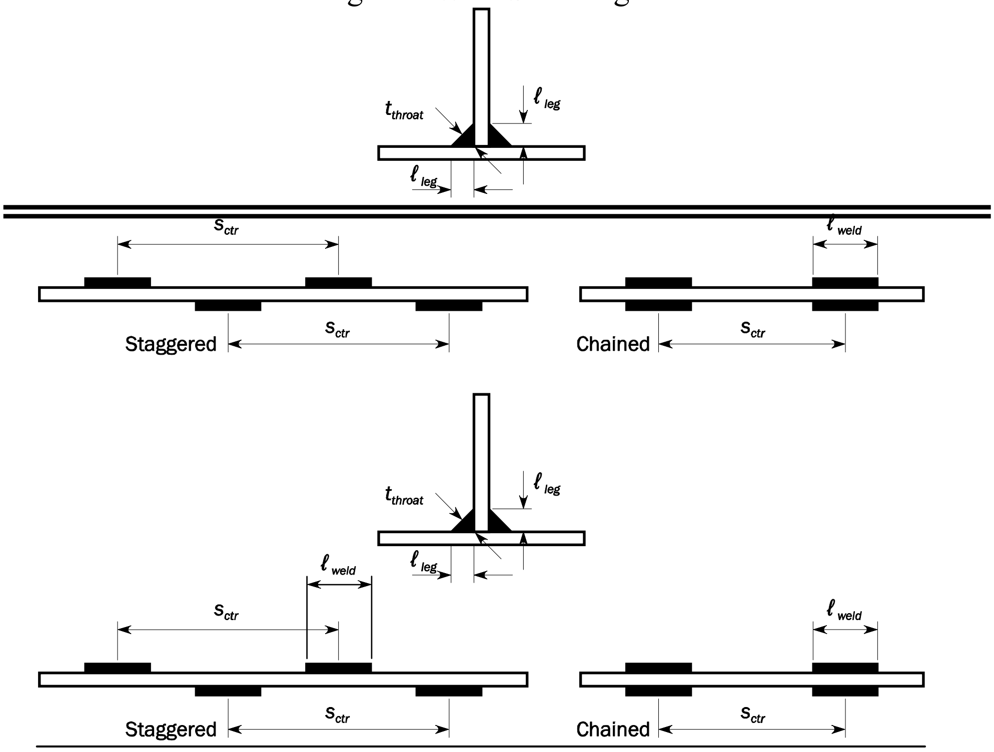
(Omitted)

Chapter 12 CONSTRUCTION

Section 3 DESIGN OF WELD JOINTS

Fig. 4 has been amended as follows.

Fig. 4 Weld Scantlings



4. Other Types of Joints

4.1 Lapped Joints

Paragraph 4.1.3 has been amended as follows.

4.1.3 Overlaps for lugs

The overlaps for lugs and collars in way of cut-outs for the passage of stiffeners through webs and bulkhead plating are not to be less than three times the thickness of the lug but need not be greater than 50 *mm*.

Chapter 13 SHIP IN OPERATION – RENEWAL CRITERIA

Section 1 PRINCIPLES AND SURVEY REQUIREMENTS

1. Principles

1.3 Requirements for Documentation

Paragraph 1.3.2 has been amended as follows.

1.3.2 Hull girder sectional properties

The Midship section plan to be supplied onboard the ship is to include the minimum required hull girder sectional properties, as defined in **Ch 5**, **Sec 1**, for the typical transverse sections of all cargo holds.

Part 2 SHIP TYPES

Chapter 1 BULK CARRIERS

Section 2 STRUCTURAL DESIGN PRINCIPLES

3. Structural Detail Principles

3.3 Deck Structures

Paragraph 3.3.4 has been amended as follows.

3.3.4 Openings in strength deck - Corner of hatchways

(a) Within the cargo hold region

For <u>cargo</u> hatchways located within the cargo hold region, insert plates, ~~whose~~ <u>the</u> thicknesses <u>of which</u> are to be determined according to the formula given after, are to be fitted in way of corners where the plating cut-out has a circular profile.

(Omitted)

Section 3 HULL LOCAL SCANTLING

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

3.3 Net Section Modulus at the Lower End of the Corrugations

Paragraphs 3.3.3 and 3.3.4 have 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 ~~the factor~~ I_{SH} to be taken as:

(Omitted)

3.3.4 Effective gusset plates

Provided that effective gusset plates are fitted, when calculating the section modulus at the lower end of the corrugations (Sections '1' in **Fig. 5** and **Fig. 6**), the net area, in cm^2, of flange plates may be increased by ~~the factor~~ I_G to be taken as:

(Omitted)

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

4. Primary Supporting Members

4.2 Design Load Sets

Paragraph 4.2.2 has been amended as follows.

4.2.2 Loading conditions

The severest loading conditions from the loading manual or otherwise specified by the designer are to be considered for the calculation of P_{in} in design load sets BC-~~9~~ 11 to BC-~~10~~ 12.

If primary supporting members support deck structure or tank/watertight boundaries, applicable design load sets in **Pt 1, Ch 6, Sec 2, Table 1** are also to be considered.

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)	$T_{BAL\text{-}H}$ (3)	$S+D$	Heavy ballast condition
	WB-6	P_{in}	-	S	Harbour/test condition
Bulk cargo hold	BC-~~9~~ 11	$P_{in} - P_{ex}$ (1)	T_{SC}	$S+D$	Cargo loading condition
	BC-~~10~~ 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.

4.7 Primary Supporting Member in Bilge Hopper Tanks and Topside Tanks

Paragraph 4.7.2 has been amended as follows.

4.7.2 Net section modulus, net shear sectional area and web thickness

The net section modulus Z, in cm^3, the net shear sectional area A_{shr}, in cm^2, and the net web thickness t_w, in mm, subjected to lateral pressure are not to be less than the values obtained from the following formulae:

$$Z = \frac{|P|\, S\, \ell_{bdg}^{\;2}}{f_{bdg}\, C_{s-pr}\, R_{eH}} 10^3$$

$$A_{shr} = \frac{5|P|S\ell_{shr}}{C_{t-pr}\tau_{eH}}$$

$$t_w = 1.75 \sqrt[3]{\frac{h_w C_{t-pr} \tau_{eH}}{10^4 C_5} A_{shr}}$$

where:

P : Design pressure in *kN/m*^{2}, for the design load set being considered according to **Pt 1, Ch 6, Sec 2, 2.1.3**, calculated at the mid-point of span ℓ of a web frame located midway between transverse bulkheads of holds.

S : Spacing of primary supporting members, in *m*.

ℓ_{bdg} : Effective bending span, in m, of primary supporting members, measured between the supporting members as defined in **Pt 1, Ch 3, Sec 7, 1.1.6**.

ℓ_{shr} : Effective shear span, in *m*, of primary supporting members, measured between the supporting members as defined in **Pt 1, Ch 3, Sec 7, 1.1.7**.

f_{bdg} : Bending moment factor:

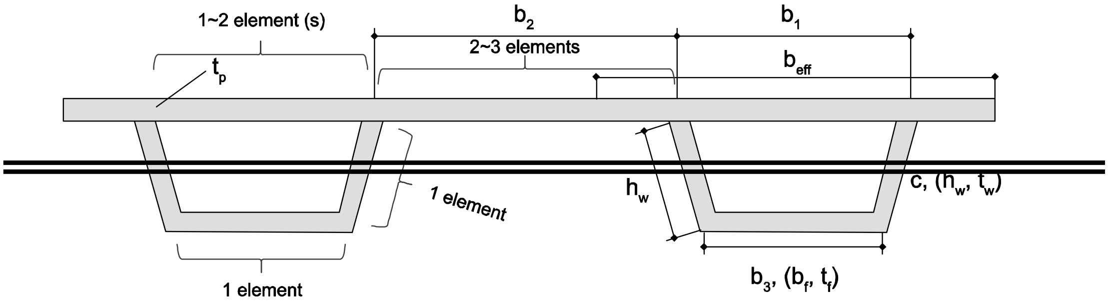
- For continuous ~~stiffeners~~ primary supporting members and where end connections are fitted consistent with idealisation of the ~~stiffener~~ primary supporting members as having ~~as~~ fixed ends and is not to be taken higher than:
  $f_{bdg} = 10$
- For ~~stiffeners~~ primary supporting members with reduced end fixity, the yield check is to be considered on a case-by-case basis.

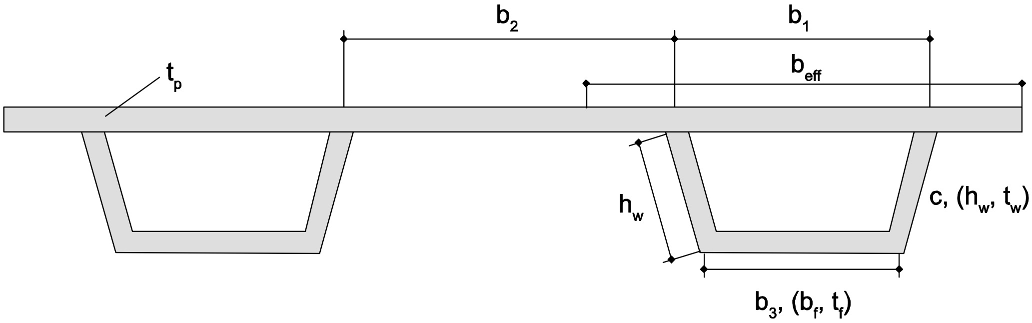
(Omitted)

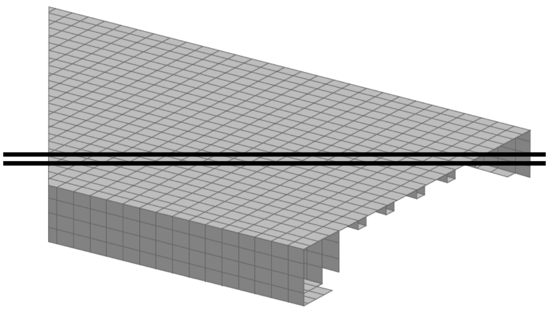
Section 5 CARGO HATCH COVERS

Fig. 1 has been amended as follows.

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







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, $A_{shr\text{-}n50}$ 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:

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

ℓ_{shr}: Effective shear span as defined in **1.3.2**.

P: Design pressure, in kN/m^2, as defined in **1.3.2**.

n_1: Coefficient taken as:

$$n_1 = 0.00935\left(\frac{\ell_{shr}}{S}\right)^2 - 0.163\left(\frac{\ell_{shr}}{S}\right) + 1.289$$

n_2: Coefficient taken as:

$$n_2 = 1.3 - \left(\frac{S}{12}\right)$$

<u>S: Double bottom floor spacing, in m, as defined in **Pt 1, Ch 3, Sec 7, 1.2.2**.</u>

Paragraph 1.4.3 has been amended as follows.

1.4.3 Net shear area of side girders

For double bottom side girders where no longitudinal bulkhead is fitted above, the net shear area, $A_{shr\text{-}n50}$ in cm^2, of the double bottom side 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.

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

n_3: Coefficient taken as:

$$n_3 = 1.072 - 0.0357\left(\frac{\ell_{shr}}{S}\right)$$

n_4: Coefficient taken as:

$$n_4 = 1.2 - \left(\frac{S}{18}\right)$$

S: Double bottom floor spacing, in m, as defined in **Pt 1, Ch 3, Sec 7, 1.2.2**.

ℓ_{shr}: Effective shear span as defined in **1.3.2**.

P: Design pressure, in kN/m^2, as defined in **1.3.2**.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 July 2017.

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.