12-391

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part CSR-B Common Structural Rules for Bulk Carriers

Rules for the Survey and Construction of Steel Ships
Part CSR-B 2012 AMENDMENT NO.1

Rule No.29 15th June 2012
Resolved by Technical Committee on 10th February 2012
Approved by Board of Directors on 6th March 2012

ClassNK
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Rule No.29 15th June 2012
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 COMMON STRUCTURAL RULES FOR BULK CARRIERS

Chapter 1 GENERAL PRINCIPLES

Section 4 SYMBOLS AND DEFINITIONS

3. Definitions

Section 3.21 has been added as follows.

3.21 Single Side Skin and Double Side Skin construction

3.21.1 Single side skin construction

A hold of single side skin construction is bounded by the side shell between the inner bottom plating or the hopper tank plating when fitted, and the deck plating or the topside tank plating when fitted.

3.21.2 Double side skin construction

A hold of double side skin construction is bounded by a double side skin, including hopper tank and topside tank when fitted.

Section 3.22 has been added as follows.

3.22 Bilge

3.22.1 Bilge plating

The bilge plating is the curved plating between the bottom shell and side shell. It is to be taken as follows:

- within the cylindrical part of the ship (see **Fig.4**):
  from the start of the curvature at the lower turn of bilge on the bottom to the end of the curvature at the upper turn of the bilge,
- outside the cylindrical part of the ship (see **Fig.5**):
  From the start of the curvature at the lower turn of the bilge on the bottom to the lesser of:
  - a point on the side shell located 0.2*D* above the baseline/local centreline elevation.
  - the end of the curvature at the upper turn of the bilge.

Fig. 4 and Fig.5 have been added as follows.

Fig. 4 Vertical extent of bilge plating within the cylindrical part of the hull

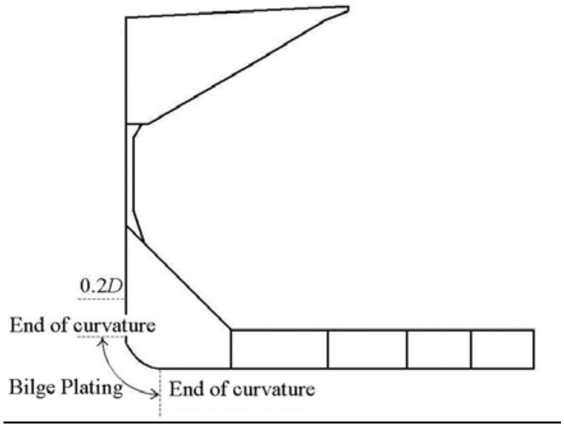
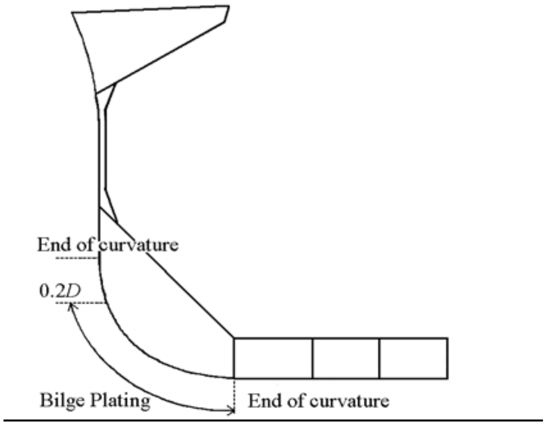


Fig. 5 Vertical extent of bilge plating outside the cylindrical part of the hull



Word ‘Fig.4’ in paragraph 4.1.1 has been amended as ‘Fig.6’.

Chapter 2 GENERAL ARRANGEMENT DESIGN

Section 1 SUBDIVISION ARRANGEMENT

2. Collision bulkhead

2.1 Arrangement of collision bulkhead

Paragraph 2.1.1 has been amended as follows.

2.1.1

Ref. SOLAS Ch. II-1, Part B, Reg. 11

A collision bulkhead is to be fitted which is to be watertight up to the freeboard deck. This bulkhead is to be located at a distance from the forward perpendicular FP_{LL} of not less than ~~5% of the length~~ 0.05L_{LL} ~~of the ship~~ or 10 *m*, whichever is the less, and, except as may be permitted by the Society, not more than ~~8% of~~ 0.08L_{LL} or 0.05 L_{LL} +3 *m*, whichever is the greater.

3. After peak, machinery space bulkheads and stern tubes

Title of 3.1 has been amended as follows.

3.1 General

Paragraph 3.1.1 has been amended as follows.

3.1.1 ~~General~~

Ref. SOLAS Ch. II-1, Part B, Reg. 11

~~An after peak bulkhead, and bulkheads dividing the machinery space from the cargo spaces forward and aft, are also to be fitted and made watertight up to the freeboard deck. The after peak bulkhead may, however, be stepped below the bulkhead deck, provided the degree of safety of the ship as regards subdivision is not thereby diminished.~~

An aft peak bulkhead, enclosing the stern tube and rudder trunk in a watertight compartment, is to be provided. Where the shafting arrangements make enclosure of the stern tube in a watertight compartment impractical alternative arrangements will be specially considered.

Paragraph 3.1.2 has been renumbered to 3.1.5.

Paragraphs 3.1.2, 3.1.3 and 3.1.4 have been added as follows.

3.1.2

The aft peak bulkhead may be stepped below the bulkhead deck, provided that the degree of safety of the ship as regards subdivision is not thereby diminished.

3.1.3

The aft peak bulkhead location on ships powered and/or controlled by equipment that does not require the fitting of a stern tube and/or rudder trunk will also be subject to special consideration.

3.1.4

The aft peak bulkhead may terminate at the first deck above the summer load waterline, provided that this deck is made watertight to the stern or to a watertight transom floor.

Section 2 COMPARTMENT ARRANGEMENT

2. Cofferdams

2.1 Cofferdam arrangement

Paragraph 2.1.3 has been amended as follows.

2.1.3

~~Spaces intended for the carriage of flammable liquids are to be separated from accommodation and service spaces by means of a cofferdam.~~ (Void)

5. Minimum bow height

5.1 General

Paragraph 5.1.1 has been amended as follows.

5.1.1

Ref. ILLC, as amended (Resolution MSC.~~143(77)~~ 223(82) Reg. 39(1))

The bow height F_b, defined as the vertical distance at the forward perpendicular between the waterline corresponding to the assigned summer freeboard and the designed trim and the top of the exposed deck at side, is to be not less than:

$$F_b = (6075(L_{LL}/100) - 1875(L_{LL}/100)^2 + 200(L_{LL}/100)^3)(2.08 + 0.609C_B - 1.603C_{wf} - 0.0129(L_{LL}/T_1))$$

where:

F_b: Calculated minimum bow height, in mm

T_1: Draught at 85% of the ~~depth for freeboard D_1~~ least moulded depth, in m

~~D_1 : Depth for freeboard, is the moulded depth amidship plus the freeboard deck thickness at side. The depth for freeboard in a ship having a rounded gunwale with a radius greater than 4% of the breadth (B) or having topsides of unusual form is the depth for freeboard of a ship having a midship section with vertical topsides and with the same round of beam and area of topside section equal to that provided by the actual midship section.~~

C_{wf} : Waterplane area coefficient forward of $L_{LL}/2$:

$$C_{wf} = \frac{A_{wf}}{\frac{L_{LL}}{2}B}$$

A_{wf} : Waterplane area forward of $L_{LL}/2$ at draught T_1, in m^2.

For ships to which timber freeboards are assigned, the summer freeboard (and not the timber summer freeboard) is to be assumed when applying the formula above.

Section 3 ACCESS ARRANGEMENT

2. Technical provisions for means of access

Title of 2.8 has been amended as follows.

2.8 Access to double side skin tanks ~~in double side bulk carriers~~ <u>of double side skin construction</u>

Title of 2.9 has been amended as follows.

2.9 Access to vertical structures of cargo holds ~~in single side bulk carriers~~ <u>of single side skin construction</u>

Title of 2.10 has been amended as follows.

2.10 Access to vertical structures of cargo holds ~~in double side bulk carriers~~ <u>of double side skin construction</u>

Title of 2.11 has been amended as follows.

2.11 Access to top side ballast tanks ~~in single side bulk carriers~~

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 3 CORROSION ADDITIONS

1. Corrosion additions

1.2 Corrosion addition determination

Paragraph 1.2.1 has been amended as follows.

1.2.1 Corrosion additions for steel

The corrosion addition for each of the two sides of a structural member, t_{C1} or t_{C2}, is specified in **Table 1**.

The total corrosion addition t_C, in *mm*, for both sides of the structural member is obtained by the following formula:

$$t_C = Roundup_{0.5}(t_{C1} + t_{C2}) + t_{reserve}$$

For an internal member within a given compartment, the total corrosion addition t_C is obtained from the following formula:

$$t_C = Roundup_{0.5}(2t_{C1}) + t_{reserve}$$

where t_{C1} is the value specified in **Table 1** for one side exposure to that compartment.

When a structural member is affected by more than one value of corrosion addition (e.g. a plate in a dry bulk cargo hold extending above the lower zone), the scantling criteria are generally to be applied considering the severest value of corrosion addition applicable to the member.

<u>The corrosion addition of a longitudinal stiffener is determined according to the coordinate of the connection of the stiffener to the attached plating.</u>

In addition, the total corrosion addition t_C is not to be taken less than 2 *mm*, except for web and face plate of ordinary stiffeners.

Section 5 CORROSION PROTECTION

1. General

1.2 Protection of seawater ballast tanks and void double side skin spaces

Paragraph 1.2.2 has been amended as follows.

1.2.2

For ships contracted for construction on or after 8 December 2006, the date of *IMO* adoption of the amended *SOLAS* regulation II-1/3-2, by which an *IMO* "Performance standard for protective coatings for ballast tanks and void spaces" will be made mandatory, the coatings of internal spaces subject to the amended *SOLAS* regulation are to satisfy the requirements of the *IMO* performance standard. For ships contracted for construction on or after 1 July 2012, the *IMO* performance standard is to be applied as interpreted by *IACS UI SC* 223 and *UI SC* 227. In applying *IACS UI SC* 223, "Administration" is to be read to be the "Classification Society".

Consistent with *IMO* Resolution *A*.798(19) and *IACS UI SC* 122, the selection of the coating system, including coating selection, specification, and inspection plan, are to be agreed between the shipbuilder, coating system supplier and the owner, in consultation with the Society, prior to commencement of construction. The specification for the coating system for these spaces is to be documented and this documentation is to be verified by the Society and is to be in full compliance with the coating performance standard.

The shipbuilder is to demonstrate that the selected coating system with associated surface preparation and application methods is compatible with the manufacturing processes and methods.

The shipbuilder is to demonstrate that the coating inspectors have proper qualification as required by the *IMO* standard.

The attending surveyor of the Society will not verify the application of the coatings but will review the reports of the coating inspectors to verify that the specified shipyard coating procedures have been followed.

1.3 Protection of cargo hold spaces

Paragraph 1.3.3 has been amended as follows.

1.3.3 Side areas to be coated

The areas to be coated are the internal surfaces of:

- the inner side plating
- the internal surfaces of the topside tank sloping plates
- the internal surfaces of the hopper tank sloping plates for a distance of 300 *mm* below the frame end bracket for ~~single side bulk carriers~~ holds of single side skin construction, or below the hopper tank upper end for ~~double side bulk carriers~~ holds of double side skin construction.

These areas are shown in **Fig. 1**.

Paragraph 1.3.4 has been amended as follows.

1.3.4 Transverse bulkhead areas to be coated

The areas of transverse bulkheads to be coated are all the areas located above a horizontal level located at a distance of 300 *mm* below the frame end bracket for ~~single side bulk carriers~~ holds of single side skin construction, or below the hopper tank upper end for ~~double side bulk carriers~~ holds of double side skin construction.

Section 6 STRUCTURAL ARRANGEMENT PRINCIPLES

1. Application

Paragraph has been amended as follows.

If not specified otherwise, ~~T~~the requirements of this section apply to ~~the cargo hold area~~ the hull structure except superstructures and deckhouses. For ~~other~~ areas outside the cargo holds area, ~~the requirements of **Ch 9**, **Sec 1** to **Ch 9**, **Sec 4** are to be applied~~ supplementary requirements are to be found in **Ch 9, Sec 1** to **Ch 9, Sec 3**.

2. General principles

2.3 Connections with higher tensile steel

Paragraph 2.3.1 has been amended as follows.

2.3.1 Connections with higher tensile steel

Where steels of different strengths are mixed in a hull structure, due consideration is to be given to the stress in the lower tensile steel adjacent to higher tensile steel.

Where stiffeners of lower tensile steel are supported by primary supporting members of higher tensile steel, due consideration is to be given to the stiffness of primary supporting members and scantlings to avoid excessive stress in the stiffeners due to the deformation of primary supporting members.

Where higher tensile steel is used at deck structures and bottom structure, longitudinal members not contributing to the hull girder longitudinal strength and welded to the strength deck or bottom plating and bilge strake, such as longitudinal hatch coamings, gutter bars, strengthening of deck openings, bilge keel, etc., are to be made of the same higher tensile steel. The same requirement is generally applicable for non continuous longitudinal stiffeners welded on the web of a primary member contributing to the hull girder longitudinal strength as hatch coamings, stringers and girders.

4. Ordinary stiffener

4.1 Profile of stiffeners

Paragraph 4.1.1 has been amended as follows.

4.1.1 Stiffener profile with a bulb section

The properties of bulb profile sections are to be determined by exact calculations. If it is not possible, ~~A~~a bulb section may be taken as equivalent to a built-up section. The dimensions of the equivalent angle section are to be obtained, in *mm*, from the following formulae.

5. Primary supporting members

5.2 Stiffening arrangement

Paragraph 5.2.1 has been amended as follows.

5.2.1

Webs of primary supporting members are to be stiffened where the height, in mm, is greater than 100*t*, where *t* is the net web thickness, in *mm*, of the primary supporting member.

In general, the web stiffeners of primary supporting members are to be spaced not more than 110*t*.

The net thickness of web stiffeners and brackets, in *mm*, are not to be less than ~~the minimum net thickness of the primary members on which they are fitted~~ the value obtained from the following formula:~~.~~

$t = 3 + 0.015 L_2$

where:

L_2 : Rule length $L_{CSR\text{-}B}$, but to be taken not greater than 300 *m*

Additional stiffeners are to be fitted in way of end brackets, at the connection with cross ties, etc. of transverse primary supporting members where shearing stress and/or compressive stress is expected to be high. These parts are not to have holes. Cut outs for penetration of ordinary stiffeners in these parts are to be reinforced with collar plates.

Depth of stiffener of flat bar type is in general to be more than 1/12 of stiffener length. A smaller depth of stiffener may be accepted based on calculations showing compliance with **Ch 6, Sec 2, 2.3.1**, **Ch 6, Sec 2, 4** and **Ch 6, Sec 3, 4**.

5.4 Effective breadth of primary supporting member

Paragraph 5.4.1 has been amended as follows.

5.4.1 General

The effective breadth b_p of the attached plating of a primary supporting member to be considered in the actual net section modulus for the yielding check ~~is to be taken as the mean spacing between adjacent primary supporting members~~ is to be determined according to **4.3.1**.

6. Double bottom

6.1 General

Paragraph 6.1.3 has been amended as follows.

6.1.3 Height of double bottom

~~Unless otherwise specified, the height of double bottom is not to be less than *B*/20 or 2 *m* whichever is the lesser.~~ Where a double bottom is required to be fitted the inner bottom shall be continued transversely in such a manner as to protect the bottom to the turn of the bilge.

Such protection will be deemed satisfactory if the inner bottom is not lower at any part than a plane parallel with the keel line and which is located not less than a vertical distance h measured from the keel line, as calculated by the formula:

$h = B/20$

However, in no case is the value of h to be less than 760 *mm*, and need not be taken as more than 2,000 *mm*.

Where the height of the double bottom varies, the variation is generally to be made gradually and over an adequate length; the knuckles of inner bottom plating are to be located in way of plate floors.

Where this is impossible, suitable longitudinal structures such as partial girders, longitudinal brackets etc., fitted across the knuckle are to be arranged.

Title of 7. has been amended as follows.

7. Double Side structure in cargo hold area

Title of 8. has been amended as follows.

8. Single side structure in cargo hold area

9. Deck structure

9.2 General arrangement

Paragraph 9.2.3 has been amended as follows.

9.2.3 Deck between hatches

Inside the line of openings, a transversely framed structure is to be generally adopted for the cross deck structures~~,~~. Hatch end beams and cross deck beams are to be adequately supported by girders and extended ~~up~~ outward to the second longitudinal from the hatch side girders towards ~~the bulwark~~ the deck side. Where this is impracticable, intercostal stiffeners are to be fitted between the hatch side girder and the second longitudinal. If the extension of beams outward to the second longitudinal is not achievable, structural checks of the structure are to be performed in compliance with the requirements in **Ch 7** or by means deemed appropriate by the Society.

Smooth connection of the strength deck at side with the deck between hatches is to be ensured by a plate of intermediate thickness.

10. Bulkhead structure

10.5 Non-tight bulkheads

Paragraph 10.5.1 has been amended as follows.

10.5.1 Non-tight bulkheads not acting as pillars

Non-tight bulkheads not acting as pillars are to be provided with bulkhead stiffeners with a maximum spacing equal to:

- 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 the value obtained from the following formula:

$t = 3 + 0.015L_2$

where:

L_2 : Rule length L_{CSR-B}, but to be taken not greater than 300 *m*

The depth of bulkhead stiffener of flat bar type is in general not to be less than 1/12 of stiffener length. ~~The net thickness of bulkhead stiffener is not to be less than the minimum thickness required for the considered bulkhead plate.~~ A smaller depth of stiffener may be accepted based on calculations showing compliance with **Ch 6, Sec 2, 2.3.1**, **Ch 6, Sec 2, 4** and **Ch 6, Sec 3, 4**.

Chapter 4 DESIGN LOADS

Section 5 EXTERNAL PRESSURES

4. Pressure in bow area

4.1 Bow flare area pressure

Paragraph 4.1.1 has been amended as follows.

4.1.1

The bow pressure, in kN/m^2, to be considered for the reinforcement of the bow flare area is to be obtained from the following formula:

$$p_{FB} = K\left(p_S + p_W\right)$$

where:

p_S, p_W : Hydrostatic pressure and maximum hydrodynamic pressures among load cases H, F, R and P~~, calculated in normal ballast condition at~~ $\cancel{T_B}$ at considered point of the hull in normal ballast condition. Minimum ballast draught in ballast condition T_B defined in **Ch 1, Sec 4, 2.1.1** is to be considered as T_{LCi} for the calculation of hydrostatic pressure and hydrodynamic pressures.

K : Coefficient taken equal to:

$$K = \frac{c_{FL}\left(0.2V + 0.6\sqrt{L_{CSR-B}}\right)^2}{42C(C_B + 0.7)\left(1 + \frac{20}{C_B}\left(\frac{x}{L_{CSR-B}} - 0.7\right)^2\right)}(10 + z - T_B) \quad \text{to be taken not less than 1.0}$$

c_{FL} : Coefficient taken equal to:

$c_{FL} = 0.8$ in general

$$c_{FL} = \frac{0.4}{1.2 - 1.09\sin\alpha}$$ where the flare angle α is greater than 40°

Where, the flare angle α at the load calculation point is to be measured in plane of the frame between a vertical line and the tangent to the side shell plating. (see **Fig. 7**)

4. Testing lateral pressure

4.1 Still water pressures

4.1.1

Table 2 has been amended as follows.

Table 2 Testing load height

Compartment or structure to be tested	Testing load height, in *m*
Double bottom tanks	The greater of the following: $z_{ST} = z_{TOP} + d_{AP}$ $z_{ST} = z_{ml}$
Hopper side tanks, topside tanks, double side tanks, fore and after peaks used as tank, cofferdams	The greater of the following: $z_{ST} = z_{TOP} + d_{AP}$ $z_{ST} = z_{TOP} + 2.4$
Tank bulkheads, deep tanks, fuel oil bunkers	The greater of the following: $z_{ST} = z_{TOP} + d_{AP}$ $z_{ST} = z_{TOP} + 2.4$ $z_{ST} = z_{TOP} + 10p_{PV}$
Ballast hold	The greater of the following: $z_{ST} = z_{TOP} + d_{AP}$ $z_{ST} = z_h + 0.9$
Fore and aft peak not used as tank	The greater of the following: $z_{ST} = z_F$ $z_{ST} = z_{ml}$
Watertight doors below freeboard deck	$z_{ST} = z_{fd}$
Chain locker (if aft of collision bulkhead)	$z_{ST} = z_{TOP}$
Independent tanks	The greater of the following: $z_{ST} = z_{TOP} + d_{AP}$ $z_{ST} = z_{TOP} + 0.9$
Ballast ducts	Testing load height corresponding to ballast pump maximum pressure
where: z_{ml} : *Z* co-ordinate, in *m*, of the bulkhead deck at side. z_h : *Z* co-ordinate, in *m*, of the top of hatch coaming. z_F : As defined in **3.2.1**. z_{fd} : *Z* co-ordinate, in *m*, of the freeboard deck. p_{PV} : Setting pressure, in *bar*, of safety valves.	

Chapter 5 HULL GIRDER STRENGTH

Section 1 YIELDING CHECK

2. Hull girder stresses

2.2 Shear stresses

Table 1 has been amended as follows.

Table 1 Shear stresses induced by vertical shear forces

Ship typology	Location	t, in *mm*	δ
Single side ~~ship~~ skin construction	Sides	t_S	0.5
Double side ~~ship~~ skin construction	Sides	t_S	$0.5(1-\phi)$
	Inner sides	t_{IS}	0.5ϕ

where:

t_S, t_{IS} : Minimum net thicknesses, in *mm*, of side and inner side, respectively

t_{SM}, t_{ISM} : Mean net thicknesses, in *mm*, over all the strakes of side and inner side , respectively. They are calculated as $\Sigma(\ell_i\, t_i)$ / $\Sigma\ell_i$, where ℓ_i and t_i are the length, in *m*, and the net thickness, in *mm*, of the *i* th strake of side and inner side.

ϕ : Coefficient taken equal to: $\phi = 0.275 + 0.25\dfrac{t_{ISM}}{t_{SM}}$

Chapter 6 HULL SCANTLINGS

Section 1 PLATING

3. Strength check of plating subjected to lateral pressure

3.2 Plating thickness

Paragraph 3.2.3 has been amended as follows.

3.2.3 Net thickness of the corrugations of transverse vertically corrugated watertight bulkheads separating cargo holds for flooded conditions

The net plate thickness *t*, in *mm*, of transverse vertically corrugated watertight bulkheads separating cargo holds is to be not less than that obtained from the following formula:

$$t = 14.9s\sqrt{\frac{1.05p}{R_{eH}}}$$

p : Pressure p_F or ~~R~~resultant pressure p, in kN/m^2, as defined in **Ch 4, Sec 6, 3.3.6** and **3.3.7**, respectively

s : Plate width, in *m*, to be taken equal to the width of the corrugation flange or web, whichever is greater.

(The rest is omitted.)

Section 2 ORDINARY STIFFENERS

3. Yielding check

3.6 Scantlings of transverse vertically corrugated watertight bulkheads separating cargo holds for flooded conditions

Paragraph 3.6.1 has been amended as follows.

3.6.1 Bending capacity and shear capacity of the corrugations of transverse vertically corrugated watertight bulkheads separating cargo holds

The bending capacity and the shear capacity of the corrugations of watertight bulkheads between 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, to be obtained, in *kN.m*, from the following formula:

$$M = F\ell_C / 8$$

F : Force F_F or ~~R~~resultant force, in *kN*, to be calculated according to **Ch 4**, **Sec 6**, **3.3.6** and **3.3.7**, respectively

ℓ_C: Span of the corrugations, in *m*, to be obtained according to **3.6.2**

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 **3.6.2**, without being taken greater than the value obtained from the following formula:

$$W_{LE,M} = W_G + \left(\frac{Q\,h_G - 0.5h_G^2\,s_C\,p_G}{R_{eH}}\right)10^3$$

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 **3.6.2**

Q : Shear force at the lower end of a corrugation, to be obtained, in *kN*, from the following formula:

$$Q = 0.8F$$

h_G : Height, in *m*, of shedders or gusset plates, as applicable (see **Fig. 11** to **Fig. 15**)

p_G : Pressure p_F or ~~R~~resultant pressure p, in kN/m^2, to be calculated in way of the middle of the shedders or gusset plates, as applicable, according to **Ch 4**, **Sec 6**, **3.3.6 and 3.3.7**, respectively

(The rest is omitted.)

4. Web stiffeners of primary supporting members

4.1 Net scantlings

Paragraph 4.1.3 has been amended as follows.

4.1.3 Connection ends of web stiffeners

Where the web stiffeners of primary supporting members are welded to ordinary stiffener face plates, the stress at ends of web stiffeners of primary supporting members in water ballast tanks, in N/mm^2, is to comply with the following formula when no bracket is fitted:

$$\sigma \leq 175$$

where:

$$\cancel{\sigma = 1.1 K_{con} K_{longi} K_{stiff} \frac{\Delta\sigma}{\cos\theta}} \qquad \underline{\sigma = K_{con} K_{longi} K_{stiff} \frac{\Delta\sigma}{\cos\theta}}$$

(The rest is omitted.)

Section 3 BUCKLING & ULTIMATE STRENGTH OF ORDINARY STIFFENERS AND STIFFENED PANELS

4. Buckling criteria of partial and total panels

4.2 Ultimate strength in lateral buckling mode

Paragraph 4.2.2 has been amended as follows.

4.2.2 Evaluation of the bending stress σ_b

The bending stress σ_b, in N/mm^2, in the stiffeners is equal to:

$$\sigma_b = \frac{M_0 + M_1}{W_{st}\, 10^3}$$

with:

M_0 : Bending moment, in *N-mm*, due to the deformation *w* of stiffener, taken equal to:

$$M_0 = F_{Ki} \frac{p_z w}{c_f - p_z}$$

with $(c_f - p_z) > 0$

M_1 : Bending moment, in *N-mm*, due to the lateral load *p*, taken equal to:

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

$$M_1 = \frac{pa(n \cdot b)^2}{8c_S\, 10^3}$$ for transverse stiffeners, with *n* equal to 1 for ordinary transverse stiffeners.

W_{st} : Net section modulus of stiffener (longitudinal or transverse), in cm^3, including effective width of plating according to **5**, taken equal to:

- if a lateral pressure is applied on the stiffener:
  W_{st} is the net section modulus calculated at flange if the lateral pressure is applied on the same side as the stiffener.
  W_{st} is the net section modulus calculated at attached plate if the lateral pressure is applied on the side opposite to the stiffener.
  <u>Note: For stiffeners sniped at both ends, W_{st} is the net section modulus calculated at attached plate. However, if M_1 is larger than M_0 and the lateral pressure is applied on the same side as the stiffener, W_{st} is the net section modulus calculated at flange.</u>
- if no lateral pressure is applied on the stiffener:
  W_{st} is the minimum net section modulus among those calculated at flange and attached plate
  <u>Note: For stiffeners sniped at both ends, W_{st} is the net section modulus calculated at attached plate.</u>

c_S : Factor accounting for the boundary conditions of the transverse stiffener

$c_S = 1.0$ for simply supported stiffeners

$c_S = 2.0$ for partially constraint stiffeners

p : Lateral load in kN/m^2, as defined in **Ch 4**, **Sec5** and **Ch 4**, **Sec 6** calculated at the load point as defined in **Ch 6**, **Sec 2**, **1.4**

F_{Ki} : Ideal buckling force, in N, of the stiffener, taken equal to:

$$F_{Kix} = \frac{\pi^2}{a^2} E I_x 10^4 \qquad \text{for longitudinal stiffeners}$$

$$F_{Kiy} = \frac{\pi^2}{(nb)^2} E I_y 10^4 \qquad \text{for transverse stiffeners}$$

I_x, I_y : Net moments of inertia, in cm^4, of the longitudinal or transverse stiffener including effective width of attached plating according to **5**. I_x and I_y are to comply with the following criteria:

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

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

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

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

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

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

t_a : Net thickness offered of attached plate, in mm

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

$$0.5(1+\psi) \qquad \text{for } 0 \leq \psi \leq 1$$

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

A_x, A_y : Net sectional area, in mm^2, of the longitudinal or transverse stiffener respectively without attached plating

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

m_1, m_2 : Coefficients taken equal to:

for longitudinal stiffeners:

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

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

for transverse stiffeners:

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

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

$w = w_0 + w_1$ <u>generally</u>

$w = |w_0 + w_1|$ for stiffeners sniped at both ends, on which the same side lateral pressure as the stiffener is applied.

w_0 : Assumed imperfection, in *mm*, taken equal to:

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

$$w_0 = \min(\frac{a}{250}, \frac{n \cdot b}{250}, 10) \text{ for transverse stiffeners}$$

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

w_1 : Deformation of stiffener, in *mm*, at midpoint of stiffener span due to lateral load *p*. In case of uniformly distributed load the following values for w_1 may be used:

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

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

c_f : Elastic support provided by the stiffener, in N/mm^2, taken equal to:

- for longitudinal stiffeners

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

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

c_{xa} : Coefficient taken equal to :

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

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

- for transverse. stiffeners :

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

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

c_{ya} : Coefficient taken equal to :

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

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

Paragraph 4.2.3 has been amended as follows.

4.2.3 Equivalent criteria for longitudinal and transverse ordinary stiffeners not subjected to lateral pressure

Longitudinal and transverse ordinary stiffeners not subjected to lateral pressure, except for sniped stiffeners, are considered as complying with the requirement of **4.2.1** if their net moments of inertia I_x and I_y, in cm^4, are not less than the value obtained by the following formula:

- For longitudinal stiffener : $$I_x = \frac{p_{zx} a^2}{\pi^2 10^4} \left(\frac{w_0 h_w}{\frac{R_{eH}}{S} - \sigma_x} + \frac{a^2}{\pi^2 E} \right)$$
- For transverse stiffener : $$I_y = \frac{p_{zy} (nb)^2}{\pi^2 10^4} \left(\frac{w_0 h_w}{\frac{R_{eH}}{S} - \sigma_y} + \frac{(nb)^2}{\pi^2 E} \right)$$

Section 4 PRIMARY SUPPORTING MEMBERS

1. General

Section 1.6 has been added as follows.

1.6 Flooding check of primary supporting members

1.6.1 General

Flooding check of primary supporting members is to be carried out according to the requirements in **5.**

5. has been added as follows.

5. Flooding check of primary supporting members

5.1 Net section modulus and net shear sectional area under flooded conditions

5.1.1

The net section modulus w, in cm^3, the net shear sectional area A_{sh}, in cm^2 subjected to flooding are to be not less than the values obtained from the following formulae:

$$w = \frac{p_F s \ell^2}{16 \alpha \lambda_S R_Y} 10^3$$

$$A_{sh} = \frac{5 p_F s \ell}{\alpha \tau_a \sin\phi}$$

Where :

α : Coefficient taken equal to:

$\alpha = 0.95$ for the primary supporting member of collision bulkhead,

$\alpha = 1.15$ for the primary supporting member of other watertight boundaries of compartments.

λ_S : Coefficient defined in **Ch 6, Sec 4 Table 11**, determined by considering σ_X in flooded condition.

p_F : Pressure, in kN/m^2, in flooded conditions, defined in **Ch 4, Sec 6, 3.2.1**.

Chapter 7 DIRECT STRENGTH ANALYSIS

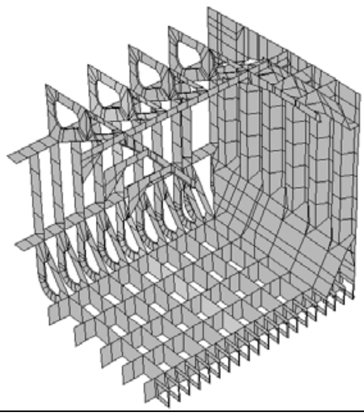
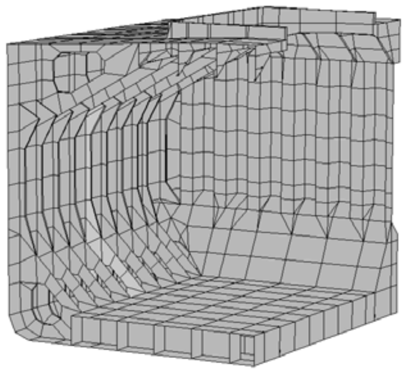
Section 3 DETAILED STRESS ASSESSMENT

2. Analysis model

2.1 Areas to be refined

Table 1 has been amended as follows.

Table 1 Typical details to be refined

Structural member	Area of interest	Additional specifications	Description
Primary supporting member	Most stressed transverse primary supporting member for double ~~skin~~ side ~~bulk carriers~~ skin construction	Refining of the most stressed transverse primary supporting members located in: double bottom hopper tank double skin side topside tank	
	Most stressed transverse primary supporting member for single ~~skin~~ side ~~bulk carriers~~ skin construction	Refining of the most stressed transverse primary supporting members located in: double bottom hopper tank topside tank side shell frame with end brackets and connections to hopper tank and topside tank	
(The rest is omitted.)			

Chapter 8 FATIGUE CHECK OF STRUCTURAL DETAILS

Section 1 GENERAL CONSIDERATION

1. General

1.3 Subject members

Paragraph 1.3.1 has been amended as follows.

1.3.1

Fatigue strength is to be assessed, in cargo hold area, ~~for members described in **Table 1**, at the considered locations~~ for all the connected members at the considered locations described in **Table 1**.

Section 4 STRESS ASSESSMENT OF STIFFENERS

2. Hot spot stress range

2.3 Stress range according to the simplified procedure

Paragraph 2.3.5 has been amended as follows.

2.3.5 Stress due to dry bulk cargo pressure

The hot spot stress, in N/mm^2, due to the dry bulk cargo pressure in load case "*i*1" and "*i*2" for loading condition "(*k*)" is to be obtained from the following formula:

$$\sigma_{LCW,\,i\,j(k)} = \frac{K_{gl} K_s p_{CW,\,i\,j(k)} s \ell^2 \left(1 - \frac{6x_f}{\ell} + \frac{6{x_f}^2}{\ell^2}\right)}{12w} 10^3 \qquad (j = 1,\,2)$$

where:

$p_{CW,\,i\,j(k)}$: Inertial pressure, in kN/m^2, due to dry bulk cargo specified in **Ch 4**, **Sec 6**, **1.3** <u>for a cargo density ρ_C specified in **Ch 4, Appendix 3**, and</u> with f_p = 0.5, in load case "*i*1" and "*i*2" for loading condition "(*k*)"

Appendix 1 CROSS SECTIONAL PROPERTIES FOR TORSION

2. Example calculation for a single side hull cross section

2.5 Notes

Paragraph 2.5.1 has been amended as follows.

2.5.1

For ~~single side bulk carrier~~ holds of single side skin construction, the hull cross section normally can be simplified in a section with four boxes (cell 1 cargo hold, cell 2 and 3 wing tanks and cell 4 hopper tanks and double bottom as shown in the calculation example) whereas the cross section of ~~a double side bulk carrier~~ holds of double side skin construction can be simplified to a cross section with two closed cells only (cell 1 cargo hold, cell 2 double hull). For the plate thickness of the line elements with variable thicknesses an equivalent plate thickness can be used calculated by the following formulae:

$$t_{eq} = \frac{t_1\ell_1 + t_2\ell_2 + \ldots + t_i\ell_i + \ldots + t_k\ell_k}{\sum_{i=1}^{k}\ell_i}$$

Due to the simplifications, the value of the sector co-ordinate ω can differ from 0 at the intersections between the cross section and centreline. The difference between the value of the sector co-ordinate ω and the value of the torsional moment of inertia I_T for the simplified cross section is in normal cases less than 3% compared to the values of the original cross section.

Chapter 9 OTHER STRUCTURES

Section 1 FORE PART

Symbols has been amended as follows.

Symbols

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

L_2 : Rule length L_{CSR-B}, but to be taken not greater than 300 *m*

T_B : Minimum ballast draught, in *m*, for normal ballast conditions

k : Material factor, defined in **Ch 3**, **Sec 1**, **2.2**

m : Coefficient taken equal to:

m = 10 for vertical stiffeners, vertical primary supporting members

m = 12 for other stiffeners, other primary supporting members

τ_α : Allowable shear stress, in N/mm^2, taken equal to:

$$\tau_a = \frac{R_Y}{\sqrt{3}}$$

s : Spacing, in *m*, of ordinary stiffeners or primary supporting members, measured at mid-span along the chord

ℓ : Span, in *m*, of ordinary stiffeners or primary supporting members, measured along the chord between the supporting members, see **Ch 3**, **Sec 6**, **4.2** or **5.3** respectively

c_a : Aspect ratio of the plate panel, equal to:

$$c_a = 1.21\sqrt{1 + 0.33\left(\frac{s}{\ell}\right)^2} - 0.69\frac{s}{\ell}$$, to be taken not greater than 1.0

c_r : Coefficient of curvature of the panel, equal to:

$$c_r = 1 - 0.5\frac{s}{r}$$, to be taken not less than 0.4

r : Radius of curvature, in *m*.

1. General

1.1 Application

Paragraph 1.1.2 has been added as follows.

1.1.2

Fore part structures which form the boundary of spaces not intended to carry liquids, and which do not belong to the outer shell, are to be subjected to lateral pressure in flooding conditions. Their scantlings are to be determined according to the relevant criteria in **Ch 6**.

2. Arrangement

2.3 Floors and bottom girders

Paragraph 2.3.2 has been amended as follows.

2.3.2 Solid floors

In case of transverse framing, solid floors are to be fitted at every frame.

In case of the longitudinal framing, the spacing of solid floors is not to be greater than 3.5 *m* or four transverse frame spaces, whichever is the smaller. Larger spacing of solid floors may be accepted, provided that the structure is verified by means of FEA deemed appropriate by the Society.

Paragraph 2.3.3 has been amended as follows.

2.3.3 Bottom girders

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*.

Larger spacing of solid floors may be accepted, provided that the structure is verified by means of FEA deemed appropriate by the Society.

4. Scantlings

4.2 Plating

4.2.1

Table 1 has been amended as follows.

Table 1 Net minimum thickness of plating

Minimum net thickness, in *mm*	
Bottom	$5.5 + 0.03L_{CSR-B}$
Side	$0.85L_{CSR-B}^{1/2}$
Inner bottom	$5.5 + 0.03L_{CSR-B}$
Strength deck	$4.5 + 0.02L_{CSR-B}$
Platform and wash bulkhead	6.5
Transverse and longitudinal watertight bulkheads	$0.6\ L_{CSR-B}^{1/2}$

4.4 Primary supporting members

Paragraph 4.4.4 has been amended as follows.

4.4.4 Deck primary supporting members

~~Scantlings of deck primary supporting members are to be in accordance with **Ch 6, Sec 4**, considering the loads in **3.2** and **3.3**.~~

The net scantlings of deck primary supporting members are to be not less than those obtained from the formulae in **Table 5**. The design pressures in the formulae are taken from intact conditions and testing conditions respectively as stated in **3.2**. For a complex deck structure, a calculation deemed appropriate by the Society may be carried out in lieu of the formulae.

Table 5 to Table 7 have been renumbered to Table 6 to Table 8, and Table 5 has been added as follows.

Table 5 Net scantlings of deck primary supporting members

Condition	Net section modulus w, in cm^3	Net sectional shear area A_{sh}, in cm^2
Primary supporting members subjected to lateral pressure in intact conditions	$w = \frac{(p_S + p_W)s\ell^2}{0.9mR_Y}10^3$	$A_{sh} = \frac{5(p_S + p_W)s\ell}{\tau_a \sin\phi}$
Primary supporting members subjected to lateral pressure in testing conditions	$w = \frac{p_T s\ell^2}{1.05mR_Y}10^3$	$A_{sh} = \frac{5p_T s\ell}{1.05\tau_a \sin\phi}$
where: ϕ : Angle, in deg, between the primary supporting member's web and the shell plate, measured at the middle of the primary supporting member's span; the correction is to be applied when ϕ is less than 75.		

Title of 5. has been amended as follows.

5. Strengthening of ~~flat~~ bottom forward area

5.1 Application

Paragraph 5.1.1 has been amended as follows.

5.1.1

The ~~flat~~ bottom forward area to be reinforced is the ~~flat~~ part of the ship's bottom extending forward of $0.2V\sqrt{L_{CSR-B}}$ from the fore perpendicular end, up to a height of $0.05T_B$ or 0.3 m above base line, whichever is the smaller.

5.2 Bottom plating

Paragraph 5.2.1 has been amended as follows.

5.2.1

The net thickness, in *mm*, of the ~~flat~~ bottom forward area, is not to be less than:

$$t = 15.8 C_a C_r s \sqrt{\frac{C_s p_{SL}}{R_{eH}}}$$

where:

C_s: Coefficient relating to load patch of impact pressure, taken equal to:

C_s = 1.0 where no intermediate longitudinals is provided between ordinary stiffeners

C_s = 1.3 where intermediate longitudinals are provided between ordinary stiffeners.

5.3 Ordinary stiffeners

Paragraph 5.3.1 has been amended as follows.

5.3.1

The net section modulus, in cm^3, of transverse or longitudinal ordinary stiffeners of the ~~flat~~ bottom forward area is not to be less than:

$$w = \frac{C_s p_{SL} s \ell^2}{16 R_{eH}} 10^3$$

where:

C_s: Coefficient defined in **5.2.1**.

Paragraph 5.3.2 has been amended as follows.

5.3.2

The net shear area, in cm^2, of transverse or longitudinal ordinary stiffeners of the ~~flat~~ bottom forward area is not to be less than:

$$A = \frac{5\sqrt{3} p_{SL} s (\ell - 0.5 s)}{R_{eH} \sin\phi}$$

The area of the welded connection has to be at least twice this value.

5.4 Primary supporting members

Paragraph 5.4.1 has been amended as follows.

5.4.1 Girders

The net thickness of girders in double bottom forward area, in *mm*, is not to be less than the greatest of either of the value t_1 to t_3 specified in the followings according to each location:

$$t_1 = \frac{c_A p_{SL} S \ell}{2(d_0 - d_1)\tau_a}$$

$$t_2 = 1.75 \sqrt[3]{\frac{H^2 a^2 \tau_a}{C_1'} t_1}$$

$$t_3 = \frac{C_1'' a}{\sqrt{k}}$$

where:

c_A : Coefficient taken equal to:

$c_A = 3/A$, with $0.3 \le c_A \le 1.0$

A : Loaded area, in m^2, between the supports of the structure considered, obtained from the following formula:

$A = S\ \ell$

p_{SL} : As defined in **3.4**

S : Spacing of centre or side girders under consideration, in *m*

ℓ : Span of centre or side girders between floors under consideration, in *m*

d_0 : Depth of the centre or side girder under consideration, in *m*

d_1 : Depth of the opening, if any, at the point under consideration, in *m*

H : Value obtained from the following formulae:

(a) Where the girder is provided with an unreinforced opening : $H = 1 + 0.5 \dfrac{\phi}{\alpha}$

(b) In other cases: $H = 1.0$

ϕ : Major diameter of the openings, in *m*

α : The greater of a or S_1, in *m*.

a : Depth of girders at the point under consideration, in *m*, Where, however, if horizontal stiffeners are fitted on the girder, a is the distance from the horizontal stiffener under consideration to the bottom shell plating or inner bottom plating, or the distance between the horizontal stiffeners under consideration

S_1 : Spacing, in *m*, of vertical ordinary stiffeners or floors

C_1' : Coefficient obtained from **Table ~~5~~6** depending on S_1/a. For intermediate values of S_1/a, C_1' is to be determined by linear interpolation.

C_1'' : Coefficient obtained from **Table ~~6~~7** depending on S_1/a. For intermediate values of S_1/a, C_1'' is to be obtained by linear interpolation.

Table ~~5~~6 Coefficient C_1'

$\frac{S_1}{a}$	0.3 and under	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4 and over
C_1'	64	38	25	19	15	12	10	9	8	7

Table ~~6~~7 Coefficient C_1''

$\frac{S_1}{a}$		0.3 and under	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6 and over
C_1''	Centre girder	4.4	5.4	6.3	7.1	7.7	8.2	8.6	8.9	9.3	9.6	9.7
	Side girder	3.6	4.4	5.1	5.8	6.3	6.7	7.0	7.3	7.6	7.9	8.0

Paragraph 5.4.2 has been amended as follows.

5.4.2 Floors

The net thickness of floors in double bottom forward area, in mm, is not to be less than the greatest of either of the value t_1 to t_3 specified in the followings according to each location:

$$t_1 = \frac{c_A p_{SL} S\ell}{2(d_0 - d_1)\tau_a}$$

$$t_2 = 1.75\sqrt[3]{\frac{H^2 a^2 \tau_a}{C_2'} t_1}$$

$$t_3 = \frac{8.5 S_2}{\sqrt{k}}$$

where :

c_A: Coefficient taken equal to:

$c_A = 3/A$, with $0.3 \le c_A \le 1.0$

A : Loaded area, in m^2, between the supports of the structure considered, obtained from the following formula:

$A = S\ \ell$

p_{SL} : As defined in **3.4**

S : Spacing of solid floors under consideration, in *m*

ℓ : Span of floors between centre girder and side girder or side girders under consideration, in *m*

d_0 : Depth of the solid floor at the point under consideration in *m*

d_1 : Depth of the opening, if any, at the point under consideration in *m*

H : Value obtained from the following formulae:

a) Where openings with reinforcement or no opening are provided on solid floors:

1) Where slots without reinforcement are provided:

$H = \sqrt{4.0\frac{d_2}{S_1} - 1.0}$, without being taken less than 1.0

2) Where slots with reinforcement are provided: $H = 1.0$

b) Where openings without reinforcement are provided on solid floors:

1) Where slots without reinforcement are provided:

$H = \left(1 + 0.5\frac{\phi}{d_0}\right)\sqrt{4.0\frac{d_2}{S_1} - 1.0}$, without being taken less than $1 + 0.5\frac{\phi}{d_0}$

2) Where slots with reinforcement are provided:

$H = 1 + 0.5\frac{\phi}{d_0}$

d_2 : Depth of slots without reinforcement provided at the upper and lower parts of solid floors, in *m*, whichever is greater

S_1 : Spacing, in *m*, of vertical ordinary stiffeners or girders

ϕ : Major diameter of the openings, in *m*.

a : Depth of the solid floor at the point under consideration, in *m*, Where, however, if horizontal stiffeners are fitted on the floor, a is the distance from the horizontal stiffener under consideration to the bottom shell plating or the inner bottom plating or the distance between the horizontal stiffeners under consideration

S_2 : The smaller of S_1 or a, in *m*

C_2' : Coefficient given in **Table ~~7~~8** depending on S_1/d_0. For intermediate values of S_1/d_0, C_2' is to be determined by linear interpolation.

Table ~~7~~8 Coefficient C_2'

S_1/d_0	0.3 and under	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4 and over
C_2'	64	38	25	19	15	12	10	9	8	7

Section 2 AFT PART

Symbols has been amended as follows.

Symbols

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

L_1 : Rule length $L_{CSR\text{-}B}$, but to be taken not greater than 200 *m*

L_2 : Rule length $L_{CSR\text{-}B}$, but to be taken not greater than 300 *m*

k : Material factor, defined in **Ch 3**, **Sec 1**, **2.2**

z_{TOP} : Z co-ordinate, in *m*, of the top of the tank

m : Coefficient taken equal to:

$m = 10$ for vertical stiffeners, vertical primary supporting members

$m = 12$ for other stiffeners, other primary supporting members

τ_α : Allowable shear stress, in N/mm^2, taken equal to:

$$\tau_a = \frac{R_Y}{\sqrt{3}}$$

s : Spacing, in *m*, of ordinary stiffeners or primary supporting members, measured at mid-span along the chord

ℓ : Span, in *m*, of ordinary stiffeners or primary supporting members, measured along the chord between the supporting members, see **Ch 3**, **Sec 6**, **4.2** or **5.3** respectively

c_a : Aspect ratio of the plate panel, equal to:

$$c_a = 1.21\sqrt{1 + 0.33\left(\frac{s}{\ell}\right)^2} - 0.69\frac{s}{\ell}$$, to be taken not greater than 1.0

c_r : Coefficient of curvature of the panel, equal to:

$$c_r = 1 - 0.5\frac{s}{r}$$, to be taken not less than 0.4

r : Radius of curvature, in *m*.

4. Scantlings

4.1 Plating

4.1.1

Table 1 has been amended as follows.

Table 1 Net minimum thickness of plating

Minimum net thickness, in *mm*	
Bottom	$5.5 + 0.03L_{CSR\text{-}B}$
Side and transom	$0.85L_{CSR\text{-}B}^{1/2}$
Inner bottom	$5.5 + 0.03L_{CSR\text{-}B}$
Strength deck	$4.5 + 0.02L_{CSR\text{-}B}$
Platform and wash bulkhead	6.5
Transverse and longitudinal watertight bulkheads	$0.6\ L_{CSR\text{-}B}^{1/2}$

4.3 Primary supporting members

Paragraph 4.3.4 has been amended as follows.

4.3.4 Deck primary supporting members

~~Scantlings of deck primary supporting members are to be in accordance with **Ch 6**, **Sec 4**, considering the loads in **2.2**.~~

The net scantlings of deck primary supporting members are to be not less than those obtained from the formulae in **Table 5**. The design pressures in the formulae are taken from intact conditions and testing conditions respectively as stated in **2.2**. For a complex deck structure, a direct strength calculation may be carried out in lieu of the formulae.

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

Table 5 Net scantlings of deck primary supporting members

Condition	Net section modulus w, in cm^3	Net sectional shear area A_{sh}, in cm^2
Primary supporting members subjected to lateral pressure in intact conditions	$w = \dfrac{(p_S + p_W)s\ell^2}{0.9mR_Y}10^3$	$A_{sh} = \dfrac{5(p_S + p_W)s\ell}{\tau_a \sin\phi}$
Primary supporting members subjected to lateral pressure in testing conditions	$w = \dfrac{p_T s\ell^2}{1.05mR_Y}10^3$	$A_{sh} = \dfrac{5p_T s\ell}{1.05\tau_a \sin\phi}$
where: ϕ : Angle, in deg, between the primary supporting member's web and the shell plate, measured at the middle of the primary supporting member's span; the correction is to be applied when ϕ is less than 75.		

6. Sternframes

6.3 Propeller posts

Paragraph 6.3.2 has been amended as follows.

6.3.2 Gross scantlings of propeller posts

The gross scantlings of propeller posts are to be not less than those obtained from the formulae in **Table ~~5~~6** for single screw ships and **Table ~~6~~7** for twin screw ships.

Scantlings and proportions of the propeller post which differ from those above may be considered acceptable provided that the section modulus of the propeller post section about its longitudinal axis is not less than that calculated with the propeller post scantlings in **Table ~~5~~6** or **Table ~~6~~7**, as applicable.

Paragraph 6.3.3 has been amended as follows.

6.3.3 Section modulus below the propeller shaft bossing

In the case of a propeller post without a sole piece, the section modulus of the propeller post may be gradually reduced below the propeller shaft bossing down to 85% of the value calculated with the scantlings in **Table ~~5~~6** or **Table ~~6~~7**, as applicable.

In any case, the thicknesses of the propeller posts are to be not less than those obtained from the formulae in the tables.

Table ~~5~~6 Single screw ships - Gross scantlings of propeller posts

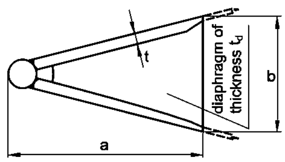
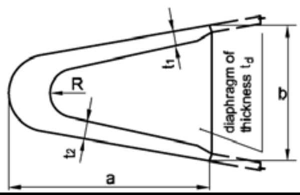
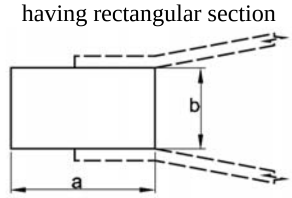
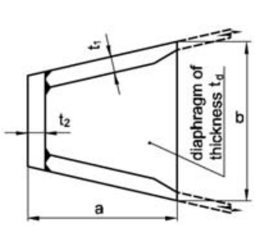
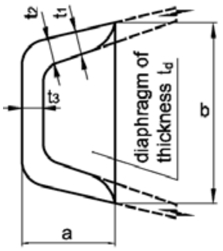
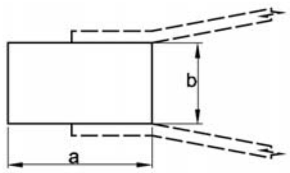
Gross scantlings of propeller posts, in *mm*	Fabricated propeller post 	Cast propeller post 	Bar propeller post, cast or forged, having rectangular section 
a	$50\ L_{CSR-B}^{1/2}$	$33\ L_{CSR-B}^{1/2}$	$10\sqrt{7.2L_{CSR-B}-256}$
b	$35\ L_{CSR-B}^{1/2}$	$23\ L_{CSR-B}^{1/2}$	$10\sqrt{4.6L_{CSR-B}-164}$
t_1 (1)	$2.5\ L_{CSR-B}^{1/2}$	$3.2\ L_{CSR-B}^{1/2}$ to be taken not less than 19 *mm*	-
t_2 (1)	-	$4.4\ L_{CSR-B}^{1/2}$ to be taken not less than 19 *mm*	-
t_D	$1.3\ L_{CSR-B}^{1/2}$	$2.0\ L_{CSR-B}^{1/2}$	-
R	-	$50\ L_{CSR-B}^{1/2}$	-
(1) Propeller post thicknesses t_1, and t_2 are, in any case, to be not less than $(0.05L_{CSR-B} + 9.5)$ *mm*.			

Table ~~6~~7   Twin 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	$25\ L_{CSR\text{-}B}{}^{1/2}$	$12.5\ L_{CSR\text{-}B}{}^{1/2}$	$2.4L_{CSR\text{-}B}+6$
b	$25\ L_{CSR\text{-}B}{}^{1/2}$	$25\ L_{CSR\text{-}B}{}^{1/2}$	$0.8L_{CSR\text{-}B}+2$
t_1 (1)	$2.5\ L_{CSR\text{-}B}{}^{1/2}$	$2.5\ L_{CSR\text{-}B}{}^{1/2}$	-
t_2 (1)	$3.2\ L_{CSR\text{-}B}{}^{1/2}$	$3.2\ L_{CSR\text{-}B}{}^{1/2}$	-
t_3	-	$4.4\ L_{CSR\text{-}B}{}^{1/2}$	-
t_D	$1.3\ L_{CSR\text{-}B}{}^{1/2}$	$2.0\ L_{CSR\text{-}B}{}^{1/2}$	-
(1) Propeller post thicknesses t_1, t_2 and t_3 are, in any case, to be not less than ($0.05\ L_{CSR\text{-}B} + 9.5$) *mm*.			

Section 3 MACHINERY SPACE

2. Double bottom

2.1 Arrangement

Paragraph 2.1.5 has been amended as follows.

2.1.5 Side bottom girders in way of machinery seatings

Additional side bottom girders are to be fitted in way of machinery seatings.

Side bottom girders arranged in way of main machinery seatings are to extend for the full length of the machinery space.

Bottom girders are to extend as far aft as practicable in relation to the shape of the bottom and are to be supported by floors and side primary supporting members at the ends.

Forward of the machinery space forward bulkhead, the bottom girders are to be <u>generally</u> tapered for at least three frame spaces and are to be effectively connected to the hull structure.

Section 5 HATCH COVERS

4. Load model

4.2 Load point

Paragraph 4.2.1 has been amended as follows.

4.2.1 ~~Wave lateral pressure for hatch covers on exposed decks~~ Sea pressures

The wave lateral pressure to be considered as acting on each hatch cover is to be calculated at a point located~~:~~ longitudinally, at the hatch cover mid-length.

- ~~longitudinally, at the hatch cover mid-length~~
- ~~transversely, on the longitudinal plane of symmetry of the ship~~
- ~~vertically, at the top of the hatch cover.~~

Paragraph 4.2.2 has been amended as follows.

4.2.2 ~~Lateral pressures other than the wave pressure~~ Other pressures

The lateral pressure is to be calculated:

- in way of the geometrical centre of gravity of the plate panel, for plating
- at mid-span, for ordinary stiffeners and primary supporting members.

Internal dynamic lateral pressure to be considered as acting on the bottom of a hatch cover is to be calculated at a point located:

- longitudinally, at the hatch cover mid-length
- transversely, at hatchway side
- Vertically, at the top of the hatch coaming for internal ballast water pressures

Chapter 10 HULL OUTFITTING

Section 1 RUDDER AND MANOEUVRING ARRANGEMENT

5. Rudder body, rudder bearings

5.1 Strength of rudder body

Paragraph 5.1.4 has been amended as follows.

5.1.4

In rudder bodies with cut-outs (semi-spade rudders) the following stress values are not to be exceeded:

- bending stress, *N/mm*^{2}, due to M_R:
  $\sigma_b = \cancel{90}\ \underline{75}$
- shear stress, *N/mm*^{2}, due to Q_1:
  $\tau = 50$
- torsional stress, *N/mm*^{2},due to M_t:
  $\tau_t = 50$
- equivalent stress, in *N/mm*^{2}, due to bending and shear and equivalent stress due to bending and torsion:
  $\sigma_{v1} = \sqrt{\sigma_b^2 + 3\tau^2} = \cancel{120}\ \underline{100}$
  $\sigma_{v2} = \sqrt{\sigma_b^2 + 3\tau_t^2} = 100$

where:

(The rest is omitted.)

Chapter 11 CONSTRUCTION AND TESTING

Section 2 WELDING

2. Types of welded connections

2.2 Butt welding

Paragraph 2.2.2 has been amended as follows.

2.2.2 Welding of plates with different thicknesses

In the case of welding of plates with a difference in as-built thickness ~~equal to or~~ greater than 4 *mm*, the thicker plate is normally to be tapered. The taper has to have a length of not less than 3 times the difference in as-built thickness.

2.4 Full penetration welds

Paragraph 2.4.1 has been amended as follows.

2.4.1 Application

Full penetration welds are to be used in the following connections:

- rudder horns and shaft brackets to shell structure
- rudder side plating to rudder stock connection areas
- vertical corrugated bulkhead to inner bottom plating that are situated in the cargo area and arranged without transverse lower stool
- vertical corrugated bulkhead to top plating of transverse lower stool
- pillars to plating member, in case the stress acting on the pillar is tension (i.e. engine room, fore peak and deckhouses).
- edge reinforcement or pipe penetrations both to strength deck, sheer strake and bottom plating within $0.6L_{CSR-B}$ amidships, when the dimension of the opening exceeds 300 *mm*
- abutting plate panels with as-built thickness less than or equal to 12 *mm*, forming boundaries to the sea below the summer load waterline. For as-built thickness greater than 12 *mm*, deep penetration weld with a maximum root face length $f = T/3$ is acceptable (see **Fig. 2**).

Section 3 TESTING OF COMPARTMENTS

3. Testing requirements

3.1 General

3.1.1

Table 1 has been amended as follows.

Table 1 General testing requirements

Item number	Structure to be tested	Type of testing	Structural test pressure	Remarks
1	Double bottom tanks	Structural testing (1)	The greater of the following: ・head of water up to the top of overflow ・head of water up to the bulkhead deck	Tank boundaries tested from at least one side
2	Double side tanks	Structural testing (1)	The greater of the following: ・head of water up to the top of overflow ・2.4 *m* head of water above highest point of tank	Tank boundaries tested from at least one side
3	Tank bulkheads, deep tanks	Structural testing (1)	The greater of the following: (2) ・head of water up to the top of overflow ・2.4 *m* head of water above highest point of tank ・setting pressure of the safety relief valves, where relevant	Tank boundaries tested from at least one side
	Fuel oil tanks	Structural testing		
4	Ballast holds	Structural testing (1)	The greater of the following: ・head of water up to the top of overflow ・~~0.90 *m*~~ head of water ~~above~~ up to the top of hatch coaming	
5	(The rest is omitted.)			

EFFECTIVE DATE AND APPLICATION

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

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

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

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

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

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

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

Note:
This Procedural Requirement applies from 1 July 2009.