09-392

# RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

## Part CSR-T Common Structural Rules for Double Hull Oil Tankers

**Rules for the Survey and Construction of Steel Ships**
**Part CSR-T 2009 AMENDMENT NO.1**

Rule No.19 15th April 2009
Resolved by Technical Committee on 4th February 2009
Approved by Board of Directors on 24th February 2009

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Rule No.19 15th April 2009
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-T Common Structural Rules for Double Hull Oil Tankers

Amendment 1-1

## Section 1 INTRODUCTION

### 1. Introduction to Common Structural Rules for Oil Tankers

#### 1.1 General

#### 1.1.1 Applicability

Paragraphs 1.1.1.1 and 1.1.1.2 have been amended as follows.

1.1.1.1 This Part apply to double hull oil tankers of 150*m* length, ~~L~~$L_{CSR-T}$, and upward classed with the Society and contracted for construction[(1)] on or after 1 April 2006. The definition of the rule length, ~~L~~$L_{CSR-T}$, is given in **Section 4/1.1.1.1.**
1.1.1.2 Generally, for double hull tankers of less than 150*m* in length, ~~L~~$L_{CSR-T}$, the Rules of the Society are to be applied.

# Section 2 RULE PRINCIPLES

## 2. General Assumptions

### 2.1 General

Table 2.2.1 has been amended as follows.

**Table 2.2.1 IACS Unified Requirements Applicable to Oil Tankers**

| Number | Title |
|---|---|
| (Omitted) | |
| S2 | *Definitions of ship's length* ~~$L$~~$\underline{L_{CSR-T}}$ *and block coefficient* $C_b$ |
| (Omitted) | |

## 3. Design Basis

### 3.1 General

### 3.1.2 Arrangement and layout

Paragraph 3.1.2.4 has been amended as follows.

3.1.2.4 The Rules assume the following hull form with respect to environmental loading:
- (a) full form ship with block coefficient ($C_b$) greater than 0.7
- (b) the ship length breadth ratio (~~$L$~~$\underline{L_{CSR-T}}$ $/B$) greater than 5

(Omitted)

## 5. Application of Principles

### 5.3 Minimum Requirements

### 5.3.1 General

Paragraph 5.3.1.1 has been amended as follows.

5.3.1.1 The minimum requirements are usually in one of the following forms:
- (a) minimum thickness, which is independent of the yield stress, these are based on service experience and are usually expressed in the following format:

  $t = A + B$ ~~$L$~~$\underline{L_{CSR-T}}$

  Where:

  $A$, $B$ : constants

  ~~$L$~~$\underline{L_{CSR-T}}$ : rule length, as defined in **Section 4/1.1.1.1**
- (b) minimum stiffness and proportion, which are based on prescriptive buckling requirements

# Section 4 BASIC INFORMATION

## 1. Definitions

### 1.1 Principal Particulars

Paragraph 1.1.1 has been amended as follows.

**1.1.1 ~~L~~$L_{CSR-T}$, rule length**

1.1.1.1 ~~L~~$L_{CSR-T}$, the rule length, is the distance on the waterline at the scantling draught, from the forward side of the stem to the centreline of the rudder stock, in metres. ~~L~~$L_{CSR-T}$ is not to be less than 96%, and need not be greater than 97%, of the extreme length on the summer load waterline. In ships with an unusual stern and bow arrangement the length, ~~L~~$L_{CSR-T}$, will be specially considered.

Paragraph 1.1.6 has been amended as follows.

**1.1.6 Amidships**

1.1.6.1 Amidships is to be taken as the middle of the rule length, ~~L~~$L_{CSR-T}$.

Paragraph 1.1.9 has been amended as follows.

**1.1.9 Block coefficient**

1.1.9.1 $C_b$, the block coefficient at the scantling draught, is defined as:

~~$C_b = \frac{\nabla}{LB_{WL}T_{sc}}$~~ $$C_b = \frac{\nabla}{L_{CSR-T}B_{WL}T_{sc}}$$

Where:

$\nabla$ : moulded displacement volume at the scantling draught, in $m^3$

~~L~~$L_{CSR-T}$ : rule length, as defined in **1.1.1.1**

$B_{WL}$ : moulded breadth measured amidships, in $m$, at the scantling draught waterline

$T_{sc}$ : scantling draught, as defined in **1.1.5.5**

1.1.9.2 $C_{b-LC}$, the block coefficient at considered loading condition, is defined as:

~~$C_{b-LC} = \frac{\nabla_{LC}}{LB_{WL}T_{LC}}$~~ $$C_{b-LC} = \frac{\nabla_{LC}}{L_{CSR-T}B_{WL}T_{LC}}$$

Where:

$\nabla_{LC}$ : moulded displacement volume at the $T_{LC}$, in $m^3$

~~L~~$L_{CSR-T}$ : rule length, as defined in **1.1.1.1**

$B_{WL}$ : moulded breadth measured amidships, in $m$, at the $T_{LC}$

$T_{LC}$ : draught at amidships, in $m$, in the loading condition being considered.

Paragraph 1.1.11 has been amended as follows.

**1.1.11 The forward perpendicular**

1.1.11.1 *F.P.*, the forward perpendicular, is the perpendicular at the intersection of the scantling draught waterline with the fore side of the stem. The *F.P.* is the forward end of the rule length, ~~$L$~~$\underline{L_{CSR-T}}$.

Paragraph 1.1.12 has been amended as follows.

**1.1.12 The aft perpendicular**

1.1.12.1 *A.P.*, the aft perpendicular, is the perpendicular at the aft end of the rule length, ~~$L$~~$\underline{L_{CSR-T}}$, measured from the *F.P.*

Paragraph 1.1.13 has been amended as follows.

**1.1.13 Load line block coefficient**

1.1.13.1 $C_{bL}$, the load line block coefficient, is defined in the *International Convention on Load Lines* as follows:

$$C_{bL} = \frac{\nabla_L}{L_L B T_L}$$

Where:

$\nabla_L$ : moulded displacement volume at the moulded draught, $T_L$, in $m^3$

~~$L$~~$\underline{L_L}$ : load line length, as defined in **1.1.2.1**

$B_L$ : moulded breadth, in $m$, as defined in **1.1.3.1**

$T_L$ : the moulded draught measured to the waterline at 85% of the least moulded depth, in $m$

# 3. Structure Design Details

## 3.2 Termination of Local Support Members

### 3.2.2 Longitudinal members

Paragraph 3.2.2.1 has been amended as follows.

3.2.2.1 All longitudinals are to be kept continuous within the 0.4~~$L$~~$\underline{L_{CSR-T}}$ amidships cargo tank region. In special cases, in way of large openings, foundations and partial girders, the longitudinals may be terminated, but end connection and welding is to be specially considered.

# Section 5 STRUCTURAL ARRANGEMENT

## 3. Double Hull Arrangement

### 3.1 General

### 3.1.2 Capacity of ballast tanks

Paragraphs 3.1.2.2 and 3.1.2.3 have been amended as follows.

3.1.2.2 The moulded draught amidships, $T_{mid}$, excluding any hogging or sagging correction, is not to be less than:

$$\sout{T_{mid} = 2.0 + 0.02L} \quad \underline{T_{mid} = 2.0 + 0.02L_{CSR-T}} \qquad (m)$$

Where:

~~$L$~~$\underline{L_{CSR-T}}$ : rule length, as defined in **Section 4/1.1.1.1**, in *m*

3.1.2.3 The draughts at the F.P. and A.P. are to correspond to those determined by the draught amidships, as given in **3.1.2.2**, and in association with a trim by the stern not greater than 0.015 ~~$L$~~$\underline{L_{CSR-T}}$ ($m$).

# Section 6 MATERIALS AND WELDING

## 1. Steel Grades

### 1.2 Application of Steel Materials

Table 6.1.3 has been amended as follows.

**Table 6.1.3 Material Class or Grade of Structural Members**

| Structural member category | Material Class or Grade | |
|---|---|---|
| | Within 0.4~~L~~$\underline{L_{CSR-T}}$ Amidships | Outside 0.4~~L~~$\underline{L_{CSR-T}}$ |
| (Omitted) | | |
| Special<br>Sheer strake at strength deck (1)(2)(3)(10)<br>Stringer plate in strength deck (1)(2)(3)(10)<br>Deck strake at longitudinal bulkhead (2)(4)(10)<br>Strength deck plating at outboard corners of cargo hatch openings<br>Bilge strake (2)(5)(6)<br>Continuous longitudinal hatch coamings | Class III | Class II<br>(Class I outside 0.6~~-L~~$\underline{L_{CSR-T}}$ amidships) |
| (Omitted) | | |

Note

1. Not to be less than *E/EH* within 0.4~~L~~$\underline{L_{CSR-T}}$ amidships in vessels with length, ~~L~~$\underline{L_{CSR-T}}$, exceeding 250*m*.
2. Single strakes required to be of material class III or *E/EH* are, within 0.4~~L~~$\underline{L_{CSR-T}}$ amidships, to have breadths not less than 800 + 5~~L~~$\underline{L_{CSR-T}}$ *mm*, but need not be greater than 1800*mm*.
3. (Omitted)
4. (Omitted)
5. May be class II in vessels with a double bottom over the full breadth, *B*, and with a length, ~~L~~$\underline{L_{CSR-T}}$, less than 150*m*.
6. To be not lower than *D/DH* within 0.6~~L~~$\underline{L_{CSR-T}}$ amidships of vessels with length, ~~L~~$\underline{L_{CSR-T}}$, exceeding 250*m*.
7. (Omitted)
8. Grade *B/AH* to be used for plate thickness more than 40*mm*. However, engine foundation heavy plates outside 0.6~~L~~$\underline{L_{CSR-T}}$ amidships may be of Grade *A/AH*.
9. (Omitted)
10. The material class for deck plating, sheer strake and upper strake of longitudinal bulkhead within 0.4 ~~L~~$\underline{L_{CSR-T}}$ amidships is also to be applied at structural breaks of the superstructure, irrespective of position.

## 5. Weld Design and Dimensions

### 5.3 Tee or Cross Joints

### 5.3.2 Continuous welding

Paragraph 5.3.2.1 has been amended as follows.

5.3.2.1 Continuous welding is to be adopted in the following locations:

(Omitted)

(j) primary support members and stiffener members to bottom shell in the 0.3~~L~~$\underline{L_{CSR-T}}$ forward region

(Omitted)

### 5.3.4 Full or partial penetration corner or tee joints

Paragraph 5.3.4.3 has been amended as follows.

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

(Omitted)

(e) edge reinforcements within 0.6~~*L*~~$\underline{L_{CSR-T}}$ amidships to the strength deck, sheer strake, bottom and bilge plating, when the transverse dimensions of the opening exceeds 300*mm*, see **Fig. 6.5.5**. Where collar plates are fitted in way of pipe penetrations, the collar plate is to be welded by a continuous fillet weld.

(Omitted)

Table 6.5.1 and Table 6.5.5 have been amended as follows.

**Table 6.5.1 Weld Factors**

| Items | Weld Factor<br>$f_{weld}$ | Remarks |
|---|---|---|
| (Omitted) | | |
| (6) Construction in 0.25~~*L*~~$\underline{L_{CSR-T}}$ forward | | |
| In way of flat of bottom: | | |
| floors to shell and inner bottom | 0.18 | |
| girders to shell and inner bottom | 0.28 | |
| Bottom longitudinals to shell: | | |
| flat of bottom forward | 0.30 | |
| Elsewhere | 0.18 | |
| side shell stringers to shell | 0.24 | |
| Fore peak construction: | | |
| internal structures | 0.18 | |
| (Omitted) | | |

**Table 6.5.5 Stiffener End Connection Welds**

| Connection | Weld area, $A_{weld}$, in $cm^2$ | Weld Factor, $f_{weld}^{(1)}$ |
|---|---|---|
| (1) Stiffener welded direct to plating | $0.25A_{stf\text{-}grs}$ or 6.5 $cm^2$ whichever is the greater | 0.38 |
| (2) Bracketless connection of stiffeners, stiffener lapped to bracket or bracket lapped to stiffener: | | |
| (a) in dry space | $1.2\sqrt{Z_{grs}}$ | 0.26 |
| (b) in tank | $1.4\sqrt{Z_{grs}}$ | 0.38 |
| (c) main frame to tank side bracket in 0.15~~*L*~~$\underline{L_{CSR-T}}$ forward | as **(a)** or **(b)** | 0.38 |
| (3) Bracket welded to face of stiffener and bracket connection to plating | — | 0.38 |
| (Omitted) | | |

# Section 7 LOADS

## 2. Static Load Components

### 2.1 Static Hull Girder Loads

#### 2.1.2 Minimum hull girder still water bending moment

Paragraph 2.1.2.1 has been amended as follows.

2.1.2.1 The minimum hull girder hogging and sagging still water bending moment for seagoing operations, $M_{sw\text{-}min\text{-}sea\text{-}mid}$, at amidships is to be taken as:

for hogging:

$$M_{sw-min-sea-mid} = f_{sea}\,(Z_{v-\min}\,\sigma_{perm-sea}\,10^3 - M_{wv-hog}) \qquad (kNm)$$

which is identical to

$$\sout{M_{sw-min-sea-mid} = 0.01\,C_{wv}\,L^2\,B\,(11.97 - 1.9C_b)}$$

$$\underline{M_{sw-min-sea-mid} = 0.01\,C_{wv}\,L_{CSR-T}{}^2\,B\,(11.97 - 1.9C_b)} \qquad (kNm)$$

for sagging:

$$M_{sw-min-sea-mid} = f_{sea}\,(Z_{v-\min}\,\sigma_{perm-sea}\,10^3 + M_{wv-sag}) \qquad (kNm)$$

which is identical to

$$\sout{M_{sw-min-sea-mid} = -0.05185\,C_{wv}\,L^2\,B\,(C_b + 0.7)}$$

$$\underline{M_{sw-min-sea-mid} = -0.05185\,C_{wv}\,L_{CSR-T}{}^2\,B\,(C_b + 0.7)} \qquad (kNm)$$

(Omitted)

~~$L$~~$\underline{L_{CSR-T}}$ : rule length, , in $m$, as defined in **Section 4/1.1.1.1**

(Omitted)

Paragraph 2.1.2.2 has been amended as follows.

2.1.2.2 The minimum hull girder hogging and sagging still water bending moment for seagoing operations, $M_{sw\text{-}min\text{-}sea}$, at any longitudinal position is to be taken as:

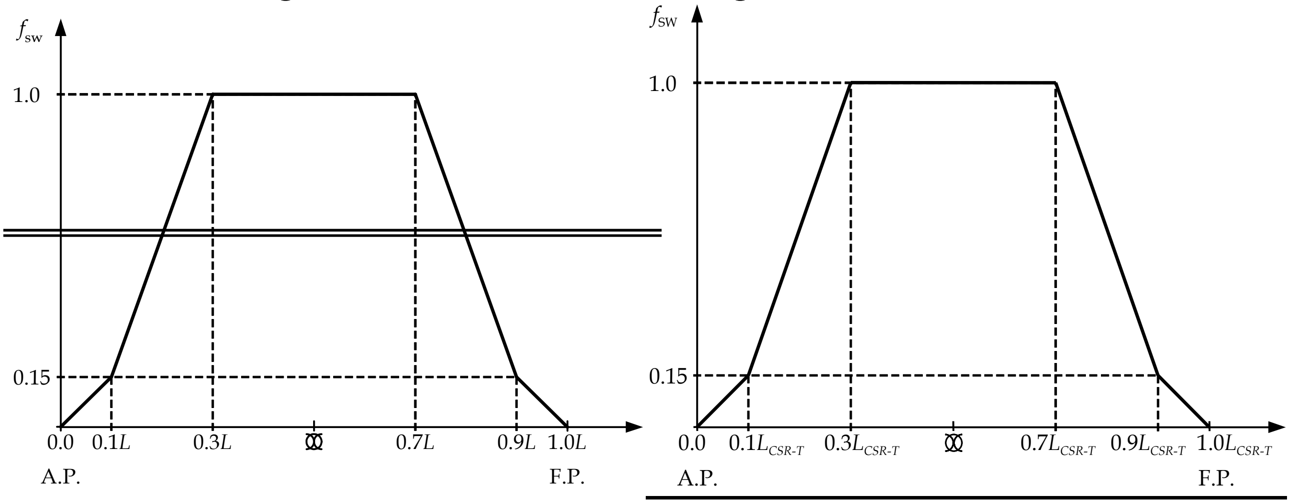
$$M_{sw-min-sea} = f_{sw}\,M_{sw-min-sea-mid} \qquad (kNm)$$

Where:

$f_{sw}$ 1.0 within 0.4~~$L$~~$\underline{L_{CSR-T}}$ amidships
0.15 at 0.1~~$L$~~$\underline{L_{CSR-T}}$ from A.P. or F.P.
0 at A.P. and F.P.
intermediate $f_{sw}$ values are to be obtained by linear interpolation, see **Fig. 7.2.1**

Fig.7.2.1 has been amended as follows.

**Fig. 7.2.1 Still Water Bending Moment Distribution**




## 3. Dynamic Load Components

### 3.2 Motions

Paragraph 3.2.3 has been amended as follows.

**3.2.3 Pitch motion**

3.2.3.1 The characteristic pitch period, $U_{pitch}$, is to be taken as:

~~$U_{pitch} = f_V \sqrt{0.6 \frac{2\pi}{g} (1 + f_T) L}$~~ $$U_{pitch} = f_V \sqrt{0.6 \frac{2\pi}{g} (1 + f_T) L_{CSR-T}} \quad (s)$$

Where:

$f_V$ ~~$= 1.0 + \frac{V_0}{V}\left(\frac{L}{525} - 0.67\right)$~~ $= 1.0 + \frac{V_0}{V}\left(\frac{L_{CSR-T}}{525} - 0.67\right)$

(Omitted)

~~$L$~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

3.2.3.2 The pitch angle, $\varphi$, is to be taken as:

~~$\varphi = 960 \left(\frac{V_1}{C_b}\right)^{0.25} \frac{1}{L} \frac{\pi}{180}$~~ $$\varphi = 960 \left(\frac{V_1}{C_b}\right)^{0.25} \frac{1}{L_{CSR-T}} \frac{\pi}{180} \quad (radians)$$

(Omitted)

~~$L$~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

### 3.3 Ship Accelerations

Paragraphs 3.3.2, 3.3.3 and 3.3.5 have been amended as follows.

#### 3.3.2 Common acceleration parameter

3.3.2.1 The common acceleration parameter, $a_0$, is to be taken as:

~~$a_0 = (1.58 - 0.47C_b)\left(\frac{2.4}{\sqrt{L}} + \frac{34}{L} - \frac{600}{L^2}\right)$~~

$$a_0 = (1.58 - 0.47C_b)\left(\frac{2.4}{\sqrt{L_{CSR-T}}} + \frac{34}{L_{CSR-T}} - \frac{600}{{L_{CSR-T}}^2}\right)$$

Where:

$C_b$ : block coefficient, as defined in **Section 4/1.1.9.1**

~~$L$~~ $L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

#### 3.3.3 Vertical acceleration

3.3.3.1 The envelope vertical acceleration, $a_v$, at any position, is to be taken as:

(Omitted)

$a_{pitch-z}$ : vertical acceleration due to pitch, is to be taken as

~~$= \left(0.3 + \frac{L}{325}\right)\varphi\left(\frac{2\pi}{U_{pitch}}\right)^2 |x - 0.45L|$~~

$$= \left(0.3 + \frac{L_{CSR-T}}{325}\right)\varphi\left(\frac{2\pi}{U_{pitch}}\right)^2 |x - 0.45L_{CSR-T}| \qquad (m/s^2)$$

(Omitted)

~~$L$~~ $L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

3.3.3.2 For scantling requirements and strength assessment:

$f_{prob}$ is to be taken as 1.0

$f_V$ is to be taken as 1.0

3.3.3.3 For fatigue strength:

$f_{prob}$ is to be taken as 0.45

$f_V$ ~~$= \left(\frac{C_{b-LC}}{C_b}\right)^2\left(1.2 - \frac{L}{1000}\right)$~~ $= \left(\frac{C_{b-LC}}{C_b}\right)^2\left(1.2 - \frac{L_{CSR-T}}{1000}\right)$

(Omitted)

~~$L$~~ $L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

#### 3.3.5 Longitudinal acceleration

3.3.5.1 The envelope longitudinal acceleration, $a_{lng}$, at any position, is to be taken as:

~~$a_{lng} = 0.7 f_{prob}\sqrt{a_{surge}^2 + \left(\frac{L}{325}\left(g\, sin\varphi + a_{pitch-x}\right)\right)^2}$~~

$$a_{lng} = 0.7 f_{prob}\sqrt{a_{surge}^2 + \left(\frac{L_{CSR-T}}{325}\left(g\, sin\varphi + a_{pitch-x}\right)\right)^2} \qquad (m/s^2)$$

(Omitted)

~~$L$~~ $L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

### 3.4 Dynamic Hull Girder Loads

Paragraphs 3.4.1, 3.4.2 and 3.4.3 have been amended as follows.

#### 3.4.1 Vertical wave bending moment

3.4.1.1 The envelope hogging and sagging vertical wave bending moments, $M_{wv\text{-}hog}$ and $M_{wv\text{-}sag}$ , are to be taken as:

~~$M_{wv-hog} = f_{prob} 0.19 f_{wv-v} C_{wv} L^2 B C_b$~~

~~$M_{wv-sag} = -f_{prob} 0.11 f_{wv-v} C_{wv} L^2 B (C_b + 0.7)$~~

$$M_{wv-hog} = f_{prob} 0.19 f_{wv-v} C_{wv} L_{CSR-T}{}^2 B C_b$$

$$M_{wv-sag} = -f_{prob} 0.11 f_{wv-v} C_{wv} L_{CSR-T}{}^2 B (C_b + 0.7) \qquad (kNm)$$

(Omitted)

$C_{wv}$ : wave coefficient to be taken as

~~$= 10.75 - \left(\frac{300-L}{100}\right)^{\frac{3}{2}}$ for $150 \le L \le 300$~~

$= 10.75 - \left(\frac{300-L_{CSR-T}}{100}\right)^{\frac{3}{2}}$ for $150 \le L_{CSR-T} \le 300$

~~$= 10.75$ for $300 < L \le 350$~~

$= 10.75$ for $300 < L_{CSR-T} \le 350$

~~$= 10.75 - \left(\frac{L-350}{150}\right)^{\frac{3}{2}}$ for $350 < L \le 500$~~

$= 10.75 - \left(\frac{L_{CSR-T}-350}{150}\right)^{\frac{3}{2}}$ for $350 < L_{CSR-T} \le 500$

~~$L$~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

3.4.1.2 For scantling requirements and strength assessment:

$f_{wv-v}$ : distribution factor for vertical wave bending moment along the vessel length, is to be taken as

0.0 at A.P.

1.0 for 0.4~~$L$~~$L_{CSR-T}$ to 0.65~~$L$~~$L_{CSR-T}$ from A.P.

0.0 at F.P.

intermediate values to be obtained by linear nterpolation, see **Fig. 7.3.1**

$f_{prob}$ is to be taken as 1.0

~~$L$~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

3.4.1.3 For fatigue strength:

$f_{wv-v}$ : distribution factor for vertical wave bending moment along the vessel length, is to be taken as

0.0 at A.P.

0.1 at 0.1~~$L$~~$L_{CSR-T}$ from A.P.

1.0 for 0.4~~$L$~~$L_{CSR-T}$ to 0.65~~$L$~~$L_{CSR-T}$ from A.P.

0.1 at 0.9~~L~~$L_{CSR-T}$ from A.P.
0.0 at F.P.
intermediate values to be obtained by linear interpolation, see **Fig. 7.3.2**

$f_{prob}$ is to be taken as 0.5

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

### 3.4.2 Horizontal wave bending moment

3.4.2.1 The envelope horizontal wave bending moment, $M_{wv-h}$, is to be taken as:

~~$M_{wv-h} = f_{prob}(0.3 + \frac{L}{2000})f_{wv-h} C_{wv} L^2 T_{LC} C_b$~~

$$M_{wv-h} = f_{prob}(0.3 + \frac{L_{CSR-T}}{2000})f_{wv-h} C_{wv} L_{CSR-T}{}^2 T_{LC} C_b \qquad (kNm)$$

(omtted)

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

3.4.2.2 For scantling requirements and strength assessment:

$f_{wv-h}$ : distribution factor for wave horizontal bending moment along the vessel length, is to be taken as
0.0 at A.P.
1.0 for 0.4~~L~~$L_{CSR-T}$ to 0.65~~L~~$L_{CSR-T}$ from A.P.
0.0 at F.P.
intermediate values to be obtained by linear interpolation, see **Fig. 7.3.1**

$f_{prob}$ is to be taken as 1.0

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

3.4.2.3 For fatigue strength:

$f_{wv-h}$ : distribution factor for wave horizontal bending moment along the vessel length, is to be taken as
0.0 at A.P.
0.1 at 0.1~~L~~$L_{CSR-T}$ from A.P.
1.0 for 0.4~~L~~$L_{CSR-T}$ to 0.65~~L~~$L_{CSR-T}$ from A.P.
0.1 at 0.9~~L~~$L_{CSR-T}$ from A.P.
0.0 at F.P.
intermediate values to be obtained by linear interpolation, see **Fig. 7.3.2**

$f_{prob}$ is to be taken as 0.5

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

### 3.4.3 Vertical wave shear force

3.4.3.1 The envelope positive and negative vertical wave shear forces, $Q_{wv-pos}$ and $Q_{wv-neg}$, are to be taken as:

~~$Q_{wv-pos} = 0.3 f_{qwv-pos} C_{wv} L B (C_b + 0.7)$~~

~~$Q_{wv-neg} = -0.3 f_{qwv-neg} C_{wv} L B (C_b + 0.7)$~~

$$Q_{wv-pos} = 0.3 f_{qwv-pos} C_{wv} L_{CSR-T} B (C_b + 0.7)$$

$$Q_{wv-neg} = -0.3 f_{qwv-neg} C_{wv} L_{CSR-T} B (C_b + 0.7) \qquad (kN)$$

Where:

$f_{qwv\text{-}pos}$ : distribution factor for positive vertical wave shear force along the vessel length and is to be taken as

| | |
|---|---|
| 0.0 | at A.P. |
| $1.59\dfrac{C_b}{(C_b+0.7)}$ | for 0.2~~L~~$L_{CSR-T}$ to 0.3~~L~~$L_{CSR-T}$ from A.P. |
| 0.7 | for 0.4~~L~~$L_{CSR-T}$ to 0.6~~L~~$L_{CSR-T}$ from A.P. |
| 1.0 | for 0.7~~L~~$L_{CSR-T}$ to 0.85~~L~~$L_{CSR-T}$ from A.P. |
| 0.0 | at F.P. |

$f_{qwv\text{-}neg}$ : distribution factor for negative vertical wave shear force along the vessel length and is to be taken as

| | |
|---|---|
| 0.0 | at A.P. |
| 0.92 | for 0.2~~L~~$L_{CSR-T}$ to 0.3~~L~~$L_{CSR-T}$ from A.P. |
| 0.7 | for 0.4~~L~~$L_{CSR-T}$ to 0.6~~L~~$L_{CSR-T}$ from A.P. |
| $1.73\dfrac{C_b}{(C_b+0.7)}$ | for 0.7~~L~~$L_{CSR-T}$ to 0.85~~L~~$L_{CSR-T}$ from A.P. |
| 0.0 | at F.P. |

intermediate values of $f_{qwv\text{-}pos}$ and $f_{qwv\text{-}neg}$ are to be obtained by linear interpolation, see **Fig. 7.3.3** and **Fig. 7.3.4** respectively.

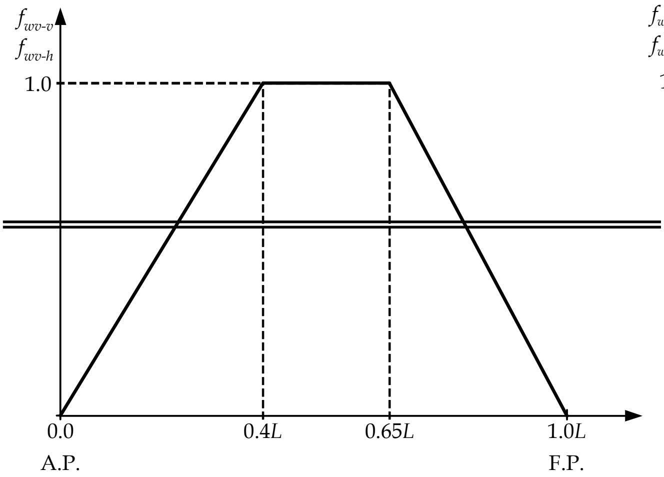
$C_{wv}$ : wave coefficient, as defined in **3.4.1.1**

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

Fig.7.3.1, Fig.7.3.2, Fig.7.3.3 and Fig.7.3.4 have been amended as follows.

**Fig. 7.3.1 Vertical and Horizontal Wave Bending Moment Distribution for Scantling Requirements and Strength Assessment**



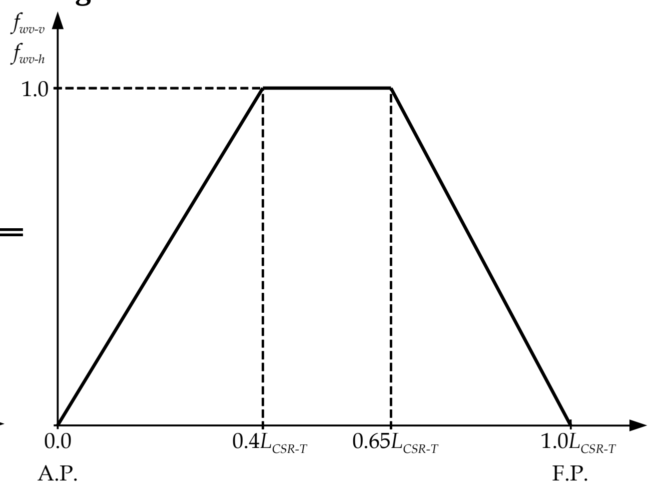



**Fig. 7.3.2 Vertical and Horizontal Wave Bending Moment Distribution for Fatigue Strength**

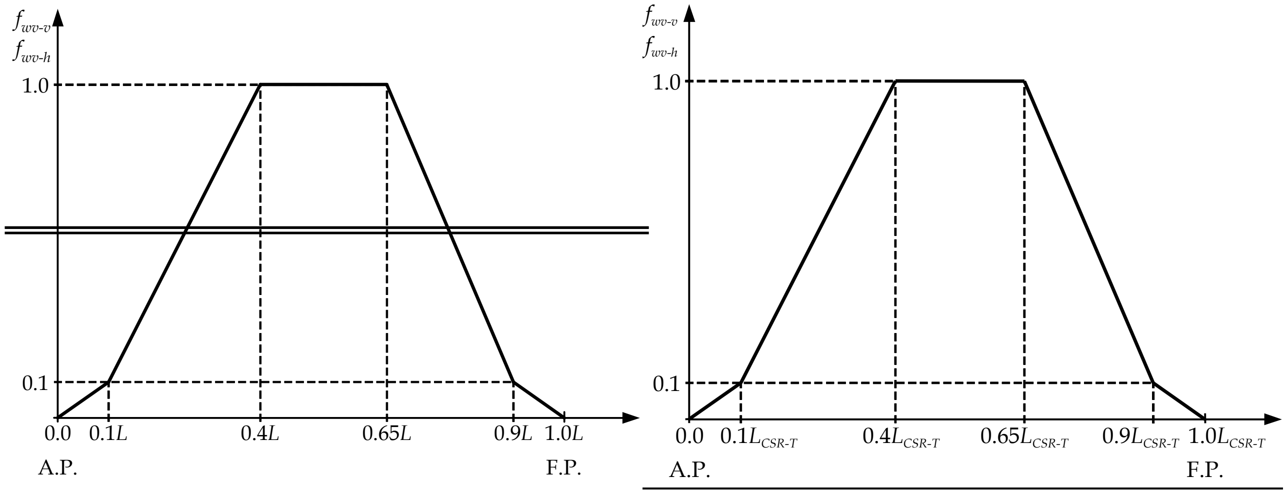



**Fig. 7.3.3 Positive Vertical Wave Shear Force Distribution**

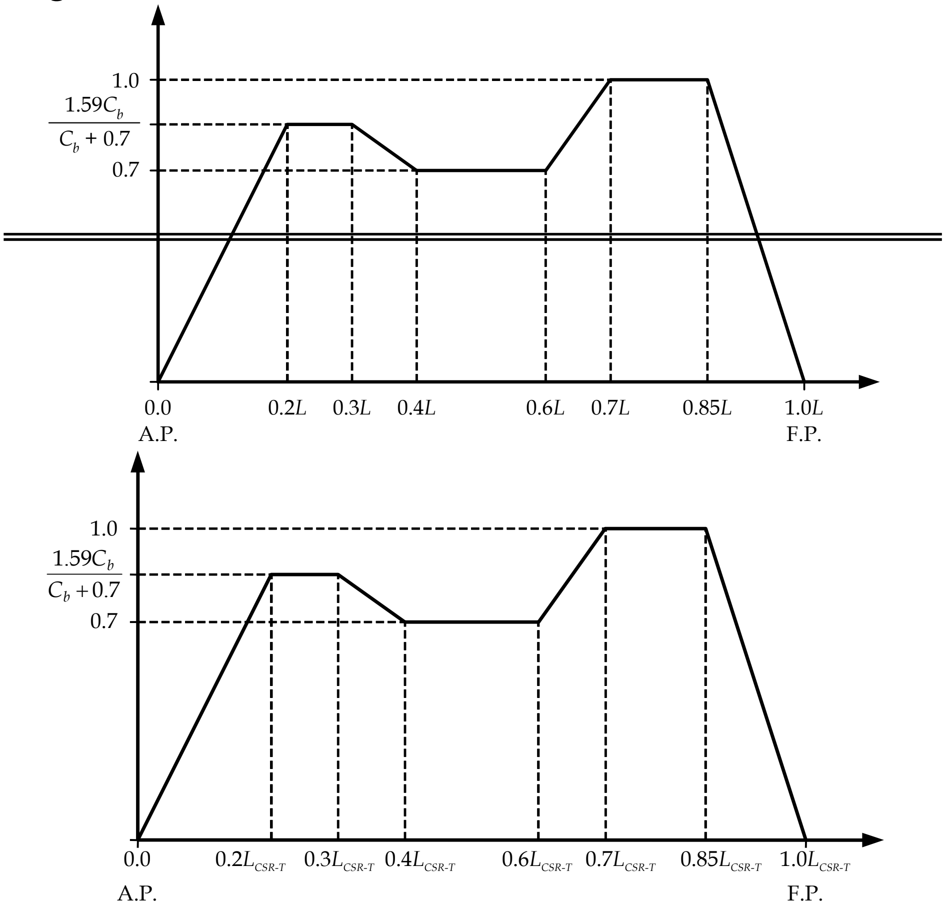
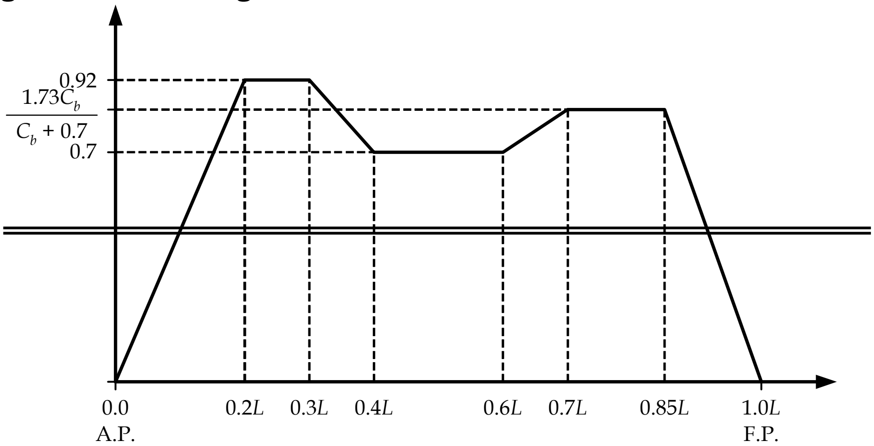
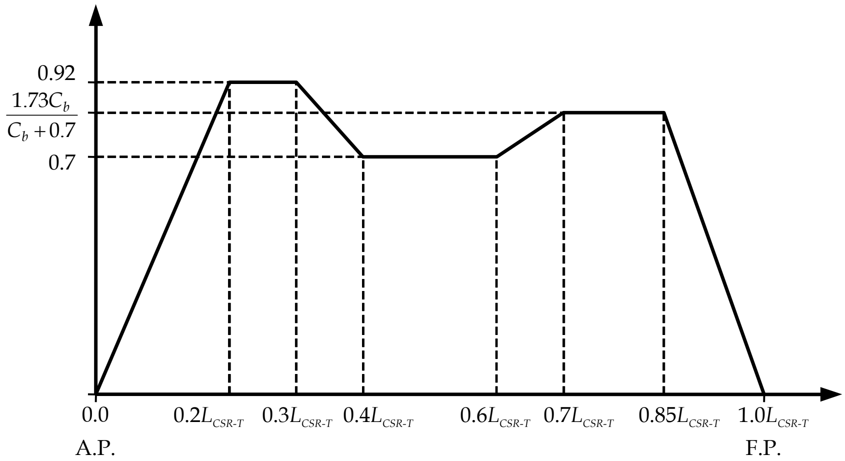


**Fig. 7.3.4 Negative Vertical Wave Shear Force Distribution**




## 3.5 Dynamic Local Loads

### 3.5.2 Dynamic wave pressure

Paragraphs 3.5.2.1 and 3.5.2.3 have been amended as follows.

3.5.2.1 The envelope dynamic wave pressure, $P_{ex\text{-}dyn}$, is to be taken as the greater of the following:

(Omitted)

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

$f_s$ $= C_b + \frac{1.33}{\sqrt{C_b}}$ at, and aft of A.P.

$= C_b$ between 0.2~~L~~$L_{CSR-T}$ and 0.7~~L~~$L_{CSR-T}$ from A.P.

$= C_b + \frac{1.33}{C_b}$ at, and forward of F.P.

intermediate values to be obtained by linear interpolation

$f_{lng}$ = 1.0 at, and aft of A.P.

= 0.7 for 0.2~~L~~$L_{CSR-T}$ to 0.7~~L~~$L_{CSR-T}$ from A.P.

= 1.0 at, and forward of F.P.

intermediate values to be obtained by linear interpolation

(Omitted)

3.5.2.3 The dynamic wave pressure pseudo-amplitude (half range), $P_{ex\text{-}amp}$, for fatigue strength, see **Fig. 7.3.7**, is to be taken as:

(Omitted)

$P_1$ : as defined in **3.5.2**. , in $kN/m^2$, with

$f_{prob}$ = 0.5

$f_{nl\text{-}P1}$ = 1.0

~~$f_V = \begin{cases} 1.0 & \text{at, and aft of } 0.7L \\ 1.5 & \text{at, and forward of F.P.} \end{cases}$~~

$$f_V = \begin{cases} 1.0 & \text{at, and aft of } 0.7L_{CSR-T} \\ 1.5 & \text{at, and forward of F.P.} \end{cases}$$

intermediate values of $f_V$ to be obtained by linear interpolation

(Omitted)

Paragraph 3.5.3 has been amended as follows.

### 3.5.3 Green sea load

3.5.3.1 The envelope green sea load on the weather deck, $P_{wdk}$, is to be taken as the greater of the following:

(Omitted)

Where:

$f_{1-dk}$ ~~$= 0.8 + \frac{L}{750}$~~ $= 0.8 + \frac{L_{CSR-T}}{750}$

$f_{2-dk}$ $= 0.5 + \frac{|y|}{B_{wdk}}$

$f_{op}$ = 1.0 at and forward of 0.2~~$L$~~$L_{CSR-T}$ from A.P.

= 0.8 at and aft of A.P.

intermediate values to be obtained by linear interpolation

(Omitted)

~~$L$~~$L_{CSR-T}$ : rule length, in $m$, as defined in **Section 4/1.1.1.1**

$y$ : transverse coordinate of load point, in $m$

## 4. Sloshing and Impact Loads

### 4.2 Sloshing Pressure in Tanks

### 4.2.1 Application and limitations

Paragraph 4.2.1.2 has been amended as follows.

4.2.1.2 The given pressures do not include the effect of impact pressures due to high velocity impacts with tank boundaries or internal structures. For tanks with a maximum effective sloshing breadth, $b_{slh}$, greater than 0.56$B$ or a maximum effective sloshing length, $l_{slh}$, greater than 0.13 ~~L~~$\underline{L_{CSR-T}}$ at any filling height from 0.05$h_{max}$ to 0.95$h_{max}$, an additional impact assessment is to be carried out in accordance with the individual Classification Society procedures. The effective sloshing lengths and breadths, $l_{slh}$ and $b_{slh}$, are calculated using the equations in **4.2.2.1** and **4.2.3.1** respectively.

### 4.2.2 Sloshing pressure due to longitudinal liquid motion

Paragraph 4.2.2.1 has been amended as follows.

4.2.2.1 The sloshing pressure in way of transverse tight and wash bulkheads due to longitudinal liquid motion, $P_{slh\text{-}lng}$, for a particular filling height, is to be taken as:

$$\require{cancel}\cancel{P_{slh-lng} = \rho g l_{slh} f_{slh}\left[0.4 - \left(0.39 - \frac{1.7 l_{slh}}{L}\right)\frac{L}{350}\right]}$$

$$\underline{P_{slh-lng} = \rho g l_{slh} f_{slh}\left[0.4 - \left(0.39 - \frac{1.7 l_{slh}}{L_{CSR-T}}\right)\frac{L_{CSR-T}}{350}\right] \quad (kN/m^2)}$$

(Omitted)

~~L~~$\underline{L_{CSR-T}}$ : rule length, in $m$, as defined in **Section 4/1.1.1.1**

(Omitted)

### 4.3 Bottom Slamming Loads

Paragraph 4.3.1 has been amended as follows.

### 4.3.1 Application and limitations

4.3.1.1 The slamming loads in this section apply to ships with $C_b \geq 0.7$ and bottom slamming draught $\geq 0.01$~~L~~$\underline{L_{CSR-T}}$ and $\leq 0.045$~~L~~$\underline{L_{CSR-T}}$.

### 4.3.2 Slamming pressure

Paragraph 4.3.2.1 has been amended as follows.

4.3.2.1 The bottom slamming pressure, $P_{slm}$, is to be taken as the greater of:

(Omitted)

$f_{slm}$ : longitudinal slamming distribution factor, see **Fig. 7.4.5**, is to be taken as
0 at 0.5~~L~~$\underline{L_{CSR-T}}$
1 at $[0.175 - 0.5(C_{bl} - 0.7)]$~~L~~$\underline{L_{CSR-T}}$ from F.P.
1 at $[0.1 - 0.5(C_{bl} - 0.7)]$~~L~~$\underline{L_{CSR-T}}$ from F.P.
0.5 at, and forward of F.P.
intermediate values to be obtained by linear interpolation.

$C_{bl}$ : block coefficient, $C_b$, as defined in **Section 4/1.1.9.1**, but not to be taken less than 0.7 or greater than 0.8

: slamming coefficient for empty ballast tanks

$c_{slm\text{-}mt}$

~~$= 5.95 - 10.5\left(\dfrac{T_{FP-mt}}{L}\right)^{0.2}$~~ $= 5.95 - 10.5\left(\dfrac{T_{FP-mt}}{L_{CSR-T}}\right)^{0.2}$

: slamming coefficient for full ballast tanks

$c_{slm\text{-}full}$

~~$= 5.95 - 10.5\left(\dfrac{T_{FP-full}}{L}\right)^{0.2}$~~

$= 5.95 - 10.5\left(\dfrac{T_{FP-full}}{L_{CSR-T}}\right)^{0.2}$

$c_1$ is to be taken as

~~0 for $L \leq 180m$~~

0 for $L_{CSR-T} \leq 180m$

~~$= -0.0125(L - 180)^{0.705}$ for $L > 180m$~~

$= -0.0125(L_{CSR-T} - 180)^{0.705}$ for $L_{CSR-T} > 180m$

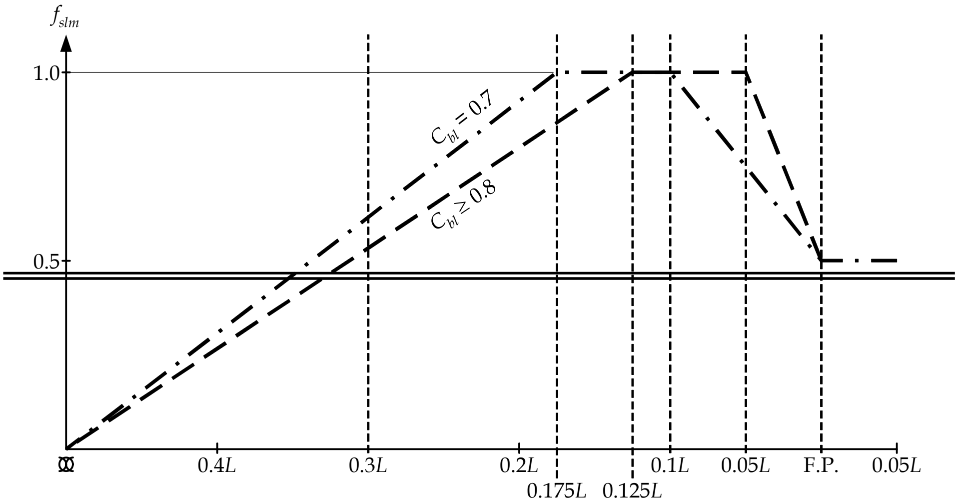
(Omitted)

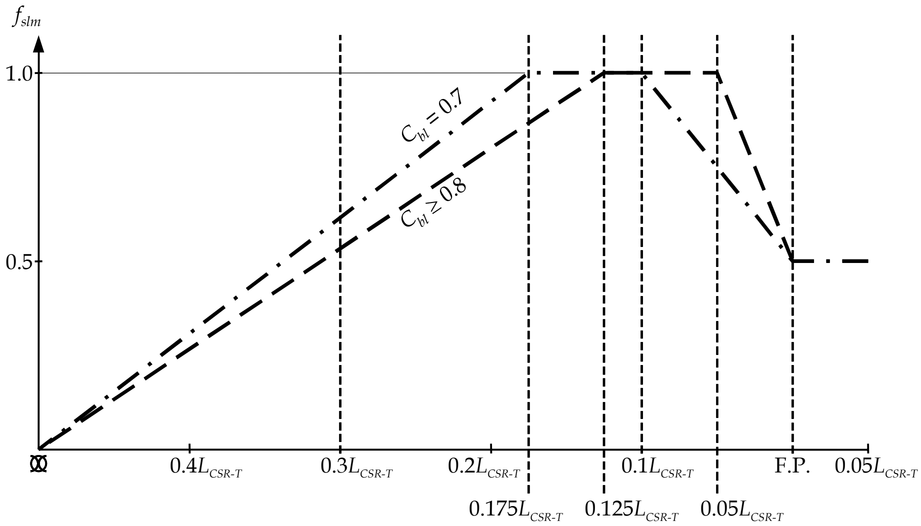
~~$L$~~$L_{CSR-T}$ : rule length, in $m$, as defined in **Section 4/1.1.1.1**

$z_{ball}$ : vertical distance from tank top to load point, in $m$

Fig.7.4.5 has been amended as follows.

**Fig. 7.4.5 Longitudinal Distribution of Slamming Pressure**



### 4.4 Bow Impact Loads

Paragraphs 4.4.1 and 4.4.2 have been amended as follows.

#### 4.4.1 Application and limitations

4.4.1.1 The bow impact pressure applies to the side structure in the area forward of 0.1~~L~~$L_{CSR-T}$ aft of F.P. and between the waterline at draught $T_{bal}$ and the highest deck at side.

#### 4.4.2 Bow impact pressure

4.4.2.1 The bow impact pressure, $P_{im}$, is to be taken as:

$$P_{im} = 1.025 f_{im} c_{im} V_{im}^2 \sin\gamma_{wl} \qquad (kN/m^2)$$

Where:

$f_{im}$ 0.55 at 0.1~~L~~$L_{CSR-T}$ aft of F.P.
0.9 at 0.0125~~L~~$L_{CSR-T}$ aft of F.P.
1.0 at and forward of F.P.
intermediate values to be obtained by linear interpolation

$V_{im}$ : impact speed, in *m/s*
~~$= 0.514 V_{fwd} \sin\alpha_{wl} + \sqrt{L}$~~ $= 0.514 V_{fwd} \sin\alpha_{wl} + \sqrt{L_{CSR-T}}$

(Omitted)

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

## 6. Combination of Loads

### 6.3 Application of Dynamic Loads

Paragraph 6.3.6 has been amended as follows.

#### 6.3.6 Green sea load for a considered dynamic load case

6.3.6.1 The simultaneously acting green sea load on the weather deck, $P_{wdk-dyn}$, for strength assessment is obtained by linear interpolation between $P_{wdk-pt}$ and $P_{wdk-stb}$:

(Omitted)

$f_{1-dk}$ ~~$= 0.8 + \frac{L}{750}$~~ $= 0.8 + \frac{L_{CSR-T}}{750}$

$f_{op}$ = 1.0 at and forward of 0.2~~L~~$L_{CSR-T}$ from A.P.
= 0.8 at and aft of A.P.
intermediate values to be obtained by linear interpolation

(Omitted)

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

6.3.6.2 The simultaneously acting green sea load on the weather deck, $P_{wdk-dyn}$, for scantling requirements is to be taken as the greater of:

(Omitted)

$f_{1-dk}$ ~~$= 0.8 + \frac{L}{750}$~~ $= 0.8 + \frac{L_{CSR-T}}{750}$

$f_{2-dk}$ $= 0.5 + \frac{|y|}{B_{wdk}}$

$f_{op}$ = 1.0 at and forward of 0.2~~L~~ $L_{CSR-T}$ from A.P.

= 0.8 at and aft of A.P.

intermediate values to be obtained by linear interpolation

(Omitted)

~~L~~ $L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

## 6.5 Dynamic Load Cases and Dynamic Load Combination for Scantling Requirements

### 6.5.1 General

Fig.7.6.7 has been amended as follows.

**Fig. 7.6.7 Illustration of Structural Regions**

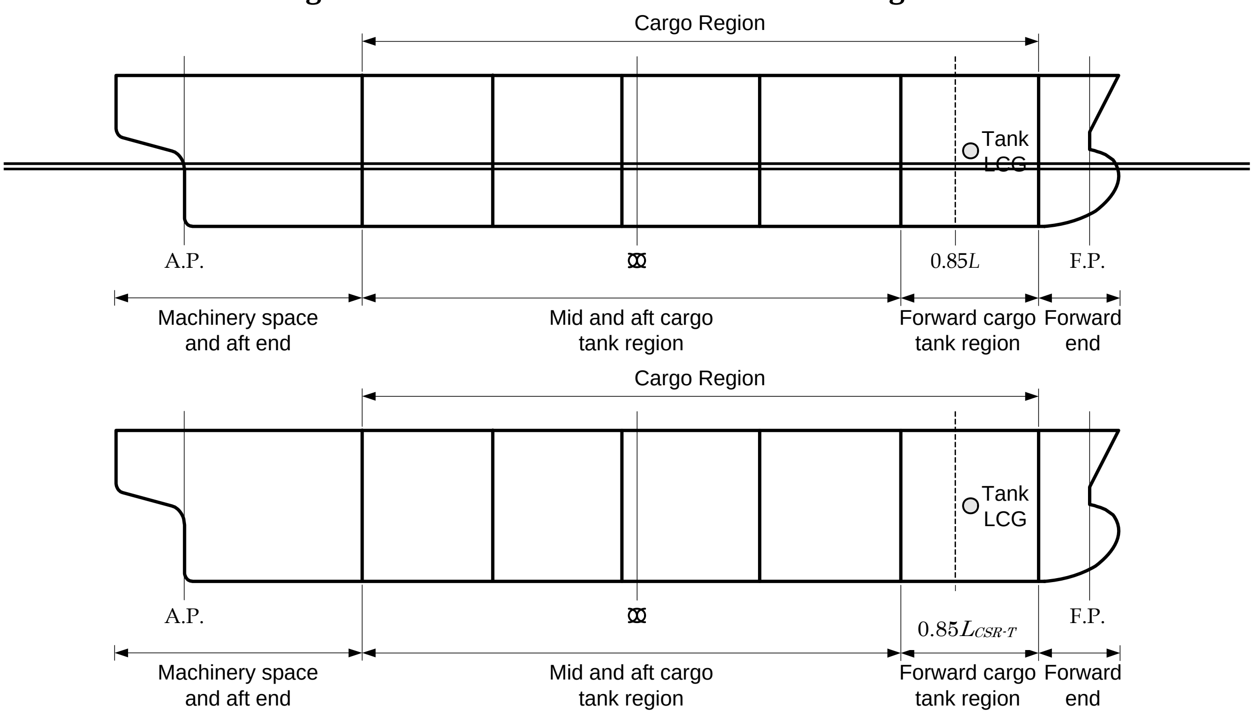



Table 7.6.3 has been amended as follows.

**Table 7.6.3 Dynamic Load Combination Factor Tables used for Structural Region and Loading Condition**

| Structural region | Machinery Space and Aft End | Mid and aft cargo tank region | Forward cargo tank region | Forward end |
|---|---|---|---|---|
| Applicable for tanks and spaces | aft of aftmost cargo tank | where the tank LCG is aft of 0.85~~L~~ $L_{CSR-T}$ | where the tank LCG is at or forward of 0.85~~L~~ $L_{CSR-T}$ | forward of foremost bulkhead |
| Loaded DLCF | **Table 7.6.8** | **Table 7.6.4** | **Table 7.6.6** | **Table 7.6.8** |
| Ballast DLCF | **Table 7.6.9** | **Table 7.6.5** | **Table 7.6.7** | **Table 7.6.9** |

# Section 8 SCANTLING REQUIREMENTS

## 1. Longitudinal Strength

### 1.1 Loading Guidance

### 1.1.2 Loading Manual

Paragraph 1.1.2.2(a) has been amended as follows.

1.1.2.2 The following loading conditions and design loading and ballast conditions upon which the approval of the hull scantlings is based are, as a minimum, to be included in the Loading Manual:
(a) Seagoing conditions including both departure and arrival conditions

(Omitted)

- a normal ballast condition where:
  - the ballast tanks may be full, partially full or empty. Where partially full options are exercised, the conditions in **1.1.2.5** are to be complied with
  - all cargo tanks are to be empty including cargo tanks suitable for the carriage of water ballast at sea
  - the propeller is to be fully immersed, and
  - the trim is to be by the stern and is not to exceed 0.015~~$L$~~$\underline{L_{CSR-T}}$, where ~~$L$~~$\underline{L_{CSR-T}}$ is as defined in **Section 4/1.1.1**
- a heavy ballast condition where:

  (Omitted)

  - all cargo tanks are to be empty including cargo tanks suitable for the carriage of water ballast at sea
  - the propeller is to be fully immersed
  - the trim is to be by the stern and is not to exceed 0.015~~$L$~~$\underline{L_{CSR-T}}$, where ~~$L$~~$\underline{L_{CSR-T}}$ is as defined in **Section 4/1.1.1**

(Omitted)

### 1.2 Hull Girder Bending Strength

### 1.2.1 General

Paragraph 1.2.1.2 has been amended as follows.

1.2.1.2 Scantlings of all continuous longitudinal members of the hull girder based on moment of inertia and section modulus requirement in **1.2.2.1** and **1.2.2.2** are to be maintained within 0.4~~$L$~~$\underline{L_{CSR-T}}$ midships.

### 1.2.2 Minimum requirements

Paragraph 1.2.2.1 has been amended as follows.

1.2.2.1 At the midship cross section the net vertical hull girder moment of inertia about the horizontal neutral axis, $I_{v\text{-}net50}$, is not to be less than the rule minimum vertical hull girder moment of inertia, $I_{v\text{-}min}$, defined as:

~~$I_{v-min} = 2.7 C_{wv} L^3 B (C_b + 0.7) \cdot 10^{-8}$~~ $\quad$ $I_{v-min} = 2.7 C_{wv} L_{CSR-T}{}^3 B (C_b + 0.7) \cdot 10^{-8}$ $(m^4)$

Where:

$C_{wv}$ : wave coefficient as defined in **Table 8.1.2**

~~$L$~~$L_{CSR-T}$ : rule length, in $m$, as defined in **Section 4/1.1.1.1**

（Omitted）

Table 8.1.2 has been amended as follows.

**Table8.1.2 Wave Coefficient $C_{wv}$**

| rule length | $C_{wv}$ |
|---|---|
| ~~$150 \le L \le 300$~~ <br> $150 \le L_{CSR-T} \le 300$ | ~~$10.75 - [(300 - L)/100]^{3/2}$~~ <br> $10.75 - [(300 - L_{CSR-T})/100]^{3/2}$ |
| ~~$300 < L < 350$~~ <br> $300 < L_{CSR-T} < 350$ | 10.75 |
| ~~$350 \le L \le 500$~~ <br> $350 \le L_{CSR-T} \le 500$ | ~~$10.75 - [(L - 350)/150]^{3/2}$~~ <br> $10.75 - [(L_{CSR-T} - 350)/150]^{3/2}$ |

Paragraph 1.2.2.2 has been amended as follows.

1.2.2.2 At the midship cross section the net vertical hull girder section modulus, $Z_{v\text{-}min}$, at the deck and keel is not to be less than the rule minimum hull girder section modulus, $Z_{v\text{-}min}$, defined as:

~~$Z_{v-min} = 0.9 k C_{wv} L^2 B (C_b + 0.7) \cdot 10^{-6}$~~ $\quad$ $Z_{v-min} = 0.9 k C_{wv} L_{CSR-T}{}^2 B (C_b + 0.7) \cdot 10^{-6}$ $(m^3)$

Where:

$k$ : higher strength steel factor, as defined in **Section 6/1.1.4**

$C_{wv}$ : wave coefficient as defined in **Table 8.1.2**

~~$L$~~$L_{CSR-T}$ : rule length, in $m$, as defined in **Section 4/1.1.1.1**

(Omitted)

### 1.2.3 Hull girder requirement on total design bending moment

Table 8.1.3 has been amended as follows.

**Table 8.1.3 Loads and Corresponding Acceptance Criteria for Hull Girder Bending Assessment**

| Design load combination | Still water bending moment, $M_{sw-perm}$ | Wave bending moment, $M_{wv-v}$ | Permissible hull girder bending stress, $\sigma_{perm}$ (1) | |
|---|---|---|---|---|
| (S) | $M_{sw-perm-harb}$ | 0 | $143/k$ | within 0.4~~L~~$L_{CSR-T}$ amidships |
| | | | $105/k$ | at and forward of 0.9~~L~~$L_{CSR-T}$ from A.P. and at and aft of 0.1~~L~~$L_{CSR-T}$ from A.P. |
| (S + D) | $M_{sw-perm-sea}$ | $M_{wv-v}$ | $190/k$ | within 0.4~~L~~$L_{CSR-T}$ amidships |
| | | | $140/k$ | at and forward of 0.9~~L~~$L_{CSR-T}$ from A.P. and at and aft of 0.1~~L~~$L_{CSR-T}$ from A.P |

Where:

| | |
|---|---|
| $M_{sw-perm-harb}$ | : permissible hull girder hogging and sagging still water bending moment for harbour/sheltered water operation, in *kNm*, as defined in **Section 7/2.1.1** |
| $M_{sw-perm-sea}$ | : permissible hull girder hogging and sagging still water bending moment for seagoing operation, in *kNm*, as defined in **Section 7/2.1.1** |
| $M_{wv-v}$ | : hogging and sagging vertical wave bending moments, in *kNm*, as defined in **Section 7/3.4.1**<br>$M_{wv-v}$ is to be taken as:<br>$M_{wv-hog}$ for assessment with respect to hogging vertical wave bending moment<br>$M_{wv-sag}$ for assessment with respect to sagging vertical wave bending moment |
| $k$ | : higher strength steel factor, as defined in **Section 6/1.1.4** |

Note

1. $\sigma_{perm}$ is to be linearly interpolated between values given.

## 1.5 Hull Girder Fatigue Strength

### 1.5.1 General

Paragraph 1.5.1.3 has been amended as follows.

1.5.1.3 The fatigue life for the deck structure as required by **Section 9/3** and **Appendix C** is normally satisfied providing the net vertical hull girder section modulus at the moulded deck line at side, $Z_{v-net50}$, as defined in **Section 4/2.6.1.1**, is not less than the required hull girder section modulus, $Z_{v-fat}$, defined as:

$$Z_{v-fat} = \frac{M_{wv-hog} - M_{wv-sag}}{1000 R_{al}} \qquad (m^3)$$

(Omitted)

| | |
|---|---|
| $R_{al}$ | : allowable stress range, in $N/mm^2$<br>= 0.17~~L~~$L_{CSR-T}$ + 86 for class F-details<br>= 0.15~~L~~$L_{CSR-T}$ + 76 for class F2-details |
| ~~L~~$L_{CSR-T}$ | : rule length, in *m*, as defined in **Section 4/1.1.1.1** |

## 1.6 Tapering and Structural Continuity of Longitudinal Hull Girder Elements

### 1.6.1 Tapering based on minimum hull girder section property requirements

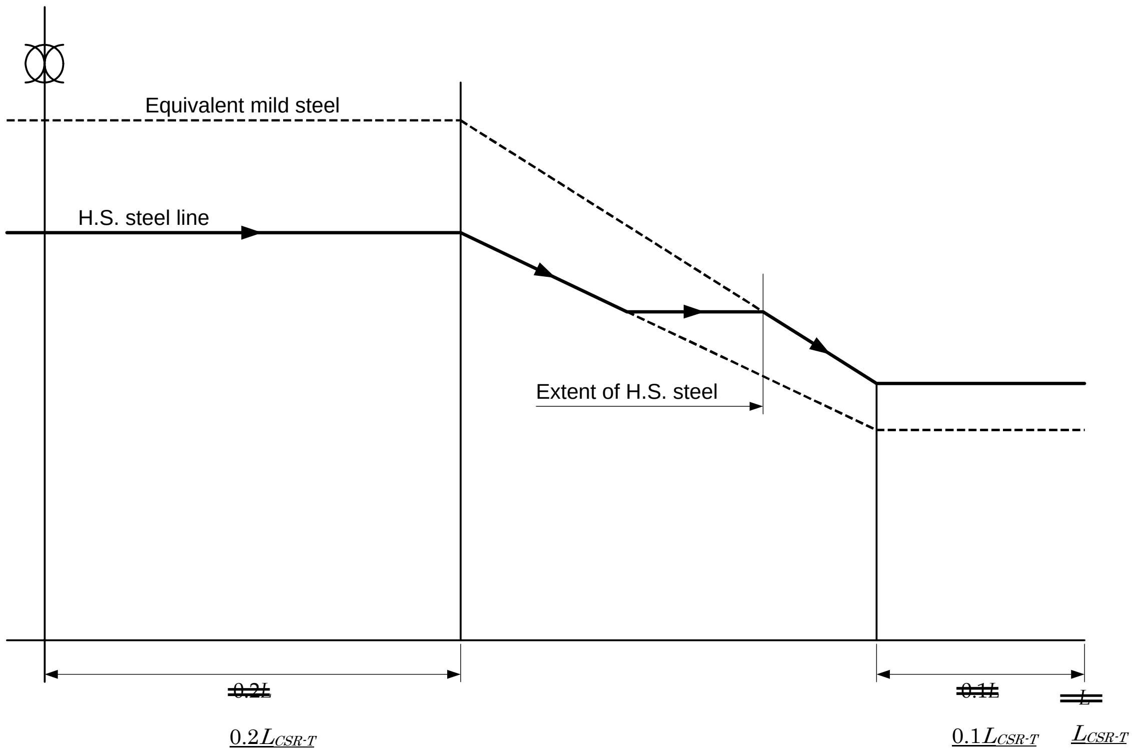
Paragraphs 1.6.1.1 and 1.6.1.2 have been amended as follows.

1.6.1.1 Scantlings of all continuous longitudinal members of the hull girder based on the moment of inertia and section modulus requirements given in **1.2.2** are to be maintained within 0.4~~*L*~~$L_{CSR-T}$ of amidships.
1.6.1.2 Scantlings outside of 0.4~~*L*~~$L_{CSR-T}$ amidships as required by the rule minimum moment of inertia and section modulus as given in **1.2.2** may be gradually reduced to the local requirements at the ends provided the hull girder bending and buckling requirements, along the full length of the ship, as given in **1.2.3** and **1.4** are complied with. For tapering of higher strength steel, see **1.6.2** and **1.6.3**.

### 1.6.2 Longitudinal extent of higher strength steel

Fig.8.1.9 has been amended as follows.

**Fig. 8.1.9 Longitudinal Extent of Higher Strength Steel**



# 2. Cargo Tank Region

## 2.1 General

### 2.1.5 Minimum thickness for plating and local support members

Table 8.2.1 has been amended as follows.

**Table 8.2.1 Minimum Net Thickness for Plating and Local Support Members in the Cargo Tank Region**

| Scantling Location | Net Thickness (*mm*) |
|---|---|
| (Omitted) | |
| Where:<br>$T_{sc}$ : as defined in **Section 4/1.1.5.5**<br>$L_2$ : rule length, ~~L~~$L_{CSR-T}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m* | |

### 2.1.6 Minimum thickness for primary support members

Table 8.2.2 has been amended as follows.

**Table 8.2.2 Minimum Net Thickness for Primary Support Members in Cargo Tank Region**

| Scantling Location | Net Thickness (*mm*) |
|---|---|
| (Omitted) | |
| Where:<br>$L_2$ : rule length, ~~L~~$L_{CSR-T}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m* | |

## 2.2 Hull Envelope Plating

### 2.2.1 Keel plating

Paragraph 2.2.1.1 has been amended as follows.

2.2.1.1 Keel plating is to extend over the flat of bottom for the complete length of the ship. The breadth, $b_{kl}$, is not to be less than:

$$b_{kl} = 800 + 5L_2 \quad (mm)$$

Where:

$L_2$ : rule length, ~~L~~$L_{CSR-T}$, as defined in **Section 4/1.1.1.1**, but not to be taken greater than 300*m*

### 2.2.3 Bilge plating

Paragraph 2.2.3.3 has been amended as follows.

2.2.3.3 Where bilge longitudinals are omitted, the bilge plate thickness outside 0.4~~L~~$L_{CSR-T}$ amidships will be considered in relation to the support derived from the hull form and internal stiffening arrangements. In general, outside of 0.4~~L~~$L_{CSR-T}$ amidships the bilge plate scantlings and arrangement are to comply with the requirements of ordinary side or bottom shell plating in the same region. Consideration is to be given where there is increased loading in the forward region.

### 2.2.5 Sheer strake

Paragraph 2.2.5.2 has been amended as follows.

2.2.5.2 The welding of deck fittings to rounded sheer strakes is to be avoided within 0.6~~L~~$L_{CSR-T}$ of amidships.

## 2.5 Bulkheads

### 2.5.7 Vertically corrugated bulkheads

Paragraph 2.5.7.7 has been amended as follows.

2.5.7.7 For tanks with effective sloshing breadth, $b_{slh}$, greater than 0.56$B$ or effective sloshing length $l_{slh}$, greater than 0.13~~L~~$L_{CSR-T}$, additional sloshing analysis is to be carried out to assess the section modulus of the unit corrugation in accordance with the requirements of the Society.

## 2.6 Primary Support Members

Paragraph 2.6.9 has been amended as follows.

### 2.6.9 Primary support members located beyond 0.4~~L~~$L_{CSR-T}$ amidships

2.6.9.1 If a cargo tank FE analysis is not available for the region outside of 0.4~~L~~$L_{CSR-T}$ amidships, the requirements given in **2.6.9.2** and **2.6.9.3** may be used to obtain the scantlings of primary support members located beyond 0.4~~L~~$L_{CSR-T}$ of amidships. Scantlings used for the 0.4~~L~~$L_{CSR-T}$ amidships are to be those required by **Sections 8/2** and **Section 9/2**, see **2.6.1.3** and **2.6.1.4**.

2.6.9.2 The net section modulus of primary support members, $Z_{end\text{-}net50}$, located beyond 0.4~~L~~$L_{CSR-T}$ of amidships is not to be less than:

$$Z_{end-net50} = \frac{Z_{mid-net50}\,\sigma_{yd-mid}\,M_{end}}{\sigma_{yd-end}\,M_{mid}} \qquad (cm^3)$$

Where:

$M_{end}$ : bending moment, in $kNm$, for the structural member under consideration located beyond 0.4~~L~~$L_{CSR-T}$ amidships, calculated in accordance with corresponding requirements of **2.6.3** to **2.6.8** and using the design pressure specified for the given location

(Omitted)

$\sigma_{yd\text{-}end}$ : specified minimum yield stress of the flange of the structural member under consideration located beyond 0.4~~$L$~~$\underline{L_{CSR-T}}$ amidships, in $N/mm^2$

$\sigma_{yd\text{-}mid}$ : specified minimum yield stress of the flange of the structural member under consideration amidships, in $N/mm^2$

2.6.9.3 The net shear area for primary support members, $A_{shr\text{-}end\text{-}net50}$, located beyond 0.4~~$L$~~$\underline{L_{CSR-T}}$ amidships is not to be less than:

$$A_{shr-end-net50} = \frac{A_{shr-mid-net50}\,\tau_{yd-mid}\,Q_{end}}{\tau_{yd-end}\,Q_{mid}} \qquad (cm^2)$$

Where:

$Q_{end}$ : shear force, in $kN$, for the structural member under consideration located beyond 0.4~~$L$~~$\underline{L_{CSR-T}}$ of amidships, calculated in accordance with the corresponding requirements of **2.6.3** to **2.6.8** and using the design pressure, specified for the given location

$Q_{mid}$ : shear force, in $kN$, for the corresponding structural member and corresponding location of cross section, amidships, obtained from the requirements of **2.6.2** to **2.6.8**

(Omitted)

$\sigma_{yd\text{-}end}$ : specified minimum yield stress of the structural member under consideration located beyond 0.4~~$L$~~$\underline{L_{CSR-T}}$ amidships, in $N/mm^2$

$\sigma_{yd\text{-}mid}$ : specified minimum yield stress of the structural member under consideration amidships, in $N/mm^2$

## 3. Forward of the Forward Cargo Tank

### 3.1 General

#### 3.1.1 Application

Paragraph 3.1.1.1 has been amended as follows.

3.1.1.1 The requirements of this Sub-Section apply to structure forward of the forward end of the foremost cargo tank. Where the forward end of the foremost cargo tank is aft of 0.1~~$L$~~$\underline{L_{CSR-T}}$ of the ship's length, measured from the F.P., special consideration will be given to the applicability of these requirements and the requirements of **Section 8/2**.

## 3.2 Bottom Structure

### 3.2.3 Bottom longitudinals

Table 8.3.1 has been amended as follows.

**Table 8.3.1 Minimum Net Thickness of Structure Forward of the Forward Cargo Tank**

| Scantling Location | Net Thickness (*mm*) |
|---|---|
| (Omitted) | |
| Where:<br>$T_{sc}$ : scantling draught, in *m*, as defined in **Section 4/1.1.5.5**<br>$L_2$ : rule length, ~~L~~$L_{CSR-T}$, in *m*, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m* | |

### 3.2.6 Plate stems

Paragraph 3.2.6.2 has been amended as follows.

3.2.6.2 Between the minimum design ballast draught, $T_{bal}$, at the stem and the scantling draught, $T_{sc}$, the plate stem net thickness, $t_{stem\text{-}net}$, is not to be less than:

$$t_{stem-net} = \frac{L_2\sqrt{\frac{235}{\sigma_{yd}}}}{12}$$ (*mm*), but need not be taken as greater than 21*mm*

Where:

$L_2$ : rule length, ~~L~~$L_{CSR-T}$, in *m*, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*

$\sigma_{yd}$ : specified minimum yield stress of the material, in $N/mm^2$

(Omitted)

## 3.3 Side Structure

### 3.3.3 Side shell primary support structure

Paragraph 3.3.3.1 has been amended as follows.

3.3.3.1 In general, the spacing of web frames, *S* as defined in **Section 4/2.2.2**, is to be taken as:

$$S = 2.6 + 0.005L_2$$ (*m*), but not to be taken greater than 3.5*m*

Where:

$L_2$ : rule length, ~~L~~$L_{CSR-T}$, as defined in **Section 4/1.1.1.1**, but is not to be taken greater than 300*m*

# 4. Machinery Space

## 4.1 General

### 4.1.5 Minimum thickness

Table 8.4.1 has been amended as follows.

**Table 8.4.1 Minimum Net Thickness of Structure in the Machinery Space**

| Scantling Location | Net Thickness ($mm$) |
|---|---|
| (Omitted) | |
| Where:<br>$T_{sc}$ : scantling draught, in $m$, as defined in **Section 4/1.1.5.5**<br>$L_2$ : rule length, ~~$L$~~ $L_{CSR-T}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300$m$<br>$s$ : stiffener spacing, in $mm$, as defined in **Section 4/2.2** | |

# 5. Aft End

## 5.1 General

### 5.1.4 Minimum thickness

Table 8.5.1 has been amended as follows.

**Table 8.5.1 Minimum Net Thickness of Structure Aft of the Aft Peak Bulkhead**

| Scantling Location | Net Thickness ($mm$) |
|---|---|
| (Omitted) | |
| Where:<br>$T_{sc}$ : scantling draught, in $m$, as defined in **Section 4/1.1.5.5**<br>$L_2$ : rule length, ~~$L$~~ $L_{CSR-T}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300$m$ | |

## 5.2 Bottom Structure

### 5.2.3 Stern frames

Paragraph 5.2.3.3 has been amended as follows.

5.2.3.3 Fabricated stern frames are to satisfy the following criteria:

(a) ~~$t_{grs} \ge 2.25\sqrt{L}$~~ $t_{grs} \ge 2.25\sqrt{L_{CSR-T}}$ $(mm)$

(b) $w_{stn} \geq 450$ $(mm)$

(c) ~~$t_{grs} \geq \frac{C_f L^{1.5}}{w_{stn}^2 \sqrt{1+\left(\frac{2l_{stn}}{w_{stn}}\right)^2}}$~~ $\underline{t_{grs} \geq \frac{C_f L_{CSR-T}^{1.5}}{w_{stn}^2 \sqrt{1+\left(\frac{2l_{stn}}{w_{stn}}\right)^2}}}$ $(mm)$

Where:

(Omitted)

| | |
|---|---|
| ~~$L$~~ $\underline{L_{CSR-T}}$ | : rule length, as defined in **Section 4/1.1.1.1** |
| $C_f$ | = 9600 |

Paragraph 5.2.3.4 has been amended as follows.

5.2.3.4 Cast stern frames are to satisfy the following criteria:

(a) ~~$t_{1-grs} \geq 3.0\sqrt{L}$~~

$\underline{t_{1-grs} \geq 3.0\sqrt{L_{CSR-T}}}$ $(mm)$, but not to be less than 25$mm$

(b) $t_{2-grs} \geq 1.25 t_{1-grs}$ $(mm)$

(c) ~~$\frac{(t_{1-grs} + t_{2-grs})}{2} \geq \frac{C_f L^{1.5}}{w_{stn}^2 \sqrt{1+\left(\frac{2l_{stn}}{w_{stn}}\right)^2}}$~~

$\underline{\frac{(t_{1-grs} + t_{2-grs})}{2} \geq \frac{C_f L_{CSR-T}^{1.5}}{w_{stn}^2 \sqrt{1+\left(\frac{2l_{stn}}{w_{stn}}\right)^2}}}$ $(mm)$

Where:

(Omitted)

| | |
|---|---|
| ~~$L$~~ $\underline{L_{CSR-T}}$ | : rule length, as defined in **Section 4/1.1.1.1** |
| $C_f$ | = 8400 |

(Omitted)

## 5.3 Shell Structure

### 5.3.1 Shell plating

Paragraphs 5.3.1.1 to 5.3.1.3 have been amended as follows.

5.3.1.1 The net thickness of the side shell and transom plating, $t_{net}$, is to comply with the requirements in **3.9.2.1** and is not to be less than:

$$t_{net} = 0.035(L_2 - 42) + 0.009s \quad (mm)$$

Where:

$L_2$ : rule length, ~~$L$~~$\underline{L_{CSR-T}}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*

$s$ : stiffener spacing, in *mm*, as defined in **Section 4/2.2**

5.3.1.2 The net plating thickness of shell, $t_{net}$, attached to the stern frame is to comply with the requirements in **3.9.2.1** and is not to be less than:

$$t_{net} = 0.094(L_2 - 43) + 0.009s \qquad (mm)$$

Where:

$L_2$ : rule length, ~~$L$~~$\underline{L_{CSR-T}}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*

$s$ : stiffener spacing, in *mm*, as defined in **Section 4/2.2**

5.3.1.3 In way of the boss and heel plate, the shell net plating thickness, $t_{net}$, is not to be less than:

$$t_{net} = 0.105(L_2 - 47) + 0.011s \qquad (mm)$$

Where:

$L_2$ : rule length, ~~$L$~~$\underline{L_{CSR-T}}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*

$s$ : stiffener spacing, in *mm*, as defined in **Section 4/2.2**

Paragraph 5.3.1.5 has been amended as follows.

5.3.1.5 Heavy shell plates are to be fitted locally in way of the heavy plate floors as required by **5.2.2.3**. Outboard of the heavy floors, the heavy shell plates may be reduced in thickness in as gradual a manner as practicable. Where the horn plating is radiused into the shell plating, the radius at the shell connection, *r*, is not to be less than:

$$r = 150 + 0.8L_2 \qquad (mm)$$

Where:

$L_2$ : rule length, ~~$L$~~$\underline{L_{CSR-T}}$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*

## 6. Evaluation of Structure for Sloshing and Impact Loads

### 6.2 Sloshing in Tanks

#### 6.2.1 Scope and limitations

Paragraph 6.2.1.5 has been amended as follows.

6.2.1.5 For tanks with effective sloshing breadth, $b_{slh}$, greater than 0.56*B* or effective sloshing length, $l_{slh}$, greater than 0.13~~$L$~~$\underline{L_{CSR-T}}$, an additional sloshing impact assessment is to be carried out in accordance with the Society's procedures. The effective sloshing length, $l_{slh}$, and breadth, $b_{slh}$, are defined in **Section 7/4.2.2** and **Section 7/4.2.3** respectively.

### 6.2.2 Application of sloshing pressure

Paragraph 6.2.2.1 has been amended as follows.

6.2.2.1 The following tanks are to be assessed for the design sloshing pressures $P_{slh\text{-}lng}$ and $P_{slh\text{-}t}$ in accordance with **6.2.2.2** to **6.2.2.5**:

(Omitted)

(c) other tanks which allow free movement of liquid, except as follows:

- where the effective sloshing length is less than 0.03~~*L*~~<u>$L_{CSR\text{-}T}$</u>, calculations involving $P_{slh\text{-}lng}$ are not required and
- where the effective sloshing breadth is less than 0.32*B*, calculations involving $P_{slh\text{-}t}$ are not required.

(Omitted)

## 6.3 Bottom Slamming

### 6.3.1 Application

Paragraph 6.3.1.1 has been amended as follows.

6.3.1.1 Where the minimum draughts forward, $T_{FP\text{-}mt}$ or $T_{FP\text{-}full}$, as specified in **Section 7/4.3.2.1**, is less than 0.045~~*L*~~<u>$L_{CSR\text{-}T}$</u>, the bottom forward is to be additionally strengthened to resist bottom slamming pressures.

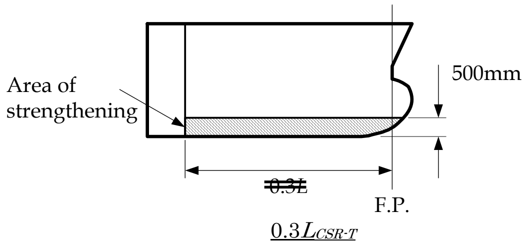
### 6.3.2 Extent of strengthening

Paragraph 6.3.2.1 has been amended as follows.

6.3.2.1 The strengthening is to extend forward of 0.3~~*L*~~<u>$L_{CSR\text{-}T}$</u> from the F.P. over the flat of bottom and adjacent plating with attached stiffeners up to a height of 500*mm* above the baseline, see **Fig. 8.6.4**.

Fig.8.6.4 has been amended as follows.

Fig. 8.6.4 Extent of strengthening against bottom slamming



### 6.3.6 Definition of idealised bottom slamming load area for primary support members

Paragraph 6.3.6.1 has been amended as follows.

6.3.6.1 The scantlings of items in **6.3.7** are based on the application of the slamming pressure defined in **Section 7/4.3** to an idealised area of hull envelope plating, the slamming load area, $A_{slm}$, given by:

~~$A_{slm} = \frac{1.1LBC_b}{1000}$~~ $A_{slm} = \frac{1.1L_{CSR-T}BC_b}{1000}$ $(m^2)$

Where:

| | |
|---|---|
| ~~$L$~~ $L_{CSR-T}$ | : rule length, as defined in **Section 4/1.1.1.1** |
| $B$ | : moulded breadth, in $m$, as defined in **Section 4/1.1.3.1** |
| $C_b$ | : block coefficient, as defined in **Section 4/1.1.9.1** |

## 6.4 Bow Impact

### 6.4.1 Application

Paragraph 6.4.1.1 has been amended as follows.

6.4.1.1 The side structure in the area forward of 0.1~~$L$~~$L_{CSR-T}$ from the F.P. is to be strengthened against bow impact pressures.

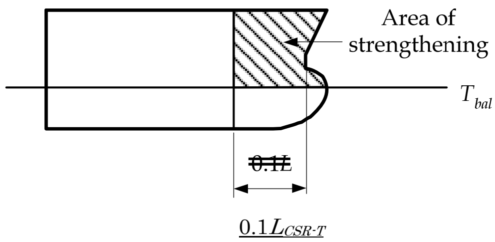
### 6.4.2 Extent of strengthening

Paragraph 6.4.2.1 has been amended as follows.

6.4.2.1 The strengthening is to extend forward of 0.1~~$L$~~$L_{CSR-T}$ from the F.P. and vertically above the minimum design ballast draught, $T_{bal}$, defined in **Section 4/1.1.5.2**. See **Figure 8.6.6**.

Fig. 8.6.6 has been amended as follows.

**Fig. 8.6.6 Extent of Strengthening Against Bow Impact**



### 6.4.6 Definition of idealised bow impact load area for primary support members

Paragraph 6.4.6.1 has been amended as follows.

6.4.6.1 The scantlings of items in **6.4.7** are based on the application of the bow impact pressure, as defined in **Section 7/4.4**, to an idealised area of hull envelope plating, where the bow impact load area, $A_{slm}$, is given by:

~~$A_{slm} = \frac{1.1LBC_b}{1000}$~~ $$A_{slm} = \frac{1.1L_{CSR-T}BC_b}{1000} \quad (m^2)$$

Where:

~~$L$~~ $L_{CSR-T}$ : rule length, as defined in **Section 4/1.1.1.1**

$B$ : moulded breadth, in $m$, as defined in **Section 4/1.1.3.1**

$C_b$ : block coefficient, as defined in **Section 4/1.1.9.1**

### 6.4.7 Primary support members

Paragraph 6.4.7.2 has been amended as follows.

6.4.7.2 To limit the deflections under extreme bow impact loads and ensure boundary constraint for plate panels, the spacing, $S$, measured along the shell girth of web frames supporting longitudinal framing or stringers supporting transverse framing is not to be greater than:

$$S = 3 + 0.008L_2 \quad (m)$$

Where:

$L_2$ : rule length, ~~$L$~~ $L_{CSR-T}$, as defined in **Section 4/1.1.1.1**, but not to be taken greater than 300$m$

# Section 9 DESIGN VERIFICATION

## 1. Hull Girder Ultimate Strength

### 1.1 General

#### 1.1.1 Application

Paragraphs 1.1.1.2 and 1.1.1.3 have been amended as follows.

1.1.1.2 The scantling requirements in this Sub-Section are to be applied within 0.4~~L~~$L_{CSR-T}$ amidships and are in addition to all other requirements within the rules.
1.1.1.3 Outside the 0.4~~L~~$L_{CSR-T}$ region of amidships the plate and stiffeners may be gradually reduced towards the local requirements at the ends.

## 2. Strength Assessment (FEM)

### 2.4 Application of Scantlings in Cargo Tank Region

Paragraph 2.4.2 has been amended as follows.

#### 2.4.2 Application of scantlings to deck

2.4.2.1 The scantlings of deck plating and deck longitudinal stiffeners are to be maintained longitudinally within 0.4~~L~~$L_{CSR-T}$ amidships. The scantlings of deck plating and deck longitudinal stiffeners at a given transverse location within 0.4~~L~~$L_{CSR-T}$ amidships are not to be taken as less than the maximum of that required for the corresponding transverse location along the length of the middle tanks of the cargo tank finite element model required by **Appendix B/1.1.1.5**.
2.4.2.2 Outside 0.4~~L~~$L_{CSR-T}$ amidships, the scantlings of the deck plating and deck longitudinal stiffeners may be tapered to that required by **Section 8** at the ends of the cargo tank region.

#### 2.4.4 Application of scantlings to bottom

Paragraphs 2.4.4.1 and 2.4.4.2 have been amended as follows.

2.4.4.1 The scantlings of bottom longitudinal stiffeners are to be maintained longitudinally within 0.4~~L~~$L_{CSR-T}$ amidships. The scantlings of the bottom longitudinal stiffener at a given transverse location within 0.4~~L~~$L_{CSR-T}$ amidships are not to be less than the maximum of that required for the corresponding transverse location along the length of the middle tanks of the cargo tank finite element model required by **Appendix B/1.1.1.5**.
2.4.4.2 Outside 0.4~~L~~$L_{CSR-T}$ amidships, the scantlings of the bottom longitudinal stiffeners may be tapered to that required by **Section 8** at the ends of the cargo region.

### 2.4.5 Application of scantlings to side shell, longitudinal bulkheads and inner hull longitudinal bulkheads

Paragraph 2.4.5.1 has been amended as follows.

2.4.5.1 The scantlings of plating and longitudinal stiffeners of side shell, longitudinal bulkheads and inner longitudinal bulkheads within 0.15*D* from the deck are to be maintained longitudinally within 0.4~~*L*~~$L_{CSR-T}$ amidships. The scantlings of plating and longitudinal stiffener at a given height are not to be less than the maximum of that required for the corresponding vertical location along the length of the middle tanks of the cargo tank finite element model required by **Appendix B/1.1.1.5**. Outside 0.4~~*L*~~$L_{CSR-T}$ amidships, the scantlings of the plating and stiffeners within 0.15*D* from the deck may be tapered to that required by **Section 8** at the ends of the cargo tank region.

# Section 11 GENERAL REQUIREMENTS

## 1. Hull Openings and Closing Arrangements

### 1.1 Shell and Deck Openings

### 1.1.6 Small hatches on the exposed fore deck

Paragraph 1.1.6.2 has been amended as follows.

1.1.6.2 These requirements apply to small hatches (generally openings $2.5m^2$ or less) on the exposed deck within 0.25~~*L*~~$L_{CSR-T}$ from the F.P. and at a height less than 0.1~~*L*~~$L_{CSR-T}$ or 22*m*, whichever is less, from the summer load water line at the location of the hatch.

### 1.2 Ventilators

### 1.2.3 Applied loading on ventilators

Paragraph 1.2.3.1 has been amended as follows.

1.2.3.1 Ventilators on an exposed deck within the forward 0.25~~*L*~~$L_{CSR-T}$, and where the height of the exposed deck at the ventilator is less than 0.1~~*L*~~$L_{CSR-T}$ or 22*m*, whichever is less, from the summer load waterline are to comply with the requirements of **1.2.3.2** through **1.2.3.3** and **1.2.4.1**.

### 1.3 Air Pipes

### 1.3.4 Applied loading on air pipes

Paragraph 1.3.4.1 has been amended as follows.

1.3.4.1 Air pipes on an exposed deck within the forward 0.25~~*L*~~$L_{CSR-T}$, where the height of the exposed deck at the air pipe is less than 0.1~~*L*~~$L_{CSR-T}$ or 22*m*, whichever is less, from the summer load waterline are to comply with the requirements of **1.3.4.2** through **1.3.4.3** and **1.3.5.1**.

## 1.4 Deck Houses and Companionways

Paragraph 1.4.10 has been amended as follows.

### 1.4.10 Exposed bulkhead plating

1.4.10.1 The gross thickness of plating, $t_{blk\text{-}grs}$, is not to be less than that calculated from 1.4.10.2 and that given by:

$$t_{blk\text{-}grs} = 3s\sqrt{k\,h_{des}} \quad (mm)$$

(Omitted)

$L_1$ : rule length, ~~L~~ $L_{CSR\text{-}T}$, as defined in **Section 4/1.1.1.1**, but is not to be taken greater than 250*m*

$L_2$ : rule length, ~~L~~ $L_{CSR\text{-}T}$, as defined in **Section 4/1.1.1.1**, but is not to be taken greater than 300*m*

$C_4$ : coefficient as given in **Table 11.1.6**

$C_5$ : coefficient

~~$1.0 + \left[\frac{(x/L) - 0.45}{C_{b1} + 0.2}\right]^2$ where $x/L \le 0.45$~~

$$1.0 + \left[\frac{(x/L_{CSR-T}) - 0.45}{C_{b1} + 0.2}\right]^2 \quad \text{where } x/L_{CSR-T} \le 0.45$$

~~$1.0 + 1.5\left[\frac{(x/L) - 0.45}{C_{b1} + 0.2}\right]^2$ where $x/L > 0.45$~~

$$1.0 + 1.5\left[\frac{(x/L_{CSR-T}) - 0.45}{C_{b1} + 0.2}\right]^2 \quad \text{where } x/L_{CSR-T} > 0.45$$

$C_{b1}$ : block coefficient as defined in **Section 4/1.1.9.1**, but is not to be taken as less than 0.60 or greater than 0.80. For aft end bulkheads forward of amidships, $C_{b1}$ may be taken as 0.80

$x$ : distance between the A.P. and the bulkhead being considered, in *m*.
Deck house side bulkheads are to be divided into equal parts not exceeding 0.15~~L~~ $L_{CSR\text{-}T}$ in length, and $x$ is to be measured from the A.P. to the centre of each part considered

~~L~~ $L_{CSR\text{-}T}$ : rule length, as defined in **Section 4/1.1.1.1**

(Omitted)

1.4.10.2 The gross thickness for the lowest tier bulkheads, $t_{blk\text{-}tier\text{-}grs}$, is not to be less than:

$$t_{blk-tier-grs} = 5.0 + L_1/100 \quad (mm)$$

For other tiers, the gross thickness of bulkheads is not to be less than:

$$t_{blk\text{-}tier\text{-}grs} = 4.0 + L_1/100 \quad (mm), \text{ or } 5.0mm, \text{ whichever is greater}$$

Where:

$L_1$ : rule length, ~~L~~ $L_{CSR\text{-}T}$, as defined in **Section 4/1.1.1.1**, but is not to be taken greater than 250*m*

Table 11.1.6, Table 11.1.7 and Table 11.1.8 have been amended as follows.

**Table 11.1.6 Values of ‘$C_4$’**

| Bulkhead location | Value of ‘$C_4$’ |
|---|---|
| (Omitted) | |
| Aft ends, aft of amidships, all tiers | ~~$0.7 + (L_2/1000) - 0.8x/L$~~<br>$0.7 + (L_2/1000) - 0.8x/L_{CSR\text{-}T}$ |
| Aft ends, forward of amidships, all tiers | ~~$0.5 + (L_2/1000) - 0.4x/L$~~<br>$0.5 + (L_2/1000) - 0.4x/L_{CSR\text{-}T}$ |

**Table 11.1.7 Values of ‘$f$’**

| ~~$L$~~$L_{CSR\text{-}T}$, in $m$ | $f$, in $m$ |
|---|---|
| 90 | 6.00 |
| 100 | 6.61 |
| 120 | 7.68 |
| (Omitted) | |

**Table 11.1.8 Origin of ‘$f$’ Values**

| ~~$L$~~$L_{CSR\text{-}T}$, in $m$ | $f$, in $m$ |
|---|---|
| ~~$L \le 150$~~<br>$L_{CSR\text{-}T} \le 150$ | ~~$(L/10)(e^{-L/300}) - [1-(L/150)^2]$~~<br>$(L_{CSR-T}/10)(e^{-L_{CSR-T}/300}) - [1-(L_{CSR-T}/150)^2]$ |
| ~~$150 < L < 300$~~<br>$150 < L_{CSR\text{-}T} < 300$ | ~~$(L/10)(e^{-L/300})$~~<br>$(L_{CSR-T}/10)(e^{-L_{CSR-T}/300})$ |
| ~~$L \ge 300$~~<br>$L_{CSR\text{-}T} \ge 300$ | 11.03 |

### 1.4.14 Closing arrangements for openings in deck houses and companionways

Paragraph 1.4.14.4 has been amended as follows.

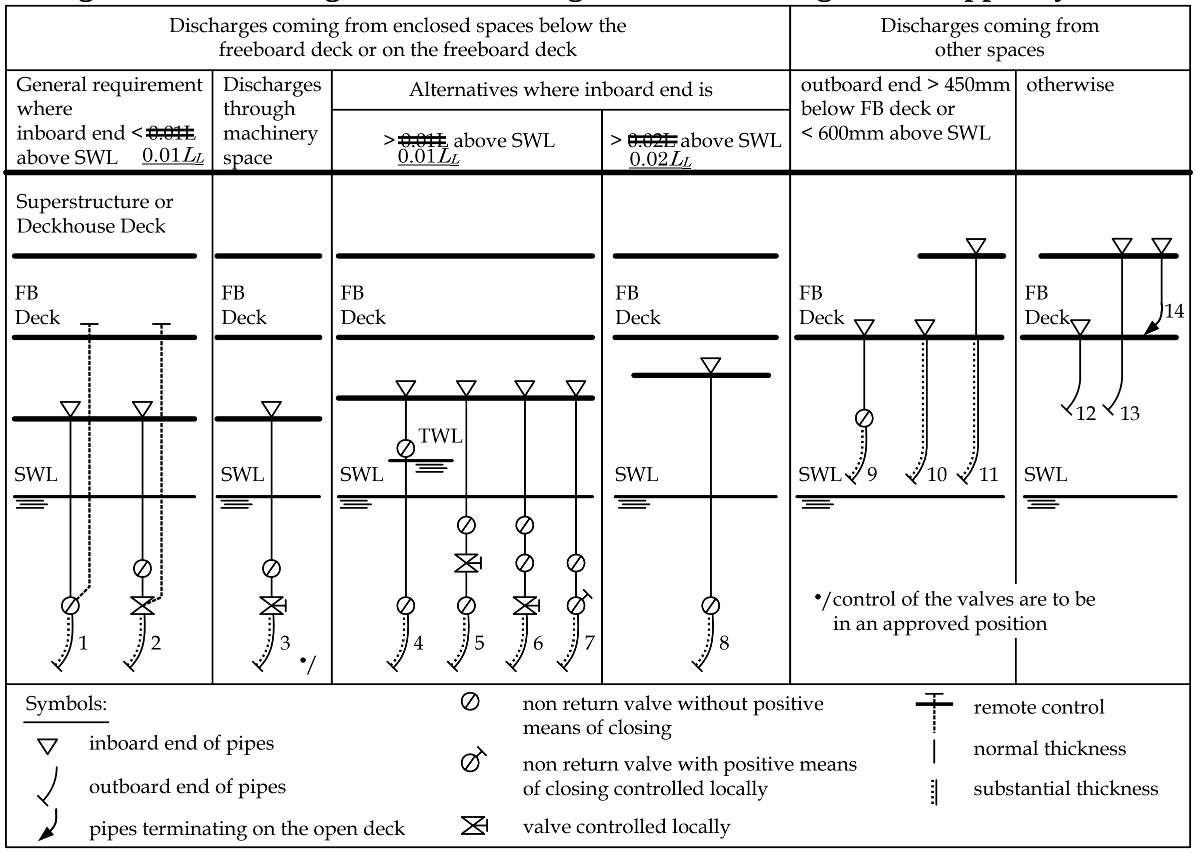
1.4.14.4 Except as permitted by **1.4.14.5**, access doors, air inlets and openings to accommodation spaces, control stations and machinery spaces, are not to face the cargo tank region. They are to be located on the transverse bulkhead or on the side of the deck house at a distance of at least 0.04~~$L$~~$L_{CSR\text{-}T}$ and not less than 3$m$ from the end of the deck house facing the cargo tank region. This distance need not exceed 5$m$.

### 1.5 Scuppers, Inlets and Discharges

### 1.5.3 Prevention of water passing inboard

Fig.11.1.3 has been amended as follows.

**Fig. 11.1.3 Diagrammatic Arrangement of Discharge and Scupper Systems**




## 2. Crew Protection

### 2.1 Bulwarks and Guardrails

### 2.1.1 General

Paragraph 2.1.1.3 has been amended as follows.

2.1.1.3 Within 0.6~~L~~$L_{CSR-T}$ amidships, bulwarks are to be arranged to ensure that they are free from hull girder stresses.

## 3. Support Structure and Structural Appendages

### 3.1 Support Structure for Deck Equipment

#### 3.1.2 Supporting structures for anchoring windlass and chain stopper

Paragraph 3.1.2.9 has been amended as follows.

3.1.2.9 The following forces are to be applied separately in the load cases that are to be examined for the design loads due to green seas in the forward 0.25~~L~~$L_{CSR-T}$, see **Figure 11.3.1**:

(Omitted)

#### 3.1.3 Supporting structure for mooring winches

Paragraphs 3.1.3.9, 3.1.3.10 and 3.1.3.14 have been amended as follows.

3.1.3.9 For mooring winches situated within the forward 0.25~~L~~$L_{CSR-T}$, the load cases for green seas are to be applied as indicated in **3.1.2.9**.
3.1.3.10 For mooring winches situated within the forward 0.25~~L~~$L_{CSR-T}$, the resultant forces in the bolts obtained from green sea design loads are to be calculated in accordance with **3.1.2.10** to **3.1.2.12**.
3.1.3.14 For mooring winches situated within the forward 0.25~~L~~$L_{CSR-T}$, the stresses resulting from green sea design loads, induced in the bolts and supporting structure, are not to exceed values indicated in **3.1.2.16** through **3.1.2.18**.

## 4. Equipment

### 4.1 Equipment Number Calculation

#### 4.1.1 Requirements

Paragraph 4.1.1.1 has been amended as follows.

4.1.1.1 Anchors and chains are to be in accordance with **Table 11.4.1** and the quantity, mass and sizes of these are to be determined by the equipment number (*EN*), given by:

$$EN = \Delta^{2/3} + 2Bh_{dk} + 0.1A$$

(Omitted)

| | |
|---|---|
| $A$ | : profile area of the hull, superstructure and houses above the summer load waterline which are within the length ~~L~~$L_{CSR-T}$, in $m^2$. Superstructures or deck houses having a breadth equal to or less than $B/4$ at any point may be excluded. With regard to determining $A$, when a screen or bulwark is more than 1.5*m* high, the area shown in **Fig. 11.4.2** as $A_2$ is to be included in $A$ |
| ~~L~~$L_{CSR-T}$ | : rule length, as defined in **Section 4/1.1.1.1** |

# Appendix B STRUCTURAL STRENGTH ASSESSMENT

## 1. General

### 1.1 Application

#### 1.1.1 General

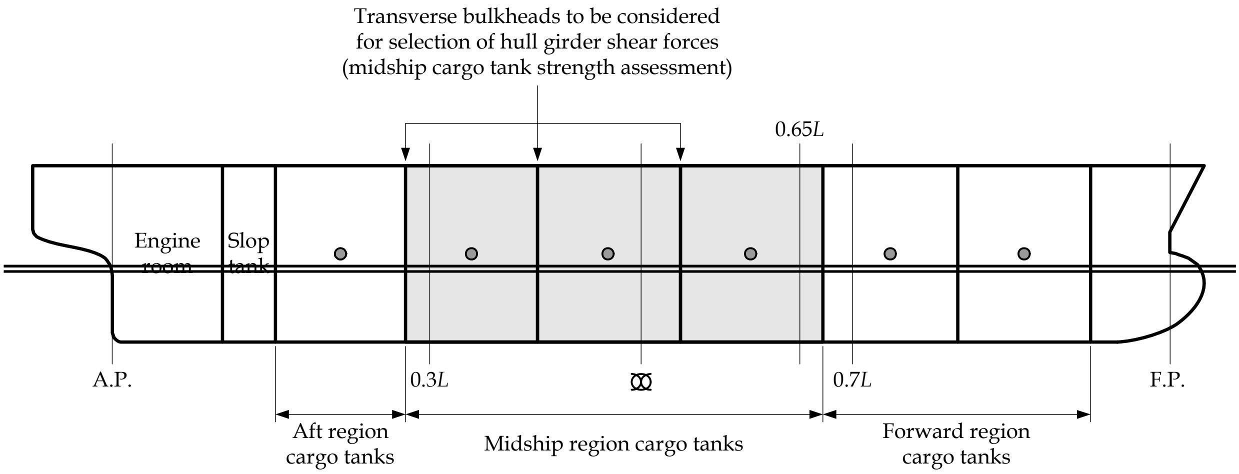
Paragraphs 1.1.1.5 and 1.1.1.6 have been amended as follows.

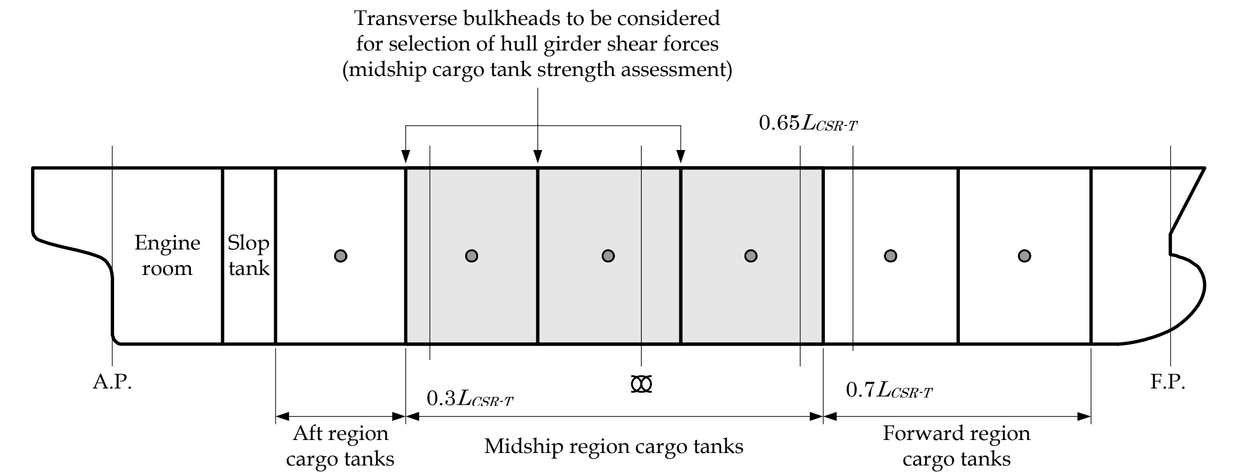
1.1.1.5 Cargo tank structural strength analysis, in accordance with **Appendix B/2**, for the assessment of scantlings of longitudinal hull girder structural members, primary supporting structural members and transverse bulkheads in tanks within the midship cargo region, is mandatory. The assessment is to be based on the maximum permissible still water (load combination S) and combined permissible still water and wave hull girder vertical shear forces (load combination S+D) between and including the forward bulkhead of the aft most cargo tank and 0.65~~*L*~~$L_{CSR-T}$ from AP, but not including the engine room and slop tank transverse bulkheads, *see* **Fig. B.1.1(a)**.
1.1.1.6 The assessment of longitudinal hull girder shear structural members in the forward cargo region, in accordance with **Appendix B/2**, is mandatory. The strengthening of these structural members in way of transverse bulkheads in the tanks of the forward cargo region may be based on the maximum permissible still water (load combination S) and combined permissible still water and wave hull girder vertical shear forces (load combination S+D) at the bulkhead positions forward of 0.65~~*L*~~$L_{CSR-T}$ from AP, but not including the forward collision bulkhead, *see* **Fig. B.1.1(b)**.

Fig.B.1.1 has been amended as follows.

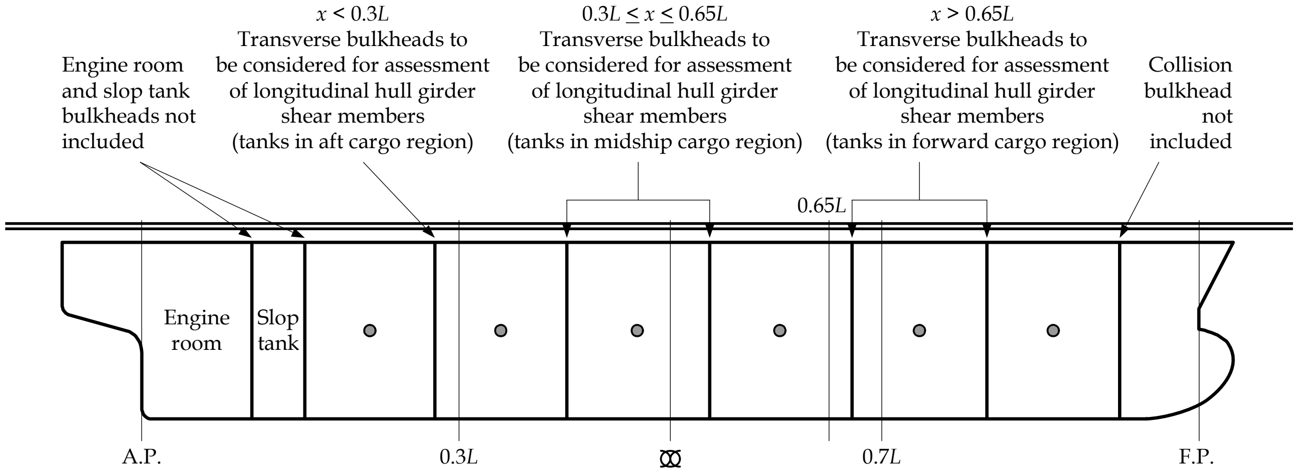
**Fig. B.1.1 Definition of Cargo Tank Regions for FE Structural Assessment**

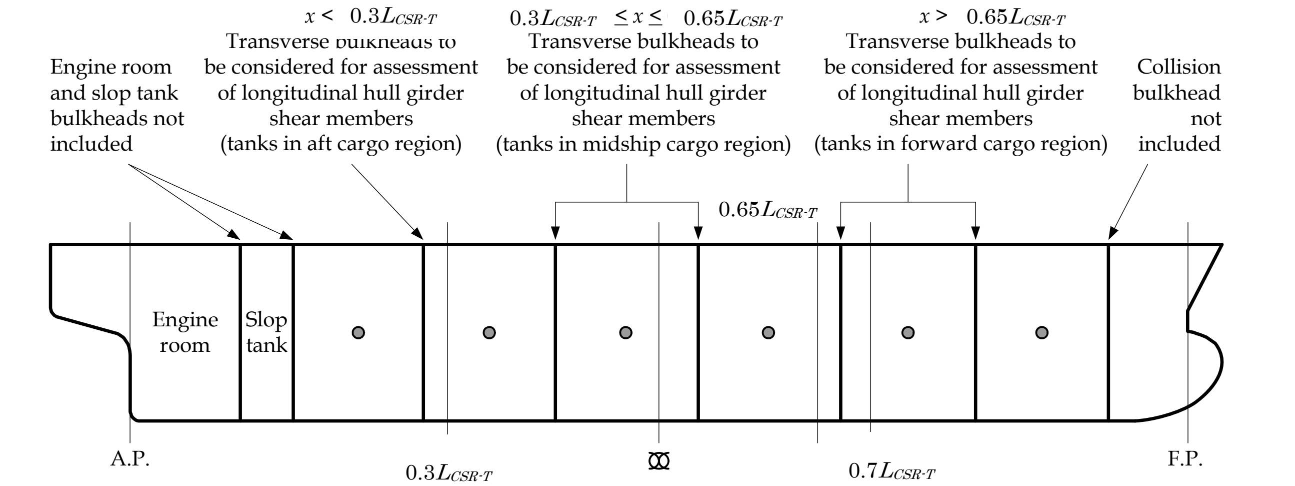
(a) Midship cargo tank strength assessment



(b) Assessment of longitudinal hull girder shear structural members




Note:

Tanks in the forward cargo region are defined as tanks with their longitudinal centre of gravity position forward of 0.7~~L~~$L_{CSR-T}$ from AP.

Tanks in the midship cargo region are defined as tanks with their longitudinal centre of gravity position at or forward of 0.3~~L~~$L_{CSR-T}$ from AP and at or aft of 0.7~~L~~$L_{CSR-T}$ from AP.

Tanks in the aft cargo region are defined as tanks with their longitudinal centre of gravity position aft of 0.3~~L~~$L_{CSR-T}$ from AP.

# 2. Cargo Tank Structural Strength Analysis

## 2.4 Application of Loads

### 2.4.1 General

Table B.2.5 has been amended as follows.

**Table B.2.5 Parameters for Calculation of Loads and Accelerations**

| Parameter | Standard Conditions | | | Optional Conditions | |
|---|---|---|---|---|---|
| | Draught $T_{sc}$ | Draught $0.9T_{sc}$ | Draught $0.6T_{sc}$ | Loaded conditions: A3 (draught > $0.6T_{sc}$) and A7 | Gale/emergency ballast conditions: A8 and B7 |
| ~~$L$~~$\underline{L_{CSR-T}}$ | Rule Length | | | Rule Length | |
| (Omitted) | | | | | |

Table B.2.6 has been amended as follows.

**Table B.2.6 Locations for the Determination of Loads and Accelerations**

| | **Strength assessment (1a)** | **Strength assessment against hull girder shear loads (1b)** | | |
|---|---|---|---|---|
| | **Midship cargo region** | **Forward cargo region** | **Midship cargo region** | **Aft cargo region** |
| **Design load combinations S + D (Sea-going load cases)** | | | | |
| **Dynamic wave pressure and green sea load** | Transverse section at 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP | Transverse section at 0.75~~$L$~~$\underline{L_{CSR-T}}$ from AP | Transverse section at 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP | Transverse section at 0.25~~$L$~~$\underline{L_{CSR-T}}$ from AP |
| **Acceleration** $a_v$, $a_t$, $a_{lng}$ | at CG position of midship tanks (i.e. 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP is within the tank boundary) | at CG position of forward tanks (i.e. 0.75~~$L$~~$\underline{L_{CSR-T}}$ from AP is within the tank boundary) | at CG position of midship tanks (i.e. 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP is within the tank boundary) | at CG position of aft tanks (i.e. 0.25~~$L$~~$\underline{L_{CSR-T}}$ from AP is within the tank boundary) |
| **VWBM and SWBM** (SWBM is to be based on sea-going permissible values, as defined in **Section 7/2.1.1** and **2.1.2**) | at 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP | at 0.75~~$L$~~$\underline{L_{CSR-T}}$ from AP | at 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP | at 0.25~~$L$~~$\underline{L_{CSR-T}}$ from AP |
| **HWBM** | at 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP | \ | \ | \ |
| **VWSF and SWSF** (SWSF is to be based on sea-going permissible values, as defined in **Section 7/2.1.3** and **2.1.4**) | at the transverse bulkhead with maximum combined seagoing permissible SWSF and VWSF in the region (see **1.1.1.5**) | at the transverse bulkhead with maximum combined seagoing permissible SWSF and VWSF in the region (see **1.1.1.6**) or at individual bulkhead position (see **1.1.1.8**) | based on midship cargo tank strength assessment (see **1.1.1.7**) or seagoing permissible SWSF and VWSF at individual transverse bulkhead position (see **1.1.1.8**) | |
| **Design load combination S (Harbour and tank testing load cases)** | | | | |
| **SWBM** (SWBM is to be based on harbour permissible values, as defined in **Section 7/2.1.1** and **2.1.2**) | at 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP | at 0.75~~$L$~~$\underline{L_{CSR-T}}$ from AP | at 0.5~~$L$~~$\underline{L_{CSR-T}}$ from AP | at 0.25~~$L$~~$\underline{L_{CSR-T}}$ from AP |
| (Omitted) | | | | |

# Appendix C FATIGUE STRENGTH ASSESSMENT

## 1. Nominal Stress Approach

### 1.4 Fatigue Damage Calculation

### 1.4.1 Fatigue strength determination

Paragraph 1.4.1.4 has been amended as follows.

1.4.1.4 Assuming the long term distribution of stress ranges fit a two-parameter Weibull probability distribution, the cumulative fatigue damage $DM_i$ for each relevant condition is to be taken as:

$$DM_i = \frac{\alpha_i N_L}{K_2} \frac{S_{Ri}^m}{(lnN_R)^{m/\xi}} \mu_i \Gamma(1+\frac{m}{\xi})$$

Where:

$N_L$ : number of cycles for the expected design life. Unless stated otherwise, $N_L$ to be taken as

$$\frac{f_0 U}{4logL} \quad = \frac{f_0 U}{4logL_{CSR-T}}$$

: The value is generally between $0.6 \times 10^8$ and $0.8 \times 10^8$ cycles for a design life of 25*years*

$f_0$ : 0.85, factor taking into account non-sailing time for operations such as loading and unloading, repairs, etc.

$U$ : design life, in seconds

$= 0.788 \times 10^9$ for a design life of 25 *years*

~~$L$~~ $L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

(Omitted)

Paragraph 1.4.1.6 has been amended as follows.

1.4.1.6 For each structural detail considered, the Weibull shape parameter is to be selected with due consideration given to the load categories contributing to the cyclic stresses. The Weibull probability distribution parameter, $\xi$, is to be taken as:

~~$\xi = f_{Weibull}(1.1 - 0.35\frac{L-100}{300})$~~ $\xi = f_{Weibull}(1.1 - 0.35\frac{L_{CSR-T}-100}{300})$

Where:

~~$L$~~ $L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

$D$ : moulded depth, in *m*, as defined in **Section 4/1.1.4.1**

$f_{Weibull}$ : area dependent modification factor, as given in **Table C.1.1** and **Fig. C.1.2**

### 1.4.4 Definition of stress components

Paragraph 1.4.4.20 has been amended as follows.

1.4.4.20 The stress range combination factors, $f_1$, $f_2$, $f_3$ and $f_4$, which are to be applied to the following zones, are given in **Tables C.1.2** to **C.1.4**:

(a) Zone M: Midship region. This zone extends over the full length of all tanks where the tank LCG lies between 0.35~~L~~$L_{CSR-T}$ and 0.8~~L~~$L_{CSR-T}$ from AP.

(Omitted)

## 2. Hot Spot Stress (FE Based) Approach

### 2.4. Fatigue Damage Calculation

### 2.4.1. Fatigue strength determination

Paragraph 2.4.1.2 has been amended as follows.

2.4.1.2 The Weibull probability distribution parameter applicable to welded knuckles between inner bottom and hopper plate, $\xi$, is to be taken as:

~~$\xi = 1.1 - 0.35\frac{L-100}{300}$~~ $\xi = 1.1 - 0.35\frac{L_{CSR-T} - 100}{300}$

Where:

~~L~~$L_{CSR-T}$ : rule length, in *m*, as defined in **Section 4/1.1.1.1**

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

**1.** The effective date of the amendments is 15 April 2009.

Amendment 1-2

# Section 4 Basic Information

## 3. Structural Design Details

### 3.2 Termination of Local Support Members

### 3.2.5 Sniped ends

Paragraph 3.2.5.1 has been amended as follows.

3.2.5.1 Stiffeners with sniped ends may be used where dynamic loads are small and where the incidence of vibration is considered to be small, i.e. structure not in the stern area and structure not in the vicinity of engines or generators, provided the net thickness of plating supported by the stiffener, $t_{p-net}$, is not less than:

$$\sout{t_{p-net} = c_1\sqrt{(1000l - \frac{s}{2})\frac{sPk}{1000}}} \qquad \underline{t_{p-net} = c_1\sqrt{(1000l - \frac{s}{2})\frac{sPk}{10^6}}} \quad (mm)$$

Where:

$l$ : stiffener span, in $m$

$s$ : stiffener spacing, in $mm$, as defined in **2.2**

$P$ : design pressure for the stiffener for the design load set being considered, in $kN/m^2$. The design load sets and method to derive the design pressure are to be taken in accordance with the following criteria, which define the acceptance criteria set to be used

(a) **Table 8.2.5** in the cargo tank region

(b) **Section 8/3.9.2.2** in the area forward of the forward cargo tank, and in the aft end

(c) **Section 8/4.8.1.2** in the machinery space

$k$ : higher strength steel factor, as defined in **Section 6/1.1.4**

$c_1$ : coefficient for the design load set being considered, to be taken as

=1.2 for acceptance criteria set AC1

=~~1.0~~1.1 for acceptance criteria set AC2

## 3.4 Intersections of Continuous Local Support Members and Primary Support Members

### 3.4.3 Connection between primary support members and intersecting stiffeners (local support members)

Paragraph 3.4.3.5 bis1 has been added as follows.

3.4.3.5 bis1 When total load, W, is bottom slamming or bow impact loads the following criteria apply in lieu of 3.4.3.3 to 3.4.3.5:

$$0.9W \le \frac{\left(A_{1-net}\tau_{perm} + A_{w-net}\sigma_{perm}\right)}{10} \qquad (kN)$$

$A_{1-net}$ : effective net shear area in $cm^2$ of the connection, as defined in **3.4.3.3**.

$A_{w-net}$ : effective net cross-sectional area in $cm^2$ of the primary support member web stiffener in way of the connection including backing bracket where fitted, as defined in **3.4.3.3**.

$\sigma_{perm}$ : permissible direct stress given in **Table 4.3.1** for AC-3, in $N/mm^2$

$\tau_{perm}$ : permissible shear stress given in **Table 4.3.1** for AC-3, in $N/mm^2$

# Section 8 SCANTLING REQUIREMENTS

## 2. Cargo Tank Region

### 2.1 General

### 2.1.5 Minimum thickness for plating and local support members

Table 8.2.1 has been amended as follows.

**Table 8.2.1 Minimum Net Thickness for Plating and Local Support Members in the Cargo Tank Region**

| Scantling Location | | | Net Thickness ($mm$) |
|---|---|---|---|
| Plating | ~~Hull envelope up to $T_{se}$ + 4.6$m$~~ Shell | Keel plating | ~~5.5~~6.5+0.03$L_2$ |
| | | Bottom shell/bilge/side shell | ~~3.5~~4.5+0.03$L_2$ |
| | ~~Hull envelope above $T_{se}$ + 4.6$m$~~ Upper Deck | ~~Side shell/upper deck~~ | 4.5+0.02$L_2$ |
| | ~~Hull internal~~ Other structure | Hull internal tank boundaries | 4.5+0.02$L_2$ |
| | | Non-tight bulkheads, bulkheads between dry spaces and other plates in general | 4.5+0.01$L_2$ |
| Local support members | Local support members on tight boundaries | | 3.5+0.015$L_2$ |
| | Local support members on other structure | | 2.5+0.015$L_2$ |
| Tripping brackets | | | 5.0+0.015$L_2$ |

Where:

~~$T_{se}$ : as defined in **Section 4/1.1.5.5**~~

$L_2$ : rule length, $L$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300$m$

## 2.5 Bulkheads

### 2.5.7 Vertically corrugated bulkheads

Paragraph 2.5.7.9 has been amended as follows.

2.5.7.9 For ships with a moulded depth, see **Section 4/1.1.4**, less than 16*m*, the lower stool may be eliminated provided the following requirements are complied with:

(a) general:

・double bottom floors or girders are to be fitted in line with the corrugation flanges for transverse or longitudinal bulkheads, respectively

・brackets/carlings are to be fitted below the inner bottom and hopper tank in line with corrugation webs.

Where this is not practicable gusset plates with shedder plates are to be fitted, see item **(c)** below and **Fig**. **8.2.3**

・the corrugated bulkhead and its supporting structure is to be assessed by Finite Element (FE) analysis in accordance with **Section 9/2**. In addition the local scantlings requirements of **2.5.6.4** and **2.5.6.5** and the minimum corrugation depth requirement of **2.5.7.4** are to be applied.

(b) inner bottom and hopper tank plating:

・~~the net thickness of~~ the inner bottom and hopper tank in way of the corrugation ~~is not to be less than the net thickness of the attached corrugated bulkhead and~~ is to be of at least the same material yield strength as the attached corrugation

(c) supporting structure:

・within the region of the corrugation depth below the inner bottom the net thickness of the supporting double bottom floors or girders is not to be less than the net thickness of the corrugated bulkhead flange at the lower end and is to be of at least the same material yield strength

・the upper ends of vertical stiffeners on supporting double bottom floors or girders are to be bracketed to adjacent structure

・brackets/carlings arranged in line with the corrugation web are to have a depth of not less than 0.5 *times* the corrugation depth and a net thickness not less than 80% of the net thickness of the corrugation webs and are to be of at least the same material yield strength

・cut outs for stiffeners in way of supporting double bottom floors and girders in line with corrugation flanges are to be fitted with full collar plates

・where support is provided by gussets with shedder plates, the height of the gusset plate, see $h_g$ in **Fig.8.2.3**, is to be at least equal to the corrugation depth, and gussets with shedder plates are to be arranged in every corrugation. The gusset plates are to be fitted in line with and between the corrugation flanges.

The net thickness of the gusset and shedder plates are not to be less than 100% and 80%, respectively, of the net thickness of the corrugation flanges and are to be of at least the same material yield strength. Also see **2.5.7.11**.

・scallops in brackets, gusset plates and shedder plates in way of the connections to the inner bottom or corrugation flange and web are not permitted.

## 2.6 Primary Support Members

### 2.6.8 Cross ties

Paragraph 2.6.8.1 has been amended as follows.

2.6.8.1 The maximum applied design axial load on cross ties, $W_{ct}$, is to be less than or equal to the permissible load, $W_{ct\text{-}perm}$ , as given by:

$$W_{ct} \le W_{ct-perm}$$

Where:

$W_{ct}$ : applied axial load
$= P\, b_{ct}\, S$ $(kN)$

$W_{ct\text{-}perm}$ : permissible load
$= 0.1\, A_{ct-net50}\, \eta_{ct}\, \sigma_{cr}$ $(kN)$

$P$ : maximum design pressure for all the applicable design load sets being considered, calculated at centre of the area supported by the cross tie located at mid tank, in $kN/m^2$

$b_{ct}$ : where cross tie is fitted in centre cargo tank:
$= 0.5\ l_{bdg\text{-}vw}$
: where cross ties are fitted in wing cargo tanks:
$= 0.5\ l_{bdg\text{-}vw}$ for design cargo pressure from the centre cargo tank
$= 0.5\ l_{bdg\text{-}st}$ for design sea pressure

$l_{bdg\text{-}vw}$ : effective bending span of the vertical web frame on the longitudinal bulkhead, in $m$, see **Section 4/2.1.4** and **Fig. 8.2.7**.

$l_{bdg\text{-}st}$ : effective bending span of the side transverse, in $m$, see **Section 4/2.1** and **Fig. 8.2.7.**

$S$ : primary support member spacing, in $m$, as defined in **Section 4/2.2.2**

$\eta_{ct}$ : utilisation factor, to be taken as:
= ~~0.50~~ 0.65 for acceptance criteria set AC1
= ~~0.60~~ 0.75 for acceptance criteria set AC2

$\sigma_{cr}$ : critical buckling stress in compression of the cross tie, in $N/mm^2$, as calculated using the net sectional properties in accordance with **Section 10/3.5.1**, where the effective length of the cross tie is to be taken as follows, in $m$
(a) for cross tie in centre tank:
distance between the flanges of longitudinal stiffeners on the starboard and port longitudinal bulkheads to which the cross tie's horizontal stiffeners are attached
(b) for cross tie in wing tank:
distance between the flanges of longitudinal stiffeners on the longitudinal bulkhead to which the cross tie's horizontal stiffeners are attached, and the inner hull plating

$A_{ct\text{-}net50}$ : net cross sectional area of the cross tie, in $cm^2$

# 3. Forward of the Forward Cargo Tank

## 3.1 General

### 3.1.4 Minimum thickness

Table 8.3.1 has been amended as follows.

**Table 8.3.1 Minimum Net Thickness of Structure Forward of the Forward Cargo Tank**

| Scantling Location | | | Net Thickness ($mm$) |
|---|---|---|---|
| Plating | ~~Hull envelope up to $T_{sc}$ + 4.6m~~ Shell | Keel plating | See **2.1.5.1** |
| | | Bottom shell/bilge/side shell plating | See **2.1.5.1** |
| | ~~Hull envelope above $T_{sc}$ + 4.6m~~ Upper Deck | ~~Side shell/upper deck plating~~ | See **2.1.5.1** |
| | ~~Hull internal~~ Other structure | Hull internal tank boundaries | See **2.1.5.1** |
| | | Non-tight bulkheads, bulkheads between dry spaces and other plates in general | See **2.1.5.1** |
| | | Pillar bulkheads | 7.5 |
| | | Breasthooks | 6.5 |
| Floors and bottom girders | | | $5.5 + 0.02L_2$ |
| Web plating of primary support members | | | $6.5 + 0.015L_2$ |
| Local support members | | | See **2.1.5.1** |
| Tripping brackets | | | See **2.1.5.1** |
| Where:<br>~~$T_{sc}$ : scantling draught, in $m$, as defined in **Section 4/1.1.5.5**~~<br>$L_2$ : rule length, $L$, in $m$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300$m$ | | | |

## 3.4 Deck Structure

### 3.4.1 Deck plating

Paragraph 3.4.1.2 has been deleted.

~~3.4.1.2 In addition to the requirements of **3.4.1.1**, the net plating thickness of decks, $t_{net}$, is not to be less than:~~ (void)

~~$t_{net} = 0.009s$ ($mm$)~~

~~Where:~~

~~$s$ : stiffener spacing, in $mm$, as defined in **Section 4/2.2**~~

### 3.4.3 Deck primary support structure

Paragraph 3.4.3.2 has been amended as follows.

3.4.3.2 ~~Web plating of primary support members is to have a depth of not less than 10% of the unsupported span in bending.~~ The web depth of primary support members is not to be less than 10% and 7% of the unsupported span in bending in tanks and in dry spaces, respectively, and is not to be less than 2.5 times the depth of the slots if the slots are not closed. Unsupported span in bending is bending span as defined in **Section 4/2.1.4** or in case of a grillage structure, the distance between connections to other primary support members.

## 3.5 Tank Bulkheads

### 3.5.3 Scantlings of tank boundary bulkheads

Paragraph 3.5.3.4 has been amended as follows.

3.5.3.4 Web plating of primary support members is to have a depth of not less than 14% of the unsupported span in bending, and is not to be less than 2.5 times the depth of the slots if the slots are not closed.

## 3.6 Watertight Boundaries

### 3.6.3 Scantlings of watertight boundaries

Paragraph 3.6.3.4 has been amended as follows.

3.6.3.4 Web plating of primary support members is to have a depth of not less than 10% of the unsupported span in bending, and is not to be less than 2.5 times the depth of the slots if the slots are not closed.

# 4. Machinery Space

## 4.1 General

### 4.1.5 Minimum thickness

Table 8.4.1 has been amended as follows.

**Table 8.4.1 Minimum Net Thickness of Structure in the Machinery Space**

| Scantling Location | | | Net Thickness ($mm$) |
|---|---|---|---|
| Plating | ~~Hull envelope up to $T_{sc}$ + 4.6*m*~~ Shell | Keel plating | See **2.1.5.1** |
| | | Bottom shell/bilge/side shell plating | See **2.1.5.1** |
| | ~~Hull envelope above $T_{sc}$ + 4.6*m*~~ Upper Deck | ~~Side shell/upper deck plating~~ | See **2.1.5.1** |
| | ~~Hull internal~~ Other structure | Hull internal tank boundaries | See **2.1.5.1** |
| | | Non-tight bulkheads, bulkheads between dry spaces and other plates in general | See **2.1.5.1** |
| | | Lower decks and flats | $3.3 + 0.0067s$ |
| | | Inner bottom | $6.5 + 0.02L_2$ |
| Bottom centreline girder | | | See **2.1.6.1** |
| Floors and bottom longitudinal girders off centreline | | | $5.5 + 0.02\ L_2$ |
| Web plating of primary support members | | | $5.5 + 0.015\ L_2$ |
| Local support members | | | See **2.1.5.1** |
| Tripping brackets | | | See **2.1.5.1** |

Where:
~~$T_{sc}$ : scantling draught, in *m*, as defined in **Section 4/1.1.5.5**~~
$L_2$ : rule length, $L$, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*
$s$ : stiffener spacing, in *mm*, as defined in **Section 4/2.2**

## 4.4 Deck Structure

### 4.4.2 Deck scantlings

Paragraph 4.4.2.5 has been amended as follows.

4.4.2.5 ~~Web plating of primary support members is to have a depth of not less than 10% of the unsupported span in bending.~~ The web depth of primary support members is not to be less than 10% and 7% of the unsupported span in bending in tanks and in dry spaces, respectively, and is not to be less than 2.5 times the depth of the slots if the slots are not closed. Unsupported span in bending is bending span as defined in **Section 4/2.1.4** or in case of a grillage structure the distance between connections to other primary support members.

## 4.6 Tank Bulkheads

### 4.6.3 Scantlings of tank boundary bulkheads

Paragraph 4.6.3.4 has been amended as follows.

4.6.3.4 Web plating of primary support members is to have a depth of not less than 14% of the unsupported span in bending and not less than 2.5 times the depth of the slots if the slots are not closed.

## 4.7 Watertight Boundaries

### 4.7.2 Scantlings of watertight boundaries

Paragraph 4.7.2.4 has been amended as follows.

4.7.2.4 Web plating of primary support members is to have a depth of not less than 10% of the unsupported span in bending and not less than 2.5 times the depth of the slots if the slots are not closed.

# 5. Aft End

## 5.1 General

### 5.1.4 Minimum thickness

Table 8.5.1 has been amended as follows.

**Table 8.5.1 Minimum Net Thickness of Structure Aft of the Aft Peak Bulkhead**

| Scantling Location | | | Net Thickness (*mm*) |
|---|---|---|---|
| Plating | ~~Hull envelope up to $T_{sc}$ + 4.6*m*~~ Shell | Keel plating | See **2.1.5.1** |
| | | Bottom shell/bilge/side shell plating | See **2.1.5.1** |
| | ~~Hull envelope above $T_{sc}$ + 4.6*m*~~ Upper Deck | ~~Side shell/upper deck plating~~ | See **2.1.5.1** |
| | ~~Hull internal~~ Other structure | Hull internal tank boundaries | See **2.1.5.1** |
| | | Non-tight bulkheads, bulkheads between dry spaces and other plates in general | See **2.1.5.1** |
| | | Pillar bulkheads | 7.5 |
| Bottom girders and aft peak floors | | | $5.5 + 0.02L_2$ |
| Web plating of primary support members | | | $6.5 + 0.015L_2$ |
| Local support members | | | See **2.1.5.1** |
| Tripping brackets | | | See **2.1.5.1** |

Where:
~~$T_{sc}$ : scantling draught, in *m*, as defined in **Section 4/1.1.5.5**~~
$L_2$ : rule length, *L*, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*

## 5.3 Shell Structure

### 5.3.1 Shell plating

Paragraph 5.3.1.1 has been amended as follows.

5.3.1.1 The net thickness of the side shell and transom plating, $t_{net}$, is to comply with the requirements in **3.9.2.1**~~and is not to be less than:~~.

~~$t_{net} = 0.035 (L_2 - 42) + 0.009s$ (*mm*)~~

~~Where:~~

~~$L_2$ : rule length, *L*, as defined in **Section 4/1.1.1.1**, but need not be taken greater than 300*m*~~

~~$s$ : stiffener spacing, in *mm*, as defined in **Section 4/2.2**~~

## 5.4 Deck Structure

### 5.4.1 Deck plating

Paragraph 5.4.1.2 has been deleted.

~~5.4.1.2 In addition to the requirements of **5.4.1.1**, the net plating thickness of decks, $t_{net}$, is not to be less than:~~ (void)

~~$t_{net} = 0.009\, s$ $(mm)$~~

~~Where:~~

~~$s$ : stiffener spacing, in *mm*, as defined in **Section 4/2.2**~~

### 5.4.3 Deck primary support members

Paragraph 5.4.3.2 has been amended as follows.

5.4.3.2 ~~Web plating of primary support members is to have a depth of not less than 10% of the unsupported span in bending.~~ The web depth of primary support members is not to be less than 10% and 7% of the unsupported span in bending in tanks and in dry spaces, respectively, and is not to be less than 2.5 times the depth of the slots if the slots are not closed. Unsupported span in bending is bending span as defined in **Section 4/2.1.4** or in case of a grillage structure the distance between connections to other primary support members.

## 5.5 Tank Bulkheads

### 5.5.3 Scantlings of tank boundary bulkheads

Paragraph 5.5.3.4 has been amended as follows.

5.5.3.4 Web plating of primary support members is to have a depth of not less than 14% of the unsupported span in bending and not less than 2.5 times the depth of the slots if the slots are not closed.

## 5.6 Watertight Boundaries

### 5.6.3 Scantlings of watertight boundaries

Paragraph 5.6.3.4 has been amended as follows.

5.6.3.4 Web plating of primary support members is to have a depth of not less than 10% of the unsupported span in bending and not less than 2.5 times the depth of the slots if the slots are not closed.

# Section 9 DESIGN VERIFICATION

## 2. Strength Assessment (FEM)

### 2.2 Cargo Tank Structural Strength Analysis

Table 9.2.2 has been amended as follows.

**Table 9.2.2 Maximum Permissible Utilisation Factor Against Buckling**

| Structural component | Buckling utilisation factor |
|---|---|
| Plate and stiffened panels [3] | $\eta \leq 1.0$ (load combination S + D)<br>$\eta \leq 0.8$ (load combination S) |
| Web plate in way of openings | $\eta \leq 1.0$ (load combination S + D)<br>$\eta \leq 0.8$ (load combination S) |
| Pillar buckling of cross tie structure | $\eta \leq$ ~~0.5~~0.75 (load combination S + D)<br>$\eta \leq$ ~~0.4~~0.65 (load combination S) |
| Corrugated bulkheads<br>flange buckling<br>column buckling | $\eta \leq 0.9$ (load combination S + D)<br>$\eta \leq 0.72$ (load combination S) |
| Where:<br>$\eta$ : utilisation factor against buckling calculated in accordance with **Appendix D/5** and **Appendix B/2.7.3**. Also see **Section 10/3.4.1** for web plate in way of openings and **Section 10/3.5.1** for cross tie structure | |
| Note :<br>1. Buckling capability of curved panels (e.g. bilge plate), face plate and tripping bracket of primary supporting members are not assessed based on finite element stress result<br>2. Where a lower stool is not fitted to a transverse or longitudinal corrugated bulkhead, the maximum permissible buckling utilisation factors are to be reduced by 10% in accordance with **2.2.5.5**<br>3. Permissible buckling utilisation factors specified in this table are applicable for the reference advanced buckling method given in **Appendix D/1.1.2**. If alternative buckling procedures are used the permissible utilisation factors are to be assessed and if required adjusted to meet acceptance criteria for equivalence specified in **Appendix D/1.1.2**. | |

# Section 10 BUCKLING AND ULTIMATE STRENGTH

## 3. Prescriptive Buckling Requirements

### 3.3 Buckling of Stiffeners

### 3.3.3 Torsional buckling mode

Paragraph 3.3.3.1 has been amended as follows.

3.3.3.1 The torsional buckling mode is to be verified against the allowable buckling utilisation factor, $\eta_{allow}$, see **3.1.1.2**. The buckling utilisation factor for torsional buckling of stiffeners is to be taken as:

$$\eta = \frac{\sigma_x}{C_T \, \sigma_{yd}}$$

Where:

$\sigma_x$ : compressive axial stress in the stiffener, in $N/mm^2$, in way of the midspan of the stiffener. See **Section 3/5.2.3.1**

$C_T$ : torsional buckling coefficient

$$= 1.0 \quad \text{for } \lambda_T \le 0.2$$

$$= \frac{1}{\Phi + \sqrt{\Phi^2 - \lambda_T^2}} \quad \text{for } \lambda_T > 0.2$$

$$\Phi = 0.5(1 + 0.21(\lambda_T - 0.2) + \lambda_T^2)$$

$\lambda_T$ : reference degree of slenderness for torsional buckling

$$= \sqrt{\frac{\sigma_{yd}}{\sigma_{ET}}}$$

$\sigma_{ET}$ : reference stress for torsional buckling, in $N/mm^2$

$$= \frac{E}{I_{p-net}} \left( \frac{\varepsilon \, \pi^2 \, I_{\omega-net} 10^{-4}}{l_t^2} + 0.385 I_{T-net} \right)$$

~~for $I_{P-net}$, $I_{T-net}$, $I_{\omega-net}$ see **Fig. 10.3.1** and **Table 10.3.2**~~

$\sigma_{yd}$ : specified minimum yield stress of the material, in $N/mm^2$

$E$ : modulus of elasticity, 206 000 , in $N/mm^2$

$I_{P-net}$ : net polar moment of inertia of the stiffener about point C, in $cm^4$, as shown in **Fig. 10.3.1** and **Table 10.3.2**~~, in $cm^4$~~

$I_{T-net}$ : net St. Venant's moment of inertia of the stiffener, in $cm^4$, as shown in **Table 10.3.2**

$I_{\omega-net}$ : net sectorial moment of inertia of the stiffener about point C, in $cm^6$, as shown in **Fig. 10.3.1** and **Table 10.3.2**~~, in $cm^6$~~

| | |
|---|---|
| $\varepsilon$ | : degree of fixation |
| | $= 1 + 100 \sqrt{\dfrac{l_t^4}{I_{\omega-net}\left(\dfrac{s}{t_{net}^3} + \dfrac{4(e_f - 0.5t_{f-net})}{3t_{w-net}^3}\right)}}$ |
| | $= 1 + 1000 \sqrt{\dfrac{l_t^4}{\dfrac{3}{4}\pi^4 I_{\omega-net}\left(\dfrac{s}{t_{net}^3} + \dfrac{4(e_f - 0.5t_{f-net})}{3t_{w-net}^3}\right)}}$ |
| $l_t$ | : torsional buckling length to be taken equal the distance between tripping supports, in *m* |
| $d_w$ | : depth of web plate, in *mm* |
| $t_{w-net}$ | : net web thickness, in *mm* |
| $b_f$ | : flange breadth, in *mm* |
| $t_{f-net}$ | : net flange thickness, in *mm* |
| $e_f$ | : distance from connection to plate (C in **Fig. 10.3.1**) to centre of flange, in *mm*<br>$= (d_w - 0.5t_{f-net})$ for bulb flats<br>$= (d_w + 0.5t_{f-net})$ for angles and T bars |
| $A_{w-net}$ | : net web area, in $mm^2$<br>$= (e_f - 0.5t_{f-net})t_{w-net}$ |
| $A_{f-net}$ | : net flange area, in $mm^2$<br>$= b_f\, t_{f-net}$ |
| $s$ | : stiffener spacing as defined in **Section 4/2.2.1**, in *mm* |

## 3.5 Other Structures

### 3.5.1 Struts, pillars and cross ties

Paragraph 3.5.1.3 has been amended as follows.

3.5.1.3 The elastic compressive column buckling stress, $\sigma_E$, of pillars subject to axial compression is to be taken as:

$$\sigma_E = 0.001 E f_{end} \frac{I_{net50}}{A_{pill-net50} l_{pill}^2} \qquad (N/mm^2)$$

Where:

| | |
|---|---|
| $I_{net50}$ | : net moment of inertia about the weakest axis of the cross-section, in $cm^4$ |
| $A_{pill-net50}$ | : net cross-sectional area of the pillar, in $cm^2$ |
| $f_{end}$ | : end constraint factor<br>1.0 where both ends are pinned |

2.0 where one end is pinned and the other end is fixed
4.0 where both ends are fixed
A pillar end may be considered fixed when effective brackets are fitted. These brackets are to be supported by structural members with greater bending stiffness than the pillar.
Column buckling capacity for cross tie shall be calculated using $f_{end}$ equal to 2.0 and span as defined in **Section 8/2.6.8.1.**

$E$ : modulus of elasticity, 206 000, in $N/mm^2$

$l_{pill}$ : unsupported length of the pillar, in *m*

Paragraph 3.5.1.4 has been amended as follows.

3.5.1.4 The elastic torsional buckling stress, $\sigma_{ET}$, with respect to axial compression of pillars is to be taken as:

$$\sigma_{ET} = \frac{GI_{sv-net50}}{I_{pol-net50}} + \frac{0.001 f_{end} E c_{warp}}{I_{pot-net50} l_{pill}^{2}} \qquad (N/mm^2)$$

Where:

$G$ : shear modulus

$$= \frac{E}{2(1+\upsilon)}$$

$E$ : modulus of elasticity, 206 000, in $N/mm^2$

$v$ : Poisson's ratio, 0.3

$I_{sv-net50}$ : net St. Venants moment of inertia, in $cm^4$, see **Table 10.3.4**

$I_{pol-net50}$ : net polar moment of inertia about the shear centre of cross section, in $cm^4$

$$= I_{y-net50} + I_{z-net50} + A_{net50}\left(y_0^2 + z_0^2\right)$$

$f_{end}$ : end constraint factor
1.0 where both ends are pinned
2.0 where one end is pinned and the other end is fixed
4.0 where both ends are fixed
Elastic torsional buckling capacity for cross tie shall be calculated using $f_{end}$ equal to 2.0 and span as defined in **Section 8/2.6.8.1.**

$c_{warp}$ : warping constant, in $cm^6$, see **Table 10.3.4**

$l_{pill}$ : unsupported length of the pillar, in *m*

$y_0$ : position of shear centre relative to the cross-sectional centroid, in *cm*, see **Table 10.3.4**

$z_0$ : position of shear centre relative to the cross-sectional centroid, in *cm*, see **Table 10.3.4**

$A_{net50}$ : net cross-sectional area, in $cm^2$

$I_{y-net50}$ : net moment of inertia about y-axis, in $cm^4$

$I_{z-net50}$ : net moment of inertia about z-axis, in $cm^4$

# Appendix C FATIGUE STRENGTH ASSESSMENT

## 1. Nominal Stress Approach

### 1.4 Fatigue Damage Calculation

### 1.4.5 Selection of S-N curves

Paragraph 1.4.5.14 has been amended as follows.

1.4.5.14 The benefits of weld toe grinding should not be taken into consideration at the design stage. However, an exception may be made for the weld connection between the hopper plate and inner bottom if ~~the required design fatigue life can not be satisfied by means of practical design options such as increasing local thickness, extending weld leg length and modifying local geometry.~~ the calculated fatigue life is greater than one half of the design fatigue life or minimum 17 *years* excluding the grinding effects, whichever is greater. ~~The calculated fatigue life is to be greater than 17 *years* excluding grinding effects.~~ Where grinding is applied, full details of the grinding standard including the extent, smoothness particulars, final weld profile, and grinding workmanship and quality acceptance criteria are to be clearly shown on the applicable drawings and submitted for review together with supporting calculations indicating the proposed factor on the calculated fatigue life. Grinding is preferably to be carried out by rotary burr and to extend below the plate surface in order to remove toe defects and the ground area is to have effective corrosion protection. The treatment is to produce a smooth concave profile at the weld toe with the depth of the depression penetrating into the plate surface to at least 0.5*mm* below the bottom of any visible undercut. The depth of groove produced is to be kept to a minimum, and, in general, kept to a maximum of 1*mm*. In no circumstances is the grinding depth to exceed 2*mm* or 7% of the plate gross thickness, whichever is smaller. Grinding has to extend to areas well outside the highest stress region. Provided these recommendations are followed, an improvement in fatigue life up ~~to a maximum of 2 *times* may~~ to the design fatigue life will be granted.

## EFFECTIVE DATE AND APPLICATION (Amendment 1-2)

**1.** The effective date of the amendments is 1 July 2009.

**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.4)

**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.

Notes:
1. This Procedural Requirement applies to all IACS Members and Associates.
2. This Procedural Requirement is effective for ships "contracted for construction" on or after 1 January 2005.
3. Revision 2 of this Procedural Requirement is effective for ships "contracted for construction" on or after 1 April 2006.
4. Revision 3 of this Procedural Requirement was approved on 5 January 2007 with immediate effect.
5. Revision 4 of this Procedural Requirement was adopted on 21 June 2007 with immediate effect.