# RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

## Part C Hull Construction and Equipment

**Rules for the Survey and Construction of Steel Ships**

**Part C 2014 AMENDMENT NO.1**

**Guidance for the Survey and Construction of Steel Ships**

**Part C 2014 AMENDMENT NO.1**

Rule No.9 / Notice No.10 26th February 2014

Resolved by Technical Committee on 4th February 2013 / 29th July 2013

Approved by Board of Directors on 4th March 2013 / 24th September 2013

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# RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

## Part C Hull Construction and Equipment

**2014 AMENDMENT NO.1**

Rule No.9 26th February 2014
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Rule No.9 26th February 2014
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 C HULL CONSTRUCTION AND EQUIPMENT

## Chapter 30 ORE CARRIERS

Section 30.1 has been amended as follows.

### 30.1 ~~Construction and Equipment~~General

#### 30.1.1 Application

**1** The construction and equipment of ships intended to be registered and classed as "ore carriers" are to be in accordance with the requirements in this Chapter or equivalent thereto.
**2** Items not covered in this Chapter are to be in accordance with the general requirements for the construction and equipment of steel ships.
**3** The requirements in this Chapter are for ships~~ not greater than 230 *m* in length~~ of usual form, having a single deck, machinery aft, two rows of longitudinal watertight bulkheads, and having double bottoms under ore holds and decks and bottoms with longitudinal framing.
**4** Where the construction of the ship differs from that specified in **-3** above~~ or the length of the ship exceeds 230 *m*~~ and the requirements in this chapter are considered to be not applicable, matters are to be determined as deemed appropriate by the Society.
**5** The ships specified in **-1** above are to be in accordance with the relevant requirements in **Chapter 31A**.

#### ~~30.1.2 Subdivision~~

~~(omitted)~~

#### 30.1.~~3~~2 Direct Calculations

Where approved by the Society, the scantlings of structural members may be determined based upon direct calculation. Where the scantlings determined by direct calculation exceed the required scantlings in this Chapter, the former is to be adopted.

#### ~~30.1.4 Double Bottoms~~

~~(omitted)~~

#### ~~30.1.5 Construction and Scantlings of Wing Tanks or Void Spaces~~

~~(omitted)~~

#### ~~30.1.6 Transverse Bulkheads in Ore Holds~~

~~(omitted)~~

#### ~~30.1.7 Relative Deformation of Wing Tanks~~

~~(omitted)~~

~~**30.1.8 Drainage of Ore Holds**~~
~~(omitted)~~

~~**30.1.9 Ore/Oil Carriers**~~
~~(omitted)~~

~~**30.1.10 Slop Tanks in Ore/Oil Carriers**~~
~~(omitted)~~

Section 30.2 has been added as follows.

## 30.2 Double Bottoms

### 30.2.1 General

**1** The specific gravity $\gamma$ of cargoes described in this Chapter is as defined by the following formula:

$$\gamma = \frac{W}{V}$$

$W$: Mass ($t$) of cargoes for the hold
$V$: Volume ($m^3$) of the hold excluding its hatchway

**2** The height of double bottoms is to be determined in such a manner that the centre of gravity of the ship is sufficiently high in full load condition. However, the height is not to be less than $h$ ($m$) as specified in **6.1.1-1**.

**3** Floor plates or bottom transverses are to be arranged at the positions of bulkheads or transverses in wing tanks or void spaces.

**4** Where double bottoms are intended to be deep tanks, the scantlings of members in double bottoms are to be in accordance with the relevant requirements in **30.3**, in addition to those of this Section. Bottom shell plating is to be in accordance with **30.3.1**, **30.3.2-1** and **-5**. Inner bottom plating is to be in accordance with **30.3.1** and **30.3.2-1**. Bottom longitudinals are to be in accordance with **30.3.3-1**, **-3**, **-4**, **-6** and **-8**. Inner bottom longitudinals are to be in accordance with **30.3.3-4**, **-6** and **-8**. Girders are to be in accordance with **30.3.1**. However, when obtaining the value of coefficient $C_2$ in **30.3.2-1**, "longitudinal bulkhead plating" is to be construed as "bottom shell plating" or "inner bottom plating".

### 30.2.2 Inner Bottom Plating

**1** The thickness $t$ of inner bottom plating is not to be less than the greater of the values obtained from the following formulae:

$$t = \frac{CK}{1000} \cdot \frac{B^2 d}{d_0} + 2.5 \quad (mm)$$

$$t = C'S\sqrt{Kh} + 2.5 \quad (mm)$$

$K$: Coefficient corresponding to the kind of steel
*e.g.* 1.0 for mild steel, the values specified in **1.1.7-2(1)** for high tensile steel
$d_0$: Height ($m$) of double bottoms at the centreline
$S$: Spacing ($m$) of inner bottom longitudinals
$h$: Vertical distance ($m$) from the top of the inner bottom plating to the upper deck at the

centreline

$C$: Coefficient given by the following formula:

$C = ab$

$a$: As given by the following formulae according to the value of $\frac{h\gamma}{d}$:

When $\frac{h\gamma}{d} < 1 - \frac{d_{min}}{d}$: $1 + 0.026\frac{L'}{d} - \frac{h\gamma}{d}$

When $1 - \frac{d_{min}}{d} \le \frac{h\gamma}{d} \le 1 + \frac{d_{min}}{d}$: $\frac{d_{min} + 0.026L'}{d}$

When $1 + \frac{d_{min}}{d} < \frac{h\gamma}{d}$: $\frac{h\gamma}{d} - 1 + 0.026\frac{L'}{d}$

$\gamma$: As specified in **30.2.1-1**

$d_{min}$: Minimum draft amidship ($m$) under all operating conditions, including conditions covering ballast water exchanges of the ship

$L'$: Length ($m$) of ship
However, where $L$ exceeds 230 $m$, $L'$ is to be taken as 230 $m$.

$b$: $b_0$ or $\alpha b_1$ given below according to the value of $\frac{B}{l_H}$:

When $\frac{B}{l_H} < 0.8$: $b_0$

When $0.8 \le \frac{B}{l_H} < 1.2$: $b_0$ or $\alpha b_1$, whichever is greater

When $1.2 \le \frac{B}{l_H}$: $\alpha b_1$

$b_0$ and $b_1$: As given in **Table C30.1** according to the value of $\frac{B}{l_H}$

$l_H$: Length ($m$) of hold
Where stools are provided at transverse bulkheads, $l_H$ may be taken as the distance between the toes.

$\alpha$: As given by the following formula:

$$\alpha = \frac{13.8}{24 - 11 f_B K}$$

$f_B$: Ratio of the section modulus of the transverse section of the hull on the basis of mild steel in accordance with the requirements in **Chapter 15** to the actual section modulus of the transverse section of the hull at the bottom

$C'$: Coefficient given by the following formulae according to the value of $\frac{l}{S}$:

When $1 \le \frac{l}{S} < 3.5$: $\left(0.46\frac{l}{S} + 2.64\right)\sqrt{\gamma}$

When $3.5 \le \frac{l}{S}$ : $4.25\sqrt{\gamma}$

*l*: Distance (*m*) between floors

Table C30.1 Coefficients $b_0$ and $b_1$

| $B/l_H$ | and over | | 0.6 | 0.8 | | 1.0 | | 1.2 | 1.4 | 2.0 | 2.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | less than | 0.6 | 0.8 | 1.0 | | 1.2 | | 1.4 | 2.0 | 2.2 | |
| $b_0$ or $b_1$ | | $b_0$ | $b_0$ | $b_0$ | $b_1$ | $b_0$ | $b_1$ | $b_1$ | $b_1$ | $b_1$ | $b_1$ |
| | | 2.0 | 1.9 | 1.5 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.1 | 1.0 |

**2** In ships whose cargoes are regularly handled by grabs or similar mechanical appliances, the thickness of inner bottom plating is not to be less than the value obtained from the requirements in **-1** above plus 2.5 *mm*. In addition, where double bottom are intended to be deep tanks, the thickness of inner bottom plating is not to be less than the greater of the values obtained from the requirements in **-1** above or **30.2.1-4** plus 2.5 *mm*.

**30.2.3 Longitudinals**

**1** The section modulus *Z* of bottom longitudinals is not to be less than the value obtained from the following formula:

$$Z = 100 C_1 C_2 S h l^2 \ (cm^3)$$

*S*: Spacing (*m*) of bottom longitudinals

*l*: Distance (*m*) between floors

*h*: Distance (*m*) from the longitudinals under consideration to the following point above the top of the keel

$$h = d + 0.026L'$$

*L'*: As specified in **30.2.2-1**

$C_1$: Coefficient given below according to the value of *L*:

When *L* is 230 *m* and below: $C_1 = 1.0$

When *L* is 400 *m* and over: $C_1 = 1.07$

For intermediate values of *L*, $C_1$ is to be obtained by linear interpolation.

$C_2$: Coefficient given by the following formula:

$$C_2 = \frac{K}{24 - 15.5 f_B K}$$

*K* and $f_B$ : As specified in **30.2.2-1**

**2** The section modulus *Z* of inner bottom longitudinals is not to be less than the value obtained from the following formula. However, the section modulus of inner bottom longitudinals is not to be less than 0.75 *times* that of the bottom longitudinals at the same location.

$$Z = 100 C_1 C_2 S h l^2 \ (cm^3)$$

*S*: Spacing (*m*) of inner bottom longitudinals

*l*: Distance (*m*) between floors

*h*: As specified in **30.2.2-1**

$C_1$: Value of $\gamma$ specified in **30.2.1-1**

However values of $C_1$ are not to be less than 0.9.

$C_2$: Coefficient given by the following formula:

$$C_2 = \frac{K}{24 - 12 f_B K}$$

$K$ and $f_B$: As specified in **30.2.2-1**

**3** Buckling strength of longitudinals is to be in accordance with the following **(1)** and **(2)**. The Society may request detailed assessments if deemed necessary according to the materials, scantlings, geometries and arrangement of these structural members.

(1) As for flat bars used for longitudinals, the ratio of depth to thickness is not to exceed 15.

(2) The full width $b$ of face plates of longitudinals is not to be less than the value obtained from the following formula:

$$b = 69.6\sqrt{d_0 l} \quad (mm)$$

$d_0$: Depth ($m$) of web of longitudinal

$l$: Spacing ($m$) of girders

### 30.2.4 Girders

The arrangements and the scantlings of girders in double bottoms are to be determined by direct calculations.

Section 30.3 has been added as follows.

## 30.3 Wing Tanks or Void Spaces

### 30.3.1 Minimum Thickness

**1** The thickness of structural members in deep tanks such as bulkhead plating, floors, girders including struts, and their end brackets is not to be less than the value determined from **Table C30.2** according to the length of ship.

**2** The thickness of structural members in deep tanks is not to be less than 7.0 *mm*.

Table C30.2 Minimum Thickness

| $L$ ($m$) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $L$ ($m$) | and over | | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 225 | 275 | 325 | 375 |
| | less than | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 225 | 275 | 325 | 375 | |
| Thickness ($mm$) | | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 | 10.5 | 11.0 | 11.5 | 12.0 | 12.5 | 13.0 | 13.5 |

### 30.3.2 Bulkhead Plating

**1** The thickness $t$ of bulkhead plating in deep tanks is not to be less than the greatest of the values obtained from the following formula when $h$ is substituted with $h_1$, $h_2$ and $h_3$. However, the thickness of plating with only one side in contact with sea water may be 0.5 *mm* less than the greatest of the values obtained from the following formula:

$$t = C_1 C_2 S \sqrt{h} + 3.5 \quad (mm)$$

$S$: Spacing ($m$) of stiffeners

$h$: $h_1$, $h_2$ and $h_3$ ($m$) as specified below

$h_1$: Vertical distance from the lower edge of the bulkhead plating under consideration to the mid-point between a point on the tank top and the upper end of the overflow pipe
For shell plating, a water head corresponding to the minimum draught amidship $d_{min}$ ($m$)

under all operating conditions, including conditions covering ballast water exchanges of the ship may be deducted therefrom. The deductible water head at the top of the keel is to be $d_{min}$, the value at point $d_{min}$ above the top of the keel is to be 0, and the value at an intermediate point is to be obtained by linear interpolation.

$h_2$: As given by the following formula:

$$h_2 = 0.85(h_1 + \Delta h)$$

Where

$\Delta h$: Additional water head given by the following formula:

$$\Delta h = \frac{16}{L}(l_t - 10) + 0.25(b_t - 10) \quad (m)$$

$l_t$: Tank length ($m$); to be 10, when less than 10 $m$

$b_t$: Tank breadth ($m$); to be 10, when less than 10 $m$

$h_3$: Value obtained from multiplying 0.7 by the vertical distance from the lower edge of the bulkhead plating under consideration to a point 2.0 $m$ above the top of overflow pipe

$C_1$: As specified in **30.2.3-1**

$C_2$: $3.6\sqrt{K}$

However, $C_2$ for $h_1$ is to be obtained by the following formulae according to the type of bulkhead and stiffening system. In determining the thickness of longitudinal bulkhead plating, coefficient $C_2$ for $h_1$ may be gradually reduced for parts forward and afterward of the midship part, and it may be taken as $3.6\sqrt{K}$ in calculations at the end parts of the ship.

In the case of longitudinal bulkhead plating of a longitudinal system:

$$C_2 = 13.4\sqrt{\frac{K}{27.7 - \alpha K}}$$

However, values of $C_2$ are not to be less than $3.6\sqrt{K}$.

In the case of longitudinal bulkhead plating of a transverse system:

$$C_2 = 100\sqrt{\frac{K}{767 - \alpha^2 K^2}}$$

In the case of transverse bulkhead plating:

$$C_2 = 3.6\sqrt{K}$$

Where

$K$: As specified in **30.2.2-1**

$\alpha$: Either $\alpha_1$ or $\alpha_2$ according to the value of $z$

However, values of $\alpha$ are not to be less than $\alpha_3$

When $z > z_B$: $\alpha_1 = 15.5 f_D \dfrac{z - z_B}{z_0}$

When $z \le z_B$: $\alpha_2 = 15.5 f_B \left(1 - \dfrac{z}{z_B}\right)$

$$\alpha_3 = \beta\left(1 - \frac{2b}{B}\right)$$

$f_D$: Ratio of the section modulus of the transverse section of the hull on the basis of mild steel in accordance with the requirements in **Chapter 15** to the actual section modulus of the transverse section of the hull at the strength deck

$f_B$: As specified in **30.2.2-1**

$z$: Vertical distance ($m$) from the top of the keel to the lower edge of the bulkhead plating under consideration

$z_B$: Vertical distance ($m$) from top of the keel amidship to the horizontal neutral axis of the transverse section of the hull

$z_0$: Greater of the values specified in **15.2.3(5)(a)** or **(b)**

$\beta$: Coefficient given by the following formulae:

When $L$ is 230 $m$ and below: $\beta = \frac{6}{a}$

When $L$ is 400 $m$ and over: $\beta = \frac{10.5}{a}$

For intermediate values of $L$, $\beta$ is to be obtained by linear interpolation.

$a$: $\sqrt{K}$ when high tensile steels are used for not less than 80% of the side shell plating at the transverse section amidships, and 1.0 for other cases

$b$: Horizontal distance ($m$) from the side shell plating to the outer end of the bulkhead plating under consideration

**2** The thickness $t$ of longitudinal bulkhead plating is to be in accordance with the requirements in **Chapter 13**, and is not to be less than the value obtained from the following formula. The thickness of longitudinal bulkhead plating forming deep tanks is also to be in accordance with the requirements in **-1** above.

$t = CS\sqrt{Kh} + 2.5$ ($mm$)

$S$: Length ($m$) of the shorter side of the panel enclosed by stiffeners, etc.

$h$: Vertical distance ($m$) from the lower end of the panel under consideration to the upper deck at center line

$K$: As specified in **30.2.2-1**

$C$: Coefficient given by the following formula:
However, it is not to be less than 3.2.

$C = 4.25ab\sqrt{\gamma}$

$a$: As given by the following formulae:

When $1 \le \frac{l}{S} < 3.5$: $0.615 + 0.11\frac{l}{S}$

When $3.5 \le \frac{l}{S}$: 1.0

$l$: Length ($m$) of the longer side of the panel enclosed by stiffeners, etc.

$b$: As given by the following formulae:

When $\beta \le 40°$: 1.0

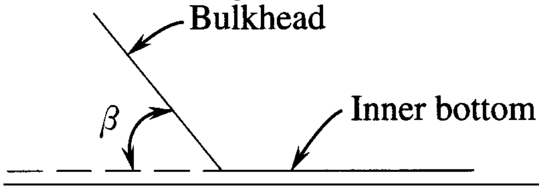
When $40° < \beta \le 80°$: $1.4 - 0.01\beta$

When $80° \le \beta$: 0.6

$\beta$: Angle of inclination (*degrees*) of the bulkhead plating under consideration to the horizontal plane (*See* **Fig. C30.1**)

$\gamma$: As specified in **30.2.1-1**

Fig. C30.1




**3** In ships whose cargoes are regularly handled by grabs or similar mechanical appliances, the thickness of the longitudinal bulkhead plating is not to be less than the value obtained from the requirements in **-2** above plus the following values. The extent of application of this requirement is to be as deemed appropriate by the Society.

Longitudinal bulkhead plating under hatchway: 2.5 *mm*

Longitudinal bulkhead plating other than the above: 1.0 *mm*

**4** The thickness of longitudinal bulkhead plating is to be in accordance with the requirements in **15.3.2** and **15.3.3** as well as **15.4**.

**5** The thickness of shell and deck plating forming deep tanks, which are taken as bulkhead plating in deep tanks, is to be in accordance with the requirements in **Chapter 16** and **Chapter 17** respectively, and is not to be less than the value obtained from the requirements in **-1** above, which may be reduced by 0.5 *mm*.

**6** The thickness of tank top plating in deep tanks is not to be less than the value obtained from the requirements in **-1** above plus 1.0 *mm*.

### 30.3.3 Longitudinals and Stiffeners

**1** The section modulus *Z* of bottom longitudinals is not to be less than the value obtained from the requirements in **30.2.3-1**.

**2** The section modulus *Z* of side longitudinals including bilge longitudinals is not to be less than the value obtained from the following formula:

$$Z = 100 C_1 C_2 S h l^2 \quad (cm^3)$$

*S*: Spacing (*m*) of side longitudinals

*l*: Spacing (*m*) of girders

*h*: Distance (*m*) from the longitudinal under consideration to the following point above the top of the keel

$$h = d + 0.038L'$$

$L'$: As specified in **30.2.2-1**

$C_1$: As specified in **30.2.3-1**

$C_2$: Coefficient given by the following formula:

$$C_2 = \frac{K}{24 - \alpha K}$$

*K*: As specified in **30.2.2-1**

$\alpha$ : $\alpha_1$ or $\alpha_2$ as given below, whichever is greater

$$\alpha_1 = 15.5 f_B \left(1 - \frac{z}{z_B}\right)$$

$f_B$ : As specified in **30.2.2-1**

*z*: Vertical distance (*m*) from the top of the keel to the longitudinal under consideration

$z_B$: As specified in **30.3.2-1**

$\alpha_2$: Coefficient given by the following formulae according to the value of *L*:

When *L* is 230 *m* and below: $\alpha_2 = \frac{6}{a}$

When *L* is 400 *m* and over: $\alpha_2 = \frac{10.5}{a}$

For intermediate values of *L*, $\alpha_2$ is to be obtained by linear interpolation.

*a*: $\sqrt{K}$ when high tensile steels are used for not less than 80% of the side shell plating at the transverse section amidships, and 1.0 for other cases

However, the section modulus *Z* does not need to exceed that of bottom longitudinals specified in **-1** above, but is not to be less than the value obtained from the following formula:

$Z = 2.9K\sqrt{L}Sl^2$ $(cm^3)$

**3** For side longitudinals, bottom longitudinals and longitudinal stiffeners attached to longitudinal bulkheads in deep tanks, sufficient consideration is to be taken against fatigue strength.

**4** For parts forward and afterward of the midship part, the scantlings of bottom longitudinals and side longitudinals may be gradually reduced and at the end parts they may be reduced by 15% of the values obtained from the requirements in **-1** and **-2** above respectively. However, the scantlings of bottom longitudinals and side longitudinals are not to be less than those required in **-1** and **-2** above respectively under any circumstances for parts between the point 0.15*L* from the fore end and the collision bulkhead.

**5** The section modulus *Z* of stiffeners attached to longitudinal bulkheads is to be in accordance with the requirements in **Chapter 13**, and is to be as specified in the following **(1)** and **(2)**:

(1) The section modulus *Z* of longitudinal stiffeners is not to be less than the value obtained from the following formula:

$Z = C_1 C_2 Shl^2$ $(cm^3)$

*S*: Spacing (*m*) of longitudinal stiffeners

*h*: Vertical distance (*m*) from the stiffener under consideration to the upper deck at the centreline

*l*: Length (*m*) of longitudinal stiffener between transverse webs

$C_1$: Coefficient given in **Table C30.3** according to the values of $\beta$ specified in **30.3.2-2** and $\gamma$ specified in **30.2.1-1**

$C_2$: Coefficient given by the following formula:

$C_2 = \frac{K}{24 - \alpha K}$

*K*: As specified in **30.2.2-1**

$\alpha$: Either $\alpha_1$ or $\alpha_2$ according to the value of *z*

When $z > z_B$: $\alpha_1 = 15.5 f_D \frac{z - z_B}{z_0}$

When $z \le z_B$: $\alpha_2 = 15.5 f_B \left(1 - \frac{z}{z_B}\right)$

$f_B$: As specified in **30.2.2-1**

$z$: As specified in **30.3.3-2**

$z_B$, $z_0$ and $f_D$: As specified in **30.3.2-1**

Table C30.3 Coefficient $C_1$

| Angle $\beta$ | $C_1$ |
|---|---|
| $\beta \le 40^\circ$ | $130\gamma$ |
| $40 < \beta < 80^\circ$ | $(214 - 2.1\beta)\gamma$ |
| $\beta \ge 80^\circ$ | $46\gamma$ |

(2) The section modulus $Z$ of transverse stiffeners is not to be less than the value obtained from the following formula:

$$Z = CKShl^2 \ (cm^3)$$

$S$: Spacing ($m$) of transverse stiffeners

$h$: Vertical distance ($m$) from the mid-point of $l$ to the upper deck at the centreline

$l$: Distance ($m$) between the supports of stiffeners

$K$: As specified in **30.2.2-1**

$C$: Coefficient given in **Table C30.4** according to the values of $\beta$ specified in **30.3.2-2** and $\gamma$ specified in **30.2.1-1**

Table C30.4 Coefficient $C$

| Angle $\beta$ | $C$ |
|---|---|
| $\beta \le 40^\circ$ | $7.8\gamma$ |
| $40 < \beta < 80^\circ$ | $(12.8 - 0.125\beta)\gamma$ |
| $\beta \ge 80^\circ$ | $2.8\gamma$ |

**6** The section modulus $Z$ of stiffeners attached to bulkhead plating in deep tanks is not to be less than the value obtained from the following formula:

$$Z = 125C_1C_2C_3Shl^2 \ (cm^3)$$

$S$: Spacing ($m$) of stiffeners

$h$: As specified in **30.3.2-1**

Where "the lower edge of the bulkhead plating under consideration" is to be construed as "the mid-point of the stiffener under consideration" for vertical stiffeners; and as "the stiffener under consideration" for horizontal stiffeners; and "shell plating" is to be construed as "stiffener attached to shell plating".

$l$: Spacing ($m$) of girders

$C_1$: As specified in **30.2.3-1**

$C_2$: $\dfrac{K}{18}$

However, $C_2$ for $h_1$ is to be in accordance with the following:

The values of $C_2$ for $h_1$ are to be as obtained from the following formula according to the stiffening system. In determining the section modulus of stiffeners attached to bulkhead plating, coefficient $C_2$ for $h_1$ may be gradually reduced for parts forward and afterward of the midship part, and it may be taken as $\frac{K}{18}$ in calculations at the end parts of the ship.

In the case of a longitudinal system: $C_2 = \frac{K}{24 - \alpha K}$

However, the value of $C_2$ is not to be less than $\frac{K}{18}$.

In the case of a transverse system or transverse bulkheads: $C_2 = \frac{K}{18}$

$K$: As specified in **30.2.2-1**

$\alpha$: As specified in **30.3.2-1**

However, "the lower edge of the bulkhead plating under consideration" and "the bulkhead plating under consideration" are to be construed as "the stiffener under consideration" in applying the requirements for $z$ and $b$.

$C_3$: As given in **Table C30.5** according to the fixity condition of the stiffener ends

Table C30.5 Value of $C_3$

| The other end | One end | | | |
|---|---|---|---|---|
| | Rigid fixity by bracket | Soft fixity by bracket | Supported by girders or lug-connection | Snip |
| Rigid fixity by bracket | 0.70 | 1.15 | 0.85 | 1.30 |
| Soft fixity by bracket | 1.15 | 0.85 | 1.30 | 1.15 |
| Supported by girders or lug-connection | 0.85 | 1.30 | 1.00 | 1.50 |
| Snip | 1.30 | 1.15 | 1.50 | 1.50 |

Notes:
1. "Rigid fixity by bracket" means the fixity in the connection between the double bottom plating or comparable stiffeners within adjoining planes and brackets, or equivalent fixity (*see* **Fig. C13.1(a)**).
2. "Soft fixity by bracket" means the fixity in the connection between beams, frames, etc., which are crossing members, and brackets (*see* **Fig. C13.1(b)**).

**7** Buckling strength of longitudinal frames, beams and stiffeners is to be in accordance with the following requirements **(1)** to **(3)**. The Society may request detailed assessments if deemed necessary according to the materials, scantlings, geometries and arrangement of these structural members.

(1) Longitudinal beams, side longitudinals attached to sheer strakes and longitudinal stiffeners attached to the longitudinal bulkhead within 0.1$D$ from the strength deck are to have a slenderness ratio not exceeding 60 at the midship part as far as practicable.

(2) As for flat bars used for longitudinal beams, frames and stiffeners, the ratio of depth to thickness is not to exceed 15.

(3) The full width $b$ of face plates of longitudinal beams, frames and stiffeners is not to be less than the value obtained from the following formula:

$b = 69.6\sqrt{d_0 l}$ ($mm$)

$d_0$: Depth ($m$) of web of longitudinal beam, frame or stiffener

$l$: Spacing ($m$) of girders

**8** Where assembled members, special shape steels or flanged plates are used as frames, beams or stiffeners in deep tanks whose scantlings are specified only in terms of the section modulus, the thickness *t* of the web is not to be less than the value obtained from the following formula. However, where the stiffeners have the sufficient strength for buckling or the depth of the web is intended to be greater than the required level due to reasons other than strength, it may be suitably modified.

$t = 15K_0 d_0 + 3.5$ (*mm*)

$d_0$: Depth (*m*) of web

$K_0$: As given by the following formulae:

$K_0 = \sqrt{\frac{1}{4}\left(3f_B + \frac{1}{K}\right)}$ for bottom longitudinals located not more than 0.25*D* above the top of the keel

$K_0 = \sqrt{\frac{1}{4}\left(3f_D + \frac{1}{K}\right)}$ for deck longitudinals located not more than 0.25*D* below deck

$K_0 = \sqrt{\frac{1}{4}\left(3 + \frac{1}{K}\right)}$ for other structural members

*K* and $f_B$: As specified in **30.2.2-1**

$f_D$: As specified in **30.3.2-1**

**9** The section modulus of longitudinal beams is not to be less than the value obtained from the requirements in **10.3.3**. The section modulus of bottom longitudinals, side longitudinals and longitudinal beams in deep tanks is not to be less than the value obtained from the requirements in **-6** above.

**30.3.4 Girders**

**1** The arrangements and scantlings of girders in wing tanks or void spaces are to be determined by direct calculations.

**2** Notwithstanding the requirements in **-1** above, the scantlings of girders in wing tanks or void spaces may be determined in accordance with the requirements in the following **-3** to **-10** for ships with *L* less than 230 *m*.

**3** The construction and scantlings of transverses, girders, webs and cross ties are to be in accordance with the requirements in the following **(1)** to **(5)**. The construction and scantlings of transverses, girders, webs and cross ties in deep tanks are also to be in accordance with the requirements in **Chapter 14**.

(1) The thickness of transverses, girders, webs and cross ties are not to be less than the value given in **Table C30.2** according to the length of the ship.

(2) Girders and transverses in the same plane are to be so arranged that abrupt changes in strength and rigidity are avoided; they are to have brackets of sufficient scantlings and with properly rounded corners at their ends.

(3) The depth of girders and transverses is not to be less than 2.5 *times* that of slots for frames, beams and stiffeners.

(4) For the face plates composing girders, the thickness is not to be less than that of web plates and the full width *b* is not to be less than the value obtained from the following formula:

$b = 85.4\sqrt{d_0 l}$

$d_0$: Depth (*m*) of girder
Where the girder is a balanced girder, $d_0$ is the depth (*m*) from the surface of the plate to the face plate.

*l*: Distance (*m*) between supports of girders

Where effective tripping brackets are provided, they may be taken as supports.

(5) Transverses are to be effectively stiffened according to the following **(a)** to **(c)**:

(a) The depth of flat bar stiffeners provided on transverses is not to be less than $0.08d_0$. However, where the stiffeners range throughout the full depth of the transverse, $d_0$ is to be taken as the depth of transverse, and where the stiffeners are fitted in parallel with face plates, $d_0$ is to be taken as the spacing of the tripping brackets. The depth and thickness of the flat bar stiffeners which support longitudinals penetrating transverses are to be as required in **1.1.14-3**.

(b) Tripping brackets are to be provided on the web of transverses at the inner edge of end brackets and at the intersectional part with cross ties, etc. and also at the proper intervals in order to support transverses effectively. Where the breadth of the face plate exceeds 180 *mm* on either side of the web plate, these brackets are to be so arranged as to support the face plate as well.

(c) Lower brackets of side transverses and transverses on longitudinal bulkheads and web plates in the vicinity of the edge of the brackets are to be provided with closely-spaced stiffeners.

**4** The scantlings of side transverses are to be in accordance with the requirements in the following **(1)** to **(5)**:

(1) The following definitions are used in this **-4**.

$$Q = Shl_0$$

$h$: Distance (*m*) from the mid-point of $l_0$ to the point $H_2$ above the top of the keel

$h_s$: Distance (*m*) from the mid-point of $b_s$ to the point $H_2$ above the top of the keel

$$H_2 = d + 0.038L \ (m)$$

$l_0$: Overall length (*m*) of side transverses, which is equal to the distance between the inner surfaces of face plates of bottom transverses and deck transverses (*See* **Fig. C30.2**)

$S$: Spacing (*m*) of transverses

$S_1$: Spacing (*m*) of stiffeners provided depthwise on the web plates of transverses at the portion where cross ties are connected

$K$: As specified in **30.2.2-1**

$k$: Correction factor for brackets as given by the following formula:

$$k = 1 - \frac{0.65(b_1 + b_2)}{l_0}$$

$b_1$ and $b_2$: Arm length (*m*) of brackets, at respective ends of transverses

$b$: Arm length (*m*) of lowest bracket

The upper end of the bracket is to be the intersection of the tangent of the free edge of the bracket that makes an angle of 45 *degrees* to the baseline, and the extension of the line of the inner edge of the side transverse. (*See* **Fig. C30.2**)

$b_s$: Width (*m*) of the area supported by cross ties (*See* **Fig. C30.2**)

$d'_0$: Depth (*m*) of side transverses at the inner edge of the lowest bracket (*See* **Fig. C30.2**)

$a$: Depth (*m*) of slot in the vicinity of inner edge of the lowest bracket. Where the slots are provided with collar plates, $a$ may be taken as zero.

$A$: Sectional area ($cm^2$) effective to support the axial force from cross tie, which is to be taken as the following **(a)** to **(c)**:

(a) Where the face plates of cross ties are continuous to the face plates of transverses and form an arc (or a similar curve), $A$ is the total sum of the sectional area of the web plate of the transverse and the stiffeners provided in the axial direction of the cross tie on the web plate between two points, and 0.5 *times* the sectional area of the face plates at these points. Each point is located on its respective arc where the tangent makes an angle of 45 *degrees* to the axial direction of the cross tie (*See* **Fig. C30.3(a)**).

(b) Where the face plates of cross ties are continuous to the face plates of transverses and form a straight line with rounded corners, $A$ is the total sum of the sectional area of the web plate of the transverse and the stiffeners provided in the axial direction of the cross tie on the web plate between two points, and 0.5 *times* the sectional area of the face plates at these points. Each point is located at the midpoint between the intersections of the line that makes an angle of 45 *degrees* to the axial direction of the cross tie and touches the inner surface plate, and the extensions of the lines of the face plates of the cross tie and transverse (*See* **Fig. C30.3(b)**).

(c) Where the face plates of cross ties are joined directly to the face plates of transverses at (or nearly at) right angles with brackets, and stiffeners are provided on the web plate of the transverse on the extensions of the lines of the face plates of the cross tie, $A$ is the total sum of the sectional area of the web plate of the transverse between two points, and the sectional area of the stiffeners mentioned above. Each point is located at the midpoint between the intersections of the line that makes an angle of 45 *degrees* to the axial direction of the cross tie and touches the free edge line of the bracket, and the face plates of the cross tie and transverse (*See* **Fig. C30.3(c)**).

$C_0$, $C_1$ and $C_2$: Coefficients given in **Table C30.6** according to the number of cross ties respectively

(2) The depth ($m$) of side transverses is not to be less than $C_0 l_0$ at the mid-point of $l_0$. Where transverses are tapered, the reduction in depth at the upper end is not to exceed 10% of the depth at the mid-point of $l_0$, and the rate of increase in depth at the lower end is not to be less than that of the reduction at the upper end.

(3) The web thickness $t$ of side transverses at the inner edge of brackets at the lower ends is not to be less than the value obtained from the following formula:

$$t = \frac{C_1 - 148\frac{b}{l_0}}{1000} \cdot \frac{QK}{d_0' - a} + 3.5 \quad (mm)$$

(4) The web thickness $t$ of side transverses at the portion where cross ties are connected is not to be less than the value obtained from the following formula. Where slots are provided in the web at the portion where cross ties are connected, the slots are to be effectively covered with collar plates.

$$t = 16 S_1 \sqrt{\frac{S b_s h_s}{A}} \quad (mm)$$

(5) The section modulus $Z$ of side transverses at the span is not to be less than the value obtained from the following formula:

$$Z = C_2 k^2 K Q l_0 \quad (cm^3)$$

**5** The scantlings of transverses on longitudinal bulkheads are not to be less than the values obtained from the requirements in **-4(2)** to **(5)** above correspondingly. For transverses without cross ties, $h$ is to be the distance from the mid-point of $l_0$ to the top of the cargo hatch.

**6** The scantlings of bottom transverses are to be in accordance with the requirements in the following **(1)** to **(3)**:

(1) The rigidity of bottom transverses is to be well balanced with that of side transverses.

(2) The section modulus $Z$ of bottom transverses at the span is not to be less than the value

obtained from the following formula:

$Z = 9.3k^2 KSh_1 l_1^2$ $(cm^3)$

$k$ and $S$: As specified in **-4(1)** above

However, $l_0$ is to be construed as $l_1$ in applying the value of $k$.

$K$: As specified in **30.2.2-1**

$h_1$: As given by the following formula:

$h_1 = d + 0.026L$

$l_1$: Overall length of bottom transverses ($m$), which is equal to the distance between the inner surface of face plates of bottom transverses and that of transverses on longitudinal bulkheads.

(3) The section modulus $Z$ of bottom transverses at the bilge and at the lower end of longitudinal bulkheads is not to be less than the value obtained from the following formula. In calculating the section modulus, the neutral axis of the section is to be taken as located at the middle of the depth $d_b$ (*See* **Fig. C30.2**) of the transverse.

$Z = C'_2 KQl_0$ $(cm^3)$

$Q$ and $l_0$: As specified in **-4(1)** above

$K$: As specified in **30.2.2-1**

$C'_2$: Coefficient given in **Table C30.6** according to the number of cross ties

**7** The scantlings of deck transverses are to be in accordance with the requirements in the following **(1)** and **(2)**:

(1) The rigidity of deck transverses is to be well balanced with that of side transverses.

(2) The section modulus $Z$ of deck transverses at the span is not to be less than the value obtained from the following formula:

$Z = 3k^2 KS\sqrt{L} l_2^2$ $(cm^3)$

$k$ and $S$: As specified in **-4(1)** above

However, $l_0$ is to be construed as $l_2$ in applying the value of $k$.

$K$: As specified in **30.2.2-1**

$l_2$: Overall length ($m$) of deck transverses, which is equal to the distance between the inner surface of face plates of side transverses and that of transverses on longitudinal bulkheads

Table C30.6 Coefficients $C_0$, $C_1$, $C_2$ and $C'_2$

| Number of cross tie | $C_0$ | $C_1$ | $C_2$ | $C'_2$ |
|---|---|---|---|---|
| 0 | 0.150 | 55.7 | 5.07 | 7.14 |
| 1 | 0.110 | 44.8 | 2.70 | 4.42 |
| 2 | 0.100 | 39.4 | 2.28 | 3.74 |
| 3 | 0.095 | 36.2 | 2.12 | 3.49 |

Fig. C30.2 Measurement of $l_0$, $d'_0$, $b$ and $b_s$, etc.

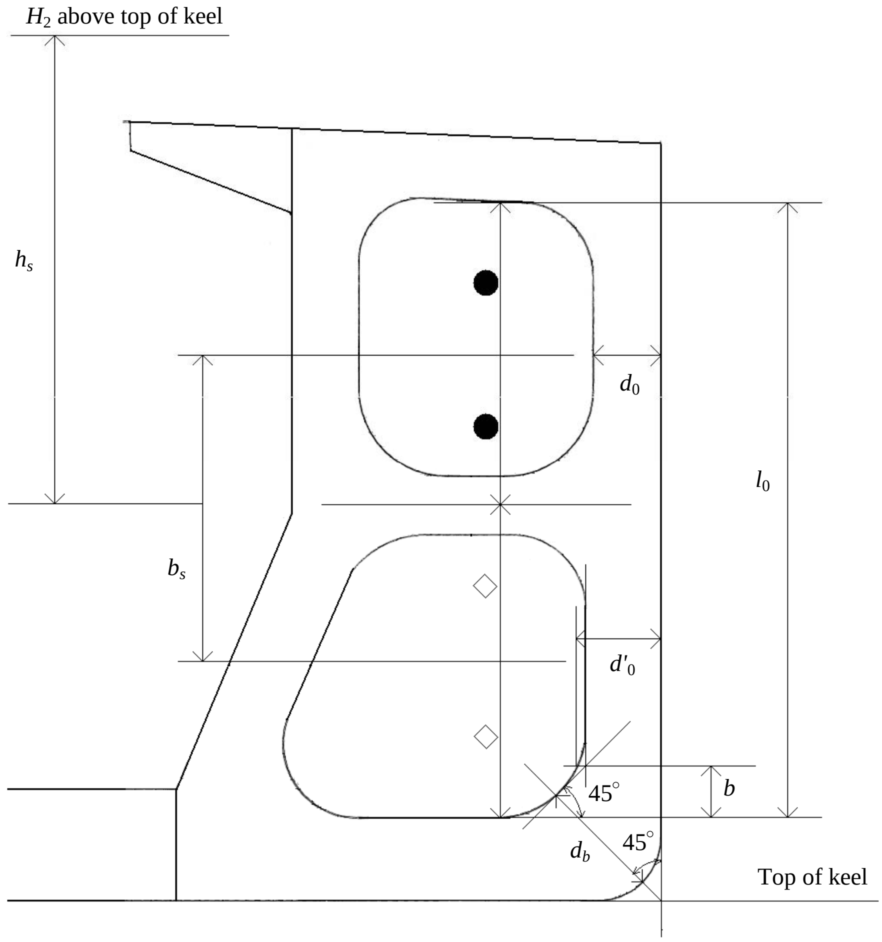
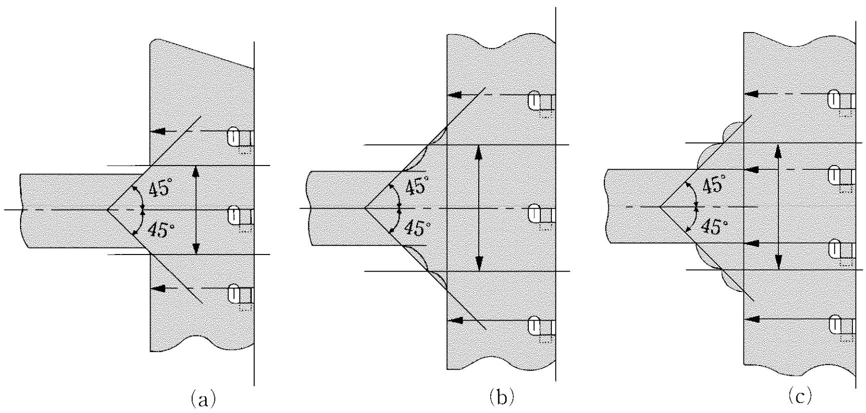



Fig. C30.3 Extent for Total Sectional Area




**8** The web thickness $t$ of transverses is not to be less than the value obtained from the following formula:

$$t = \frac{C}{\sqrt{K}} d_0 + 3.5$$

$K$: As specified in **30.2.2-1**

$d_0$: Depth ($m$) of web plate (where stiffeners are parallel to the face plate on the mid part of web plates, $d_0$ is the distance ($m$) between the stiffener and the shell plating or the face plate or adjacent stiffener)

$C$: As given in **Table C30.7** according to the ratio of $S'$ (the spacing of stiffeners on web plates provided in a depthwise direction) to $d_0$. For intermediate values of $S'/d_0$, $C$ is to be obtained by interpolation. Where the webs of girders situated higher than $D/3$ above the top of the keel or the lower edge of the face plate at the lower side of the second cross tie from the deck, whichever is the lower, $C$ may be as given in **Table C30.7** multiplied by 0.85, subject to the requirements in the following **(a)** and **(b)**:

(1) Where no stiffener is provided in parallel with the face plates: $\alpha_1$

However, where there are slots, $\alpha_2$ is to be used and is not to be less than the value obtained by applying the requirements in **(a)**

(2) Where stiffeners are provided in parallel with the face plates, for the panel between the face plate and the stiffener or between the stiffeners: $\alpha_3$

However, the thickness need not exceed the value obtained by using coefficient $\alpha_1$, assuming no slots or stiffeners parallel with the face plate are provided.

For the panel between the stiffener and the shell plating: $\alpha_2$

(a) Where slots are provided on webs with no reinforcement, $\alpha_1$, $\alpha_2$ and $\alpha_3$ are to be multiplied by the following factor:

$$\sqrt{4.0\frac{d_1}{S'}-1.0}$$

$d_1$: Depth ($m$) of slots

Where $d_1/S'$ is 0.5 or less, the multiplier is to be taken as 1.0.

(b) Where openings are provided on webs with no reinforcement, $\alpha_1$, $\alpha_2$ and $\alpha_3$ are to be multiplied by the following factor:

$$1+0.5\frac{\phi}{a}$$

$a$: Length ($m$) at the longer side of the panel surrounded by web stiffeners

$\phi$: Diameter ($m$) of openings

Where openings are oblong, $\phi$ is to be the length ($m$) of the longer diameter.

Table C30.7 $\alpha_1$, $\alpha_2$ and $\alpha_3$

| $S'/d_0$ | 0.2 and under | 0.4 | 0.6 | 0.8 | 1.0 | 1.5 | 2.0 | 2.5 and over |
|---|---|---|---|---|---|---|---|---|
| $\alpha_1$ | 2.6 | 4.5 | 5.6 | 6.4 | 7.1 | 7.8 | 8.2 | 8.4 |
| $\alpha_2$ | 2.1 | 3.7 | 4.9 | 5.8 | 6.6 | 7.4 | 7.8 | 8.0 |
| $\alpha_3$ | 3.7 | 6.7 | 8.6 | 9.6 | 9.9 | 10.3 | 10.4 | 10.4 |

**9** Where side transverses and transverses on longitudinal bulkheads in wing tanks are connected with cross ties, the construction of cross ties are to be as required in the following **(1)** and **(2)**:

(1) Brackets are to be provided at the ends of cross ties to connect cross ties with transverses.

(2) Where the breadth of face plates forming cross ties exceeds 150 $mm$ on one side of the web,

stiffeners are to be provided at proper intervals to support the face plates as well.

**10** Where side transverses and transverses on longitudinal bulkheads in wing tanks are connected with cross ties, the sectional area $A$ of cross ties is not to be less than the value obtained from the following formula:

$A = CKSb_s h_s$ ($cm^2$)

$S$, $b_s$ and $h_s$: As specified in **-4(1)** above

$K$: As specified in **30.2.2-1**

$C$: Coefficient given by the following formulae:

When $\frac{l}{k} > 0.6$: $C = \frac{0.77}{1 - 0.5\frac{l}{k\sqrt{K}}}$

When $\frac{l}{k} < 0.6$: $C = 1.1$

$l$: Length ($m$) of cross ties measured between the inner edges of the side transverses and the vertical webs on longitudinal bulkheads

$k$: As given by the following formula:

$k = \sqrt{\frac{I}{A}}$

$I$: The least moment of inertia ($cm^4$) of cross ties

$A$: Sectional area ($cm^2$) of cross ties

Section 30.4 has been added as follows.

## 30.4 Transverse Bulkheads and Stools in Ore Holds

### 30.4.1 Transverse Bulkheads in Ore Holds

**1** The scantlings of structural members of transverse bulkheads are to be in accordance with the requirements in **14.2**. In application of these requirements, $h$ in the formulae is to be substituted by $0.36\gamma h'$, where $\gamma$ is as specified in **30.2.1-1**. However, where $\gamma$ is less than 1.5, $\gamma$ is to be taken as 1.5. $h'$ is to be in accordance with the following **(1)** to **(3)**:

(1) For bulkhead plating, the vertical distance ($m$) from the lower edge of the bulkhead plate to the upper deck at the centreline of the ship

(2) For vertical stiffeners on the bulkhead, the vertical distance ($m$) from the mid-point of $l$ to the upper deck at the centreline of the ship

For horizontal stiffeners on the bulkhead, the vertical distance ($m$) from the mid-point of the stiffeners to the upper deck at the centreline of the ship

$l$: As specified in **14.2.3**

(3) For vertical webs supporting stiffeners, the vertical distance ($m$) from the mid-point of $l$ to the upper deck at the centreline of the ship

For horizontal girders supporting stiffeners the vertical distance ($m$) from the mid-point of $S$ to the upper deck at the centreline of the ship

$l$ and $S$: As specified in **14.2.5**

**2** The scantlings of structural members of transverse bulkheads are not to be less than the values obtained from the requirements in **Chapter 13**. In addition, the thickness of the transverse bulkhead plating is not to be less than 7.0 *mm*.

**3** For transverse bulkheads without lower stools, the thickness of the lowest strake of bulkhead plating is to be appropriately increased according to the thickness of the inner bottom plating.

**30.4.2 Lower and Upper Stools at Transverse Bulkheads in Ore Holds**

**1** The thickness of the side plating of the lower stool of the transverse bulkhead is not to be less than the value obtained from the formula in **30.3.2-2** using the value of coefficient *C* reduced by 10%.

**2** In ships whose cargoes are regularly handled by grabs or similar mechanical appliances, the thickness of the side plating of the lower stool of the transverse bulkhead is not to be less than the value obtained from **-1** above plus 1.0 *mm*. The extent of application of this requirement is to be as deemed appropriate by the Society.

**3** The section modulus of horizontal stiffeners provided on the side plating of the lower stool is not to be less than the value obtained from the formula in **30.3.5-5(1)**, where the coefficient, $C_2$, is to be reduced by 10%. Where vertical stiffeners are provided, the section modulus is not to be less than the value obtained from the formula in **30.3.3-5(2)**.

**4** Partial girders, etc. are partially to be arranged beneath the girders in the lower stool of the transverse bulkhead.

**5** The scantlings of structural members of the upper and lower stools of the transverse bulkhead are not to be less than the values obtained from the requirements in **Chapter 13**.

Section 30.5 has been added as follows.

## 30.5 Relative Deformation of Wing Tanks

### 30.5.1 Relative Deformation of Wing Tanks

Where the value obtained from the following formula exceeds 0.18, special consideration is to be given to the structure of the wing tanks, except where the scantlings of members are determined by direct calculations.

$$\frac{\frac{2h-0.65d}{n_b K_b + n_s \eta_s K_s + n_t \eta_t K_t} \cdot \frac{a}{b}}{l}$$

*h*: Vertical distance (*m*) between the top of the inner bottom plating and the upper deck at the centreline of the ship

*l*: Length (*m*) of one ore hold

*a*: Half-breadth (*m*) of cargo hold

*b*: Breadth (*m*) of wing tank

$n_b$, $n_s$ and $n_t$: Numbers of transverse bulkheads, swash bulkheads and transverse rings in wing tanks located within *l*, respectively
The bulkheads at the fore and after ends of *l* are to be counted as 1/2, respectively.

$\eta_s$ and $\eta_t$: Values given in **Table C30.8** in accordance with the opening ratio of swash bulkheads or transverse rings
For intermediate values of the opening ratio, $\eta_s$ and $\eta_t$ are to be obtained by interpolation.

$K_b$, $K_s$ and $K_t$: Values given by the following formula:

$$81.0\frac{Dt}{\alpha b}$$

$t$: Mean thickness ($mm$) of transverse bulkhead plating in wing tanks in obtaining $K_b$ value
Mean thickness ($mm$) of swash bulkhead plating in wing tanks in obtaining $K_s$ value
Mean thickness ($mm$) of transverse rings in wing tanks in obtaining $K_t$ value

$\alpha$: Value given by the following formulae, where transverse bulkheads or swash bulkheads in wing tanks are of corrugated form, in accordance with whether the corrugation is vertical or horizontal

For vertical corrugation:

$$\frac{l_{ath}}{b}$$

$l_{ath}$: Girth length ($m$) of bulkheads in athwartship direction

For horizontal corrugation:

$$\frac{l_{dep}}{D}$$

$l_{dep}$: Girth length ($m$) of bulkheads in depthwise direction

For cases other than the above, $\alpha$ is to be 1.0

Table C30.8 Coefficients $\eta_s$ and $\eta_t$

| Opening ratio % | 0 | 5 | 10 | 20 | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|---|---|---|---|
| $\eta_s$, $\eta_t$ | 1.00 | 0.95 | 0.80 | 0.55 | 0.35 | 0.23 | 0.15 | 0.10 | 0.06 |

Section 30.6 has been added as follows.

## 30.6 Decks and Miscellaneous

### 30.6.1 Decks, etc.

For deck plating inside the line of openings, special consideration is to be taken against buckling.

### 30.6.2 Drainage of Ore Holds

**1** In general, one bilge suction opening is to be arranged on each side of the ship at the after end of the ore hold. Where the length of the ore hold in ships having only one hold exceeds 66 $m$, an additional bilge suction opening is to be arranged in a suitable position in the forward half-length of the hold.

**2** Bilge wells are to be arranged at suitable positions so as to protect cover plates from direct contact with the ore. They are to be provided with strum boxes or other suitable means so that the suction openings are not choked by ore dust or other particles.

**3** Where bilge pipes are led through double bottoms, side tanks or void spaces, non-return valves or stop valves capable of being closed from a readily accessible position are to be provided at their open ends.

**4** Bilge suction branch pipes may be of an inside diameter obtained from the formula in **13.5.3-1, Part D**, substituting the mean breadth of the ore hold for *B*.

Section 30.7 has been added as follows.

## 30.7 Ore/Oil Carriers

### 30.7.1 General

**1** Ore carriers that are intended to carry oils in the cargo spaces (hereinafter referred to as "ore/oil carriers") are to comply with the relevant requirements for tankers, in addition to those in this Chapter.

**2** In addition to the requirements in this Chapter, special requirements for ore/oil carriers may be specified as deemed necessary by the Society.

### 30.7.2 Slop Tanks

**1** Cofferdams are to be provided around slop tanks in accordance with the requirements in **29.1.2-2**. In addition, cofferdams are to be provided between slop tanks and ore holds, except where the slop tanks are cleaned and gas-freed at any time prior to loading ore cargoes.

**2** The cofferdams specified in **-1** above are to be capable of being flooded, except where the cofferdams are used concurrently as pump rooms, fuel oil tanks or water ballast tanks, or cargo oil tanks (in case of cofferdams between slop tanks and ore holds only).

**3** Adequate ventilation devices are to be provided for the spaces surrounding slop tanks.

**4** Notice boards are to be erected at suitable points detailing the precautions to be observed prior to loading or unloading, or whilst carrying ore cargo with oily water in the slop tanks.

**5** It is recommended to provide an inert gas system for the slop tanks.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 26 August 2014.
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.

# GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

## Part C Hull Construction and Equipment

GUIDANCE

**2014 AMENDMENT NO.1**

Notice No.10 26th February 2014

Resolved by Technical Committee on 4th February 2013 / 29th July 2013

Notice No.10 26th February 2014
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

# Part C HULL CONSTRUCTION AND EQUIPMENT

Amendment 1-1

## C25 CEMENTING AND PAINTING

### C25.2 Painting

#### C25.2.1 General

Sub-paragraph -1 has been amended as follows.

**1** Limitation of Using Aluminium Paint

Paints containing aluminium greater than 10 percent aluminium by weight in the dry film are not to be used in hazardous areas defined in **4.2.3-1** or **4.2.3-2, Part H** of the Rules in tankers and ships carrying dangerous chemicals in bulk intended to carry crude oil and petroleum products having a flashpoint not exceeding $60^{\circ}C$ and a Reid vapour pressure below atmospheric pressure or other liquid cargoes having similar fire hazards.

#### C25.2.3 Corrosion Protection for Cargo Oil Tanks

Sub-paragraph -3 has been amended as follows.

**3** With respect to **25.2.3(2), Part C of the Rules**, ~~the relevant~~ IACS Unified Interpretation SC258 as amended is to be applied.

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

**1.** The effective date of the amendments is 26 February 2014.

Amendment 1-2

# C35 MEANS OF ACCESS

## C35.2 Special Requirements for Oil Tankers and Bulk Carriers

### C35.2.5 Specifications for Means of Access and Ladders

Sub-paragraph -9 has been deleted, and Sub-paragraphs -10 to -12 have been renumbered to Sub-paragraphs -9 to -11.

(-1 to -8 are omitted)

~~**9** In the application of **35.2.5-5** and **-6**, **Part C of the Rules**, for access through vertical and horizontal openings within spaces, where the opening of the dimensions required in **35.2.5-5** and **-6**, **Part C of the Rules** cannot be provided, smaller dimension openings may be accepted provided that it is demonstrated that an injured person can be removed from the space and such openings are approved by the Society.~~

~~10~~**9** (omitted)

~~11~~**10** (omitted)

~~12~~**11** (omitted)

EFFECTIVE DATE AND APPLICATION (Amendment 1-2)

**1.** The effective date of the amendments is 26 February 2014.

**2.** Notwithstanding the amendments to the Guidance, the current requirements may apply to ships for which the date of contract for construction* is before the effective date.

* "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

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

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

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

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

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

Note:
This Procedural Requirement applies from 1 July 2009.

Amendment 1-3

# C1 GENERAL

## C1.1 General

### C1.1.23 Structural Details

Sub-paragraph -1 has been amended as follows.

**1** In applying the requirements in **1.1.23-4**, **Part C** of the Rules, fatigue strength assessment of longitudinals in the midship part for tankers, ore carriers, bulk carriers and container carriers is to be in accordance with the following items **(1)** to **(3)**.

(1) For ships not less than 150 *m* in length $L_1$, the fatigue strength assessment of longitudinals that do not penetrate structural members which constrain athwartship or vertical displacements of longitudinals (such as transverse bulkheads, swash bulkheads or floors) is to be carried out in accordance with the **Annex C1.1.23-1** "**GUIDANCE FOR THE FATIGUE STRENGTH ASSESSMENT OF LONGITUDINALS**." $L_1$ is the ship length specified in **15.2.1-1. Part C** of the Rules.

(2) Fatigue strength assessment of longitudinals that penetrate structural members which constrain athwartship or vertical displacements of longitudinals (such as transverse bulkheads, swash bulkheads or floors) is to be in accordance with the following **(a)** and **(b)**.

  (a) For ships not less than 150 *m* in length $L_1$, the fatigue assessment may be dispensed with where the scantlings of the longitudinals comply with the requirements in **(1)** above and soft brackets with sufficient fatigue strength are arranged on both sides of the structural members (bulkheads, etc.).

  (b) For ships that have or are intended to have the class notation "PS-FA" appended to the classification characters, the fatigue assessment is to be carried out on the structural members penetrated by the longitudinals in accordance with **Annex C1.1.23-1** "**GUIDANCE FOR THE FATIGUE STRENGTH ASSESSMENT OF LONGITUDINALS**."

(3) A fatigue strength assessment of longitudinals other than those at the midship part is to be carried out where deemed necessary by the Society.

# C30 ORE CARRIERS

Section C30.1 has been amended as follows.

## C30.1 ~~Construction and Equipment~~General

### ~~C30.1.1 Application~~

~~(omitted)~~

### C30.1.~~3~~2 Direct Calculations

The direct calculations for determination of structural scantlings of ore carriers are to comply with the following conditions~~,~~ **(1)**~~, **(2)** and **(3)**~~ to **(4)**:~~.~~

(1) Structural members to be calculated

The direct calculations can be applied for determining the scantlings of the following members ~~forming transverse rings~~:

Bottom transverses, deck transverses, side transverses, vertical webs on longitudinal bulkhead, struts, floors, inner bottoms, bottom shell plating~~, and~~ cross decks and girders

(2) Loads, boundary conditions, and supporting condition and modelling of structure

Assumed loads, structural models, boundary conditions and supporting condition for the calculation are to be as follows:

(a) Loads

The loads are to be as shown in the Load column in **Table C30.1.~~3~~2-1**. Among these, the hydraulic test condition **(b)**, the oil loading condition and the ballasted condition **(a)** apply to ore/oil carriers only.

(b) The procedure of structural modelling is to be as follows:

i) Range of analysis

The range of structure to be analyzed is one side of the adjacent cargo hold (or tank) in the parallel part of the hull, including the whole length or half length of each cargo hold (or tank) and transverse bulkhead between these cargo holds (or tanks). However, this range is to be determined considering the loading patterns of cargo and ballast, and longitudinal and transverse symmetries of the bulkheads and girders attached thereto.

ii) Structural modelling

The following standards **1)** to **3)** apply to divisions in meshing for structural modelling. An example of meshing is shown in **Fig. C30.1.~~3~~2-1**.

1) In meshing, proper sizes of meshes are to be selected by predicting the stress distribution in the model, and meshes with abnormally large aspect ratios are to be avoided.

2) Girders and similar members having stress gradients along their depth are to be so meshed as to enable their discrimination.

3) The length of the short side of each mesh is to be restricted to longitudinal spacing or thereabouts.

(c) Boundary condition and supporting condition of structural modelling

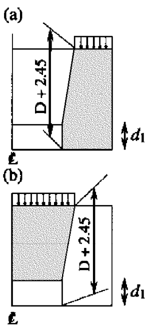
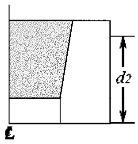
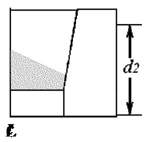
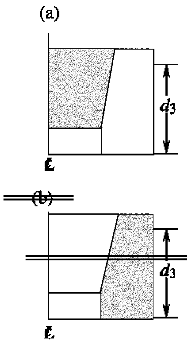
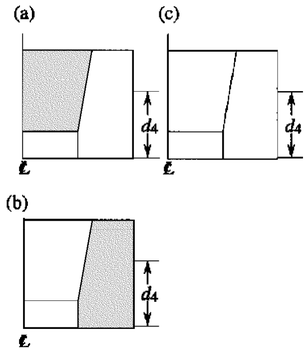
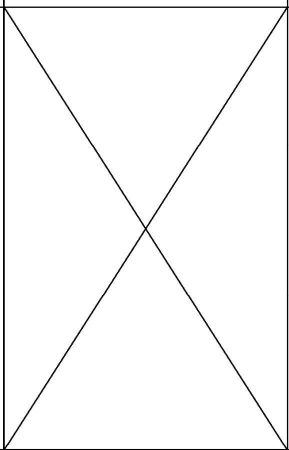
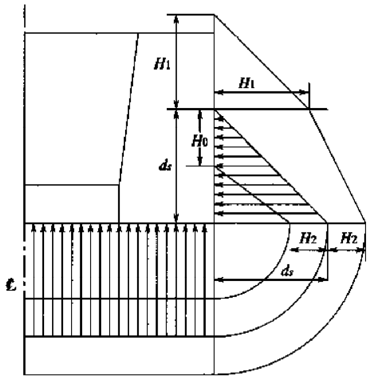
The boundary condition and supporting condition are to allow the effective reproduction of the behaviour of the structural model in accordance with the range of structural modelling.

(3) Permissible stress

The standard values of permissible stress obtained by the direct calculations using the initial scantlings of members including corrosion margins are shown in **Table C30.1.~~3~~2-2**.

(4) For cargo spaces, direct calculations for a range of analysis other than that specified in **(2)(b)i)** above are to be as deemed appropriate by the Society.

Table C30.1.~~3~~2-1

| | | Hydraulic test | Ore loading | Oil loading | Ballasted |
|---|---|---|---|---|---|
| Load | In still water |  $d_1$ = 1/3 × Designed maximum load draught | (a) In case the density of ore is light  (b) In case the density of ore is heavy  $d_2$=Designed maximum load draught |  $d_3$ = Designed maximum load draught |  $d_4$ = Ballasted draught |
| | In waves |  |  $d_s$; Draught in still water; $H_w$; $0.61L^{1/2}$ ....... $L \leqq 150\,m$; $1.41L^{1/3}$ ... $150\,m < L \leqq 250\,m$; $2.23L^{1/4}$ ... $250\,m < L \leqq 300\,m$; $9.28\,m$ ... $300\,m < L$; $H_0 = \frac{H_w}{2}$; $H_1 = h_1 \times H_0$; $H_2 = h_2 \times H_0$; $h_1 = 1.8$; $h_2 = 0.5$. $H_0$, $H_1$ and $H_2$ are to be added to or subtracted from $d_s$ as shown in the above figure. | | |
| Range of strength calcul. | | All transverses | In the range where load (a) to (c) are present | | |

Notes:

1. The density, loading height and angle of repose under ore loading, oil loading and ballasted conditions are to be selected in reference to the loading manual. The angle of repose is to be taken at ~~30~~35° unless specified otherwise.
2. The ballasted draught is to be the mean of the draughts at A.P. and F.P.
3. When the density of cargoes is not specified (e.g. in the loading manual), it is to be taken as 3.0 $t/m^3$ and the apparent density of cargoes as *W/V*.
   *W* : Maximum mass of cargoes for the hold (*t*)
   *V* : Volume of the hold excluding its hatchway ($m^3$)

Table C30.1.~~3~~2-2 Allowable Stress for Modelling by using Shell Elements

| | Structural members considered | | $\sigma_l$ | $\sigma_t$ | $\sigma_a$ | $\sigma_e$ |
|---|---|---|---|---|---|---|
| Longitudinal strength members | Bottom shell plating<br>Inner bottom plating | | 145/*K* – 35*f'*<br>but,<br>max 125/*K* | 145/*K* | - | 145/*K* |
| | Girder | | - | - | - | 175/*K* |
| Transverse strength members | Bottom transverse,<br>Deck transverse,<br>Side transverse,<br>Longitudinal bulkhead transverse,<br>Cross tie | Face plate (Parallel part) | - | - | 175/*K* | - |
| | | Face plate (Corners) | - | - | 195/*K* | - |
| | | Web plate (Parallel part) | - | - | - | 175/*K* |
| | | Web plate (Corners) | - | - | - | 195/*K* |
| | Floor, Cross deck | | - | - | - | 175/*K* |

Notes:

1. Unit: *N/mm*$^2$
2. $\sigma_e$ : $\sqrt{(\sigma_l^2 - \sigma_l \cdot \sigma_t + \sigma_t^2 + 3\tau^2)}$ (for longitudinal strength members)

   : $\sqrt{(\sigma_x^2 - \sigma_x \cdot \sigma_y + \sigma_y^2 + 3\tau^2)}$ (for transverse strength members)

   $\sigma_l$ : Normal stress in lengthwise direction

   $\sigma_t$ : Normal stress in breadthwise direction

   $\tau$ : Shearing stress on the lengthwise face in the breadthwise-direction for longitudinal strength member
   Shearing stress in the *X*-*Y* plane for transverse strength member

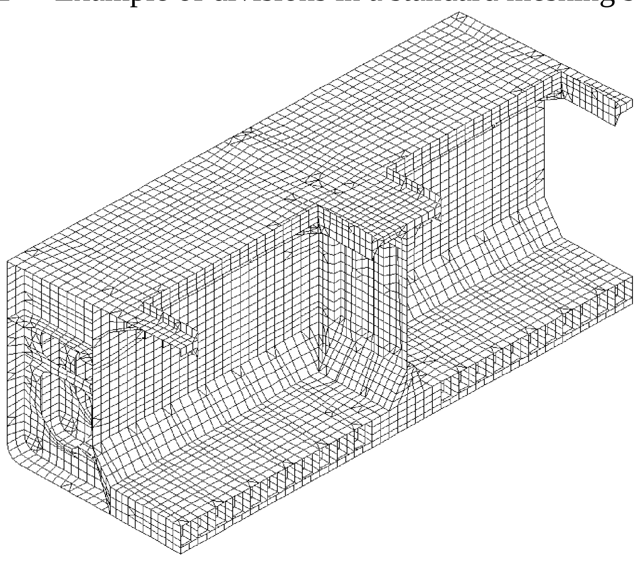
   $\sigma_x$ : Normal stress in *X* -direction of element coordinate system

   $\sigma_y$ : Normal stress in *Y* -direction of element coordinate system

   $\sigma_a$ : Normal stress of face plate
3. Openings in floors and girders, if any, are to be taken into consideration in evaluating the stresses.
4. The point of detecting stress is to be the centre of the element.
5. Value of *K* is to be as specified in **30.~~1.5-2(6)(a)~~2.2-1, Part C of the Rules**.
6. $f'$ : 0 at the position of the horizontal neutral axis of the cross sectional area of hull, $f_B$ on bottom shell plating. For intermediate values between 0 and $f_B$, $f'$ is to be determined by linear interpolation in accordance with the vertical distance from the baseline.

   $f_B$ : Ratio of section moduli of athwartship section on the basis of mild steel in accordance with the requirements of **Chapter 15** in **Part C** to actual section moduli of athwartship section concerning the strength bottom.

Fig. C30.1.~~3~~2-1 Example of divisions in a standard meshing structural model



~~**C30.1.4 Double Bottoms**~~

~~(omitted)~~

~~**C30.1.5 Construction and Scantlings of Wing Tanks or Void Spaces**~~

~~(omitted)~~

~~**C30.1.6 Transverse Bulkheads in Ore Holds**~~

~~(omitted)~~

~~**C30.1.7 Relative Deformation of Wing Tanks**~~

~~(omitted)~~

~~**C30.1.9 Ore/Oil Carriers**~~

~~(omitted)~~

Section C30.2 has been added as follows.

## C30.2 Double Bottoms

### C30.2.3 Longitudinals

The scantlings of inner bottom longitudinals are to comply with the requirements in **C31A.6.2-4**.

Section C30.3 has been added as follows.

## C30.3 Wing Tanks or Void Spaces

### C30.3.2 Bulkhead Plating

The extent of application "deemed appropriate by the Society" referred to in **30.3.2-3, Part C of the Rules** is generally to be up to a height of 3.0 *m* above the lowest point of the inner bottom excluding bilge wells.

### C30.3.3 Longitudinals and Stiffeners

The scantlings of longitudinal stiffeners attached to longitudinal bulkheads are to comply with the requirements in **C31A.6.2-4**.

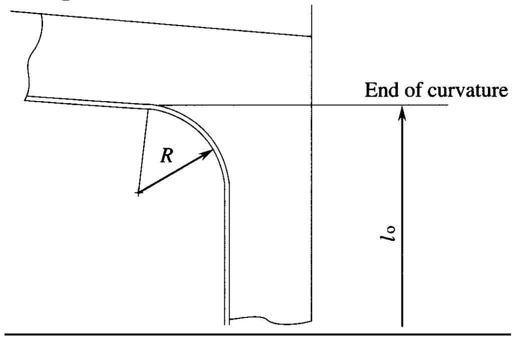
### C30.3.4 Girders

**1** In tanks and spaces other than water ballast tanks, the thickness of transverses and swash bulkheads may be reduced by 1.0 *mm*, except where the provisions of **30.3.1, Part C of the Rules**, are to be applied.

**2** Measurement of span $l$ ($l_0$, $l_1$ and $l_2$) of transverses in wing tanks and void spaces

Where the web under consideration and the adjacent web do not cross at a right angle to each other, $l$ is to be as specified in **Fig. C30.3.4-1**.

Fig. C30.3.4-1 Measurement of *l*




**3** The structural details of transverses and struts are to be in accordance with the following **(1)** to **(3)**:

(1) General

(a) The dimensions and locations of lightening holes, where provided, are to be as shown in **Fig. C30.3.4-2**.

(b) Slots are to be reinforced with collars where flanges of longitudinals are facing each other or where slots are provided at small intervals as is often the case with the bilge part.

(c) Where the depth of the girder is smaller than the required depth, the section modulus of the girder is to be decreased by the same ratio.

(d) In pump rooms or void spaces, the thickness of webs may be reduced by 1.0 *mm* from the required thickness of webs in deep tanks.

(e) The connection of web plates is to be of butt-welding or a type of connection deemed appropriate by the Society.

(f) Additional stiffeners are to be fitted at end bracket parts, connections with cross ties of transverses, and parts where shearing stress and/or compressive stress are expected to be high. These parts are not to have lightening holes. However, parts that are provided with adequate reinforcements (for example, horizontal girders are to be fitted at struts) in order to release stress do not need to be in accordance with these requirements. If considered necessary, slots for penetration of longitudinals in these parts are to be reinforced with collars. Sufficient consideration is to be taken for the continuity of strength at the connection between struts and longitudinals (for example, soft brackets are to be provided on the both sides of a transverse).

(g) No scallops are to be permitted in web plates at the connection of face plates on transverses and those of girder plates. Scallops cut out for work convenience are to be filled up by welding. Abrupt changes in dimensions are to be avoided. (*See* **Fig. C30.3.4-3**)

(h) The radius of the rounded corner of longitudinals and transverses is to be as large as practicable.

(i) Where angle bars are used instead of flat bars as stiffeners of transverses and girders, their moments of inertia with effective plates is to be approximately equivalent to the required ones.

(j) Where longitudinal frames or stiffeners penetrate bottom transverses, side transverses and vertical webs on the longitudinal bulkhead, proper reinforcement is to be made in the extents stipulated in **Table C30.3.4-1**, by fitting brackets on the opposite side of the stiffeners to secure the transverse to the longitudinals, by fitting collars on slots, or by other suitable means. In ships not exceeding 230 *m* in length, however, the extents of application of such reinforcement may be properly reduced. This reinforcement is to apply to slots under conditions similar to those in the above-mentioned girders or transverses (for example, slots in transverse swash bulkheads, etc.).

Fig. C30.3.4-2 Locations and Dimensions of Lightening Holes

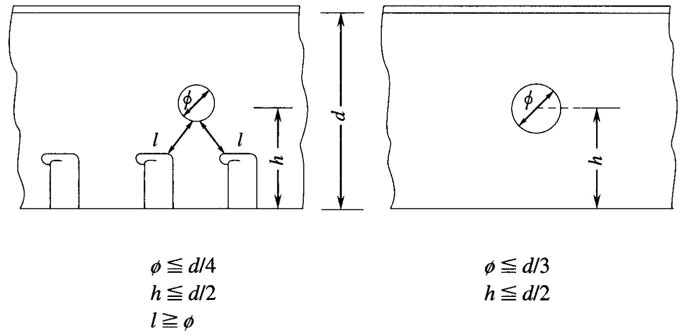



Fig. C30.3.4-3

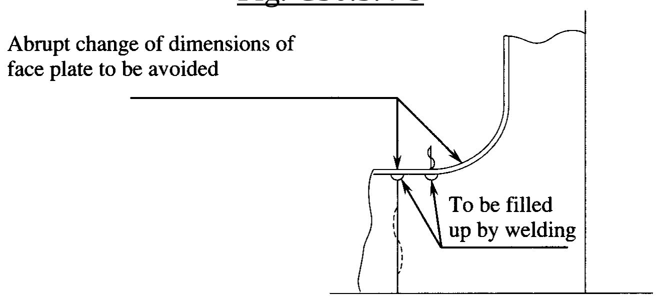


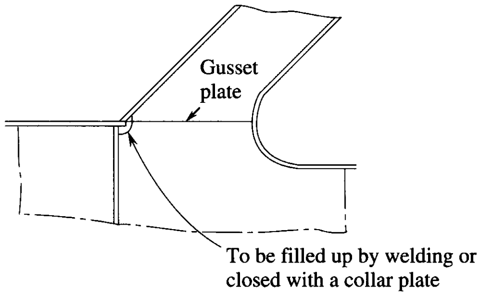

Table C30.3.4-1 Reinforcing Range

| Member | Reinforcing range |
|---|---|
| Bottom transverses | All connections |
| Side transverses | All connections below the upper end of curvature of upper cross tie, or the designed maximum load line, whichever is higher. In ships of not less than 300 *m* in length, it is recommended that similar reinforcement be applied upward beyond the limit stipulated above. |
| Transverses on longitudinal bulkhead | All connections below the upper end of curvature of upper cross tie. |

(2) The construction at the position of floors within the intersection of the inner bottom plating and longitudinal bulkhead is to comply with the following **(a)** and **(b)**:
 (a) Scallops at the above-mentioned intersections in transverses of wing tanks are to be filled up by welding or closed with collar plates. (*See* **Fig. C30.3.4-4**)
 (b) Transverses of wing tanks on the extended line of the inner bottom plating are to be fitted with gusset plates. (*See* **Fig. C30.3.4-4**)

(3) Where the construction at the intersection of the slant and vertical plates of longitudinal bulkhead forms a built up construction, scallops at the above-mentioned intersections in transverses of wing tanks are to be filled up by welding or closed with collar plates.

Fig. C30.3.4-4




Section C30.4 has been added as follows.

## C30.4 Transverse Bulkheads and Stools in Ore Holds

### C30.4.1 Transverse Bulkheads in Ore Holds

Where the vertical stiffeners are provided on transverse bulkheads (excluding corrugated bulkheads), the scantlings of the vertical stiffeners are to comply with the requirements in **C31A.6.2-4**.

### C30.4.2 Lower and Upper Stools at Transverse Bulkheads in Ore Holds

**1** The extent of application "deemed appropriate by the Society" referred to in **30.4.2-2, Part C of the Rules** is to be in accordance with the requirements in **C30.3.2**.

**2** Where the vertical stiffeners are provided on side plates of upper and lower stools at transverse bulkheads, the scantlings of the vertical stiffeners are to comply with the requirements in **C31A.6.2-4**.

Section C30.5 has been added as follows.

## C30.5 Relative Deformation of Wing Tanks

### C30.5.1 Relative Deformation of Wing Tanks

**1** Where the longitudinal bulkheads are inclined, $a$ and $b$ are to be such that the hatched parts are equal in area as shown in **Fig. C30.5.1-1**.

**2** What to do when the relative deformation exceeds limit values and how to measure the mean thickness of transverse bulkhead plating are given in the following **(1)** and **(2)**:

(1) Data demonstrating that the proposed construction has effectiveness equivalent to that required in the Rules is to be submitted.

(2) The mean thickness $t$ of plating used in the formulae in **C30.5.1, Part C of the Rules** is to be obtained from the following formula:

$$t = \frac{\sum l_i t_i}{\sum l_i} \quad (mm)$$

$l_i$ and $t_i$: To be taken as follows:

(a) For transverse bulkheads and perforated swash bulkheads:

The thickness and breadth of each strake of the bulkhead are to be taken at the middle of the breadth of the tank as shown in **Fig. C30.5.1-2**.

(b) For transverse rings and swash bulkheads of transverse ring type:
The thickness and vertical extent of the deck transverse, transverse on longitudinal bulkhead between the face plate of the deck transverse and the upper face plate of the uppermost strut, and other parts from the uppermost strut to the bottom transverse are to be taken at the middle of the breadth of the tank (at the bulkhead side if no plating is present at the middle of the breadth of the tank) as shown in **Fig. C30.5.1-3**.

Fig. C30.5.1-1

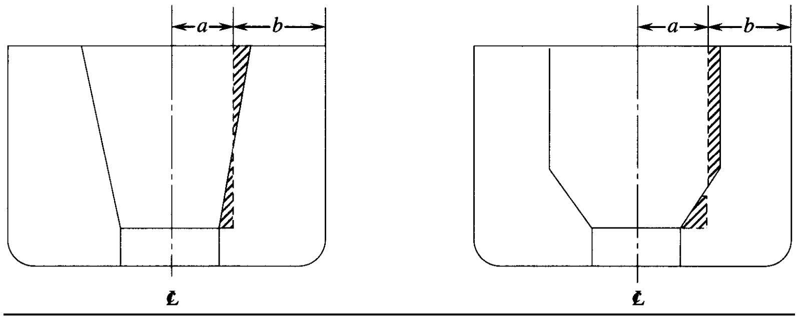



Fig. C30.5.1-2

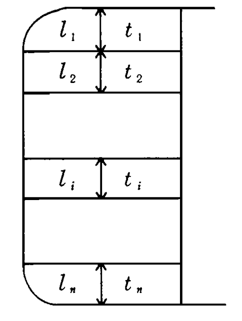
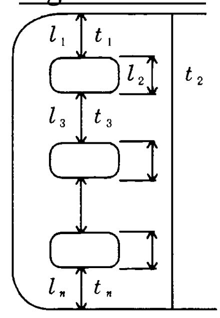



Fig. C30.5.1-3




Section C30.6 has been added as follows.

## C30.6 Decks and Miscellaneous

### C30.6.1 Decks, etc.

**1** The scantlings of deck plating inside the line of openings are to be determined by direct calculations using 1/2 + 1 + 1 + 1/2 hold models in accordance with the requirements in **C30.1.2**.

**2** Hatchways and coamings are to comply with the requirements in **C31A.6.2-1(2)**.

Section C30.7 has been added as follows.

## C30.7 Ore/Oil Carriers

### C30.7.1 General

**1** General

The construction, arrangement and equipment of ore/oil carriers are to be in accordance with the following **(1)** to **(6)** in addition to the requirements in **30.7.1-2, Part C of the Rules**.

(1) The piping arrangement is to comply with **14.5, Part D of the Rules**.

(2) The length of combined ore holds / cargo oil tanks is to comply with **C14.1.3-1**.

(3) No openings for cargo operations are to be provided in bulkheads and decks separating cargo oil tanks (including combined ore holds/cargo oil tanks) designed and equipped to carry oil having a flash point below 60°C (closed cup test) from other spaces that are not designed and equipped for its carriage.

(4) When the ship is operated as an ore carrier, all compartments except for slop tanks are to be gas-freed.

(5) Documents stipulating the details regarding cleaning and gas-freeing of cargo oil tanks (e.g. the equipment and required time) are to be submitted to the Society for reference.

(6) Precautions regarding the work that is required to convert ore/oil carriers from carrying ore to oil or vice versa are to be submitted to the owner and their copies submitted to the Society (including the precautions in relation to **14.5, Part D of the Rules** during the document approval phase.

**2** Construction of Pump Rooms

The bottom of the pump room of ore/oil carriers is to be constructed with particular care taken regarding the continuity of structural members.

(1) The longitudinal bulkheads in the hold space are to be extended aft as far as is practicable. Deep horizontal girders are to be provided on the longitudinal bulkheads at the level of the inner bottom in the hold space. The webs of these girders are to be of approximately the same thickness as the inner bottom.

(2) Centre girder

Height: same as double bottom in the hold space

Thickness: same as centre girder in the hold space

(3) Side girders

Number: 2 lines each side, if $b \leq 15\ m$

3 lines each side, if $b > 15\ m$

Thickness: same as centre girder

Height: not less than the height of the double bottom in the engine room

It is recommended that the side girders be as high as possible.

(4) Sectional area of face plates of girders

The total sectional area of face plates of girders (including total sectional areas of horizontal girders on longitudinal bulkheads, if any) is not to be less than 35% of the sectional area of the inner bottom in the hold space.

(5) Bottom longitudinals

The section modulus $Z$ of bottom longitudinals is to be 1.21 *times* the value obtained from the formula in **30.2.3-1, Part C of the Rules** and further, it is not to be less than the value obtained from the following formula:

$Z = 290dS$ $(cm^3)$

*d*: Draught (*m*)
*S*: Spacing (*m*) of longitudinals

(6) Omission of side girders

One of the side girders as per **(3)** above may be omitted, provided that the thickness of the bottom shell plating under the pump room is increased by 2.0 *mm* in excess of the required thickness (including tapering).

(7) If high tensile steel is used for strength deck plating over the pump room, the sectional area of the deck in this part is to be suitably increased in excess of the required area.

## Annex C1.1.7-1 GUIDANCE FOR HULL CONSTRUCTION CONTAINING HIGH TENSILE STEEL MEMBERS

### 1.2 Structural Members

#### 1.2.1 General

Sub-paragraph -1(2) has been amended as follows.

(2) Where scantlings of structural members are determined by direct calculation methods according to the prescriptions in **29.6.2**, **30.1.~~3~~2** or **31.1.5, Part C** of the Rules, the standard permissible stresses in members of high tensile steel are the values determined in accordance with the **C29.6.2, C30.1.~~3~~2** and **C31.1.5**. Further, the structures are to be subjected to examinations on strength against buckling under the load conditions prescribed in the Guidance.

## Annex C1.1.22-1 GUIDANCE FOR DIRECT CALCULATIONS

### 1.2 Design Loads

#### 1.2.1 General

Sub-paragraph -1(5) has been amended as follows.

(5) The loads for oil tankers, ore carriers and bulk carriers are to be in accordance with the requirements specified in **C29.6.2**, **C30.1.~~3~~2** and **C31.1.5** of the Guidance respectively, in addition to those found here in **1.2**. When deemed necessary by the Society, other loading conditions described in the Loading Manual are also to be considered.

### 1.3 Structural Models

#### 1.3.1 General

Sub-paragraph -1(5) has been amended as follows.

(5) The structural models of tankers, ore carriers and bulk carriers are to comply with the requirements in **C29.6.2**, **C30.1.~~3~~2** and **C31.1.5** of the Guidance respectively, in addition to those specified here in **1.3**.

### 1.4 Allowable Stress

#### 1.4.1 General

Sub-paragraph -1(1) has been amended as follows.

(1) For tankers, ore carriers and bulk carriers, when the loads specified in **1.2.1-1** act on the structural model according to **1.3** above, the scantlings are to be determined so that the stress generated in each structural member does not exceed the values given in **C29.6.2**, **C30.1.~~3~~2** and **C31.1.5** of the Guidance respectively.

## Annex C1.1.23-1 GUIDANCE FOR THE FATIGUE STRENGTH ASSESSMENT OF LONGITUDINALS

## 2 Stress Evaluation

### 2.1 Evaluation of Stress for Longitudinals which Penetrate Ordinary Transverse Members

### 2.1.2 Stress Due to Wave Load

Sub-paragraph -1 has been amended as follows.

**1** Stress due to wave load $\sigma_{wj}$ is given in **Table 3**.

The expressions used in the table are explained below.

$C_1$: This value is calculated using the equations given in **Table 4**

$L_1$: Length ($m$) of ship as specified in **2.1.2**, **Part A of the Rules** or 0.97 *times* the length of the ship on the designed maximum load line, whichever is smaller

$d_i$: Draft ($m$) amidships for the relevant loading condition

$y_p$: Transverse horizontal distance ($m$) from the centreline of the ship to the point being considered in the subject section

$z_p$: Vertical distance ($m$) from the bottom of the ship to the point being considered in the midship section

$B$: Breadth ($m$) as defined in **2.1.4**, **Part A of the Rules**

$T_R$: Natural period of roll ($s$) in condition being considered
Where the full load condition and ballast condition are considered and the natural period of roll corresponding to the respective conditions is not given beforehand, it may be calculated from the following equation.

$T_R = 1.15\dfrac{2K_{xx}}{\sqrt{GM}}$ ($s$) for tankers, ore carriers and bulk carriers

$T_R = 1.1\dfrac{2K_{xx}}{\sqrt{GM}}$ ($s$) for container carriers

$K_{xx}$: Roll radius ($m$) of gyration at the centre of gravity of the ship corresponding to the respective condition is given below.

For full load condition $K_{xx} = 0.35B$,

For ballast condition $K_{xx} = 0.40B$

$GM$: Metacenter height ($m$) is given below., however, the actual value is to be used for ore carriers.

*For Tanker*:

$GM = KM - KG$

$$= \left\{0.42B\left(2-\frac{d_i}{d_f}\right)-7\left(1-\frac{d_i}{d_f}\right)\right\} - \left\{0.54D\left(0.2+0.8\frac{d_i}{d_f}\right)+3\left(1-\frac{d_i}{d_f}\right)+0.6\right\} \quad (m)$$

*For Bulk Carrier*:

$GM = KM - KG$

$$= \left\{0.42B\left(2-\frac{d_i}{d_f}\right)-7\left(1-\frac{d_i}{d_f}\right)\right\}-\left\{0.54D\left(0.4+0.6\frac{d_i}{d_f}\right)+3\left(1-\frac{d_i}{d_f}\right)+0.6\right\} \quad (m)$$

*For Container Carrier*:

*GM*=*KM*－*KG*

$$= \left\{0.52B+1.25\left(1-2.4\frac{d_i}{d_f}\right)\right\}-\left\{0.55D\left(0.45+0.55\frac{d_i}{d_f}\right)-1.95\left(1-2.8\frac{d_i}{d_f}\right)\right\} \quad (m)$$

It is not to be less than 0.06*B*.

*D*: Depth (*m*) of ship defined in **2.1.6**, **Part A of the Rules**

$\phi$: Rolling angle (*radians*): obtained from the following formula:

$\phi = \frac{4}{T_R\sqrt{B}}H_j$ for tankers, ore carriers and bulk carriers

$\phi = \frac{4}{T_E\sqrt{B}}H_j$ for container carriers

$T_E$: As given by the following

$$T_E = 0.5\left(T_R+\sqrt{T_R^2-\frac{2\pi}{g}VT_R}\right) \quad \text{for} \quad T_R > \frac{2\pi}{g}V$$

$$T_E = T_R \quad \text{for} \quad T_R \le \frac{2\pi}{g}V$$

Where,

*V*: Ship speed (*knots*) as defined in **2.1.8**, **Part A of the Rules**

*C*: Distribution coefficient in the longitudinal direction of the ship is based on the equation given below.

Where the cross section being considered is positioned forward of amidship:

$$1+\frac{6}{C_b}\left(3-\frac{|4y'|}{B}\right)\left(\frac{x_l}{L}\right)^3$$

Where the considered cross section is positioned afterward of amidship:

$$1+\frac{12}{C_b}\left(1-\sqrt{\frac{|2y'|}{B}}\right)\left(\frac{x_l}{L}\right)^3$$

$x_l$: Longitudinal distance (*m*) from the midship section to the cross section being considered

*y'*: Transverse horizontal distance (*m*) from the centreline of the ship to the point being considered in the subject section

$C_C$, *Z*, *S*, $C_{cor}$, *l* and *g* are determined according to the provision in **2.1.1**.

Table 3 has been amended as follows.

Table 3 Stress Range Due to Wave Load

| Design Condition | | Design wave height $H_j$ $(m)$ | Wave pressure $P_{Wj}$ $(kN/m^2)$ | Stress $\sigma_{Wj}$ $(N/mm^2)$ |
|---|---|---|---|---|
| 1 | L-180 | For tankers, ore carriers and bulk carriers<br>$0.6175C_1\sqrt{(1.6+\frac{0.6d_i}{d_f})-\frac{25}{L}}$<br>For container carriers<br>$0.6175C_1\sqrt{\left(1.5+\frac{0.5d_i}{d_f}\right)-\frac{25}{L}}$ | $2.3C\left(\frac{z_p}{d_i}+\frac{\lvert 2y_p\rvert}{B}+1\right)H_j$ | $1000C_C\frac{P_{Wj}Sl^2}{12ZC_{cor}}$ |
| 2 | L-0 | For tankers, ore carriers and bulk carriers<br>$0.6175C_1\sqrt{(1.6+\frac{0.4d_i}{d_f})-\frac{25}{L}}$<br>For container carriers<br>$0.6175C_1\sqrt{\left(1.5+\frac{d_i}{3d_f}\right)-\frac{25}{L}}$ | $2.3\left(\frac{z_p}{d_i}+\frac{\lvert 2y_p\rvert}{B}+1\right)H_j$ | |
| 3 | R | For tankers, ore carriers and bulk carriers<br>$0.399C_1\sqrt{1+\frac{gT_R^2}{2\pi L}-\frac{25}{L}}$<br>For container carriers<br>$0.399C_1\sqrt{1+\frac{gT_E^2}{2\pi L}-\frac{25}{L}}$ | $10y'\sin\phi+\left(\frac{\lvert 2y'\rvert}{B}+1\right)H_j$ | |
| 4 | P | For tankers, ore carriers and bulk carriers<br>$0.665C_1\sqrt{(1.2+\frac{0.4d_i}{d_f})-\frac{25}{L}}$<br>For container carriers<br>$0.665C_1\sqrt{\left(1.2+\frac{0.15d_i}{d_f}\right)-\frac{25}{L}}$ | For tankers, ore carriers and bulk carriers<br>$3\left(\frac{2z_p}{d_i}+\frac{3\lvert 2y'\rvert}{B}\right)H_j$<br>For container carriers<br>$2.4\left(\frac{2z_p}{d_i}+\frac{3\lvert 2y'\rvert}{B}\right)H_j$ | |

Paragraph 2.1.3 has been amended as follows.

### 2.1.3 Stress Due to Acceleration of Ship

Stress due to acceleration of liquid in the tanks and bulk cargo in the holds induced by acceleration of the ship $\sigma_{Tj}$ is according to the equations given in **Table 6** using the acceleration of the centre of gravity of the ship is given in **Table 5**.

The expressions used in **Table 5** and **Table 6** are explained below.

*V*: Ship speed (*knots*) as defined in **2.1.8**, **Part A of the Rules**

$C_b$: Block coefficient as defined in **2.1.14**, **Part A of the Rules**

~~S~~sgn: Indicates use of either a plus or minus sign
A “plus” sign indicates that the longitudinals are inside the subject tank being assessed, while a “minus” sign is used in cases where the longitudinals are outside (are affixed to

the exterior surface of) the subject tank being assessed.

~~$B$,~~ $g$, ~~$s$~~$S$, $l$, $Z$, $C_{cor}$,~~$d_i$, $d_f$, $L$,~~ $C_C$, $\rho_c$~~,~~ and $C_p$ ~~and $T_R$~~ are determined according to **2.1.1**.

$B$, $L$, $d_i$, $d_f$ and $T_R$ are determined according to **2.1.2-1**.

$T_P$: As given by the following

$$T_P = \sqrt{\frac{2\pi\left\{0.6\left(1+ {d_i}/{d_f}\right)\right\}L}{g}} \quad (s)$$ for tankers, ore carriers and bulk carriers

$$T_P = \sqrt{\frac{2\pi\left\{0.5\left(1+ {d_i}/{d_f}\right)\right\}L}{g}} \quad (s)$$ for container carriers

$H_1$, $H_3$, $H_4$: Wave height ($m$) corresponding to the design condition of L-180, R and P, respectively, as given in **Table 3**

$x_g$: Longitudinal distance ($m$) from A.P. to the rotation centre of pitch motion (=0.45$L$)

$x_t$: Longitudinal distance ($m$) from A.P. to the centre of gravity of the tank being considered

$y_t$: Transverse horizontal distance ($m$) from the centreline of the ship to the centre of gravity of the tank being considered

$y_c$: Transverse horizontal distance ($m$) from the centre of gravity in the breadth of the tank to the longitudinal being considered

$z_c$: Vertical distance ($m$) from the tank top to the longitudinal being considered

Table 5 has been amended as follows.

Table 5 Acceleration of the Centre of Gravity of Ship

| Heave ($m/s^2$) | Roll ($rad./s^2$) | Pitch ($rad./s^2$) |
|---|---|---|
| $a_h = \frac{3g(V+5)^{0.2}}{B^{0.6}L^{0.6}\sqrt{C_b}}H_4$ | For tankers, ore carriers and bulk carriers $a_r = \frac{4H_3}{T_R\sqrt{B}}\left(\frac{2\pi}{T_R}\right)^2$ For container carriers $a_r = \frac{4H_3}{T_E\sqrt{B}}\left(\frac{2\pi}{T_R}\right)^2$ | $a_p = \frac{3(V+5)^{0.2}H_1}{L^{1.2}\sqrt{C_b}}\left(\frac{2\pi}{T_p}\right)^2$ |

Table 6 has been amended as follows.

Table 6 Stress Due to Acceleration of Liquid in Tanks and Bulk Cargo in Holds

| Design Condition | | Load due to acceleration of liquid in tanks and bulk cargo in holds $P_{Tj}$ ($kN/m^2$) | | Stress $\sigma_{Tj}$ ($N/mm^2$) |
|---|---|---|---|---|
| 1 | L-180 | Liquid:<br>$\rho_c\left(\frac{d_i}{d_f}a_h+\lvert x_t-x_g\rvert a_p\right)z_c$ | Bulk Cargo:<br>$0.75C_P\rho_c\left(\frac{d_i}{d_f}a_h+\lvert x_t-x_g\rvert a_p\right)z_c$ | |
| 2 | R | For tankers<u>, ore carriers</u> and bulk carriers<br>Liquid:<br>$\rho_c\left\{\left(\frac{\sqrt{L}}{40}a_h+y_t a_r\right)z_c+\left(\frac{4gH_3}{T_R\sqrt{B}}\right)y_c\right\}$<br>For container carriers<br>Liquid:<br>$\rho_c\left[\left\{\left(0.7-0.6\frac{d_i}{d_f}\right)a_h+y_t a_r\right\}z_c+\left(\frac{4gH_3}{T_E\sqrt{B}}\right)y_c\right]$ | Bulk Cargo<br>$\rho_c\left\{0.75C_P\left(\frac{\sqrt{L}}{40}a_h+y_t a_r\right)z_c+0.25\left(\frac{4gH_3}{T_R\sqrt{B}}\right)y_c\right\}$ | $\mathrm{sgn}\left(1000\frac{C_C P_{Tj} S l^2}{12 Z C_{cor}}\right)$ |
| 3 | P | For tankers<u>, ore carriers</u> and bulk carriers<br>Liquid:<br>$\rho_c\left\{(a_h+0.5y_t a_r)z_c+0.5\left(\frac{4gH_3}{T_R\sqrt{B}}\right)y_c\right\}$<br>For container carriers<br>Liquid:<br>$\rho_c\left\{(a_h+0.5y_t a_r)z_c+0.5\left(\frac{4gH_3}{T_E\sqrt{B}}\right)y_c\right\}$ | Bulk Cargo:<br>$\rho_c\left\{0.75C_P(a_h+0.5y_t a_r)z_c+0.25\left(0.5\frac{4gH_3}{T_R\sqrt{B}}\right)y_c\right\}$ | |

### 2.1.5 Stress Due to Wave Induced Longitudinal Bending Moment and Horizontal Bending Moment

Sub-paragraph -2 has been amended as follows.

**2** Stress due to wave induced wave horizontal moment $\sigma_{WHH}$ is determined according to the following equation.

$$\sigma_{WHH}=1000C_a\frac{0.32C_1C_3L_1{}^2d_i\sqrt{(L_1-35)/L_1}}{Z_HC_Z}\frac{2y'}{B}\quad (N/mm^2)$$

$C_1$, $L_1$, $B$, $d_i$~~, $C_z$~~ and $y'$ are determined according to **2.1.2**<u>.</u>~~and~~

$C_a$ <u>and $C_Z$</u> ~~is~~<u>are</u> determined according to **2.1.4**.

$C_3$: Coefficient specified along the length at the section under consideration determined by liner interpolation using the following values.

For $x_P=0$ (at aft perpendicular) and $x_P=L$ (at fore perpendicular), the value is taken as 0.

For $x_P=0.35L$ through $0.65L$, the value is taken as 1.

$Z_H$: The section modulus ($cm^3$) about the vertical neutral axis of the considered cross section at ship's side

# 3 Fatigue Strength Assessment

## 3.1 Calculation of Cumulative Fatigue Damage

### 3.1.3 Calculation of Cumulative Fatigue Damage

Table 9 has been amended as follows.

Table 9 Correction Coefficient

| Type of Ship | | Hull part where the longitudinal is fitted | $\eta_v$ |
|---|---|---|---|
| Tanker | | Side shell and bottom shell | 0.5 |
| | | Other than the above | 0.4 |
| Ore Carrier and Bulk Carrier | $L \geq 200$ $m$ | Side shell and bottom shell | 0.55 |
| | | Other than the above | 0.45 |
| | $L < 200$ $m$ | The value is determined at the discretion of the Society | |
| Container Carrier | Over Panamax | Side shell and bottom shell | 0.5 |
| | | Other than the above | 0.4 |
| | Panamax | Side shell and bottom shell | 0.35 |
| | | Other than the above | 0.3 |
| | Feeder | Side shell and bottom shell | 0.3 |
| | | Other than the above | 0.25 |

# Appendix C1 REFERENCE DATA FOR DESIGN

Title of 1.11 has been amended as follows.

## 1.11 Change-over of Ore/Oil Carriers (30.~~1.9~~7~~ and 30.1.10~~, Part C of the Rules)

(omitted)

EFFECTIVE DATE AND APPLICATION (Amendment 1-3)

1. The effective date of the amendments is 26 August 2014.
2. Notwithstanding the amendments to the Guidance, the current requirements may apply to ships for which the date of contract for construction is before the effective date.