# Common Structural Rules for Bulk Carriers and Oil Tankers

# Rule Change Notice 1 to 01 JAN 2020 version

Notes: (1) These Rule Changes enter into force on 1st July 2021.

# COMMON STRUCTURAL RULES FOR BULK CARRIERS AND OIL TANKERS
## RULE CHANGE NOTICE 1

This document contains amendments within the following Parts and Chapters of the Common Structural Rules for Bulk Carriers and Oil Tankers, 1 January 2020. The amendments are effective on 1 July 2021.

The technical background document containing explanation for the amendments in this document can be found in "Technical Background for Rule Change Notice 1 to 01 JAN 2020 version".

# Contents

# PART 1 GENERAL RULE REQUIREMENTS

## CHAPTER 2
## GENERAL ARRANGEMENT DESIGN

## SECTION 2 SUBDIVISION ARRANGEMENT

### 1 WATERTIGHT BULKHEAD ARRANGEMENT

~~1.2     Opening in Watertight Bulkheads~~

~~1.2.1~~

~~The number of openings in watertight bulkheads is to be kept a minimum, where penetrations of watertight bulkheads and internal decks are necessary for access, piping, ventilation, electrical cables. Arrangements are to be made to maintain the watertight integrity.~~

~~1.2.2~~

~~The tightness, operability and indication of the doors in watertight bulkheads are to be in accordance with Ch II-1, Reg 13-1 of SOLAS Convention, as amended.~~

### 3 AFT PEAK BULKHEADS

3.1 General

3.1.2

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

3.1.4

~~The aft peak bulkhead may terminate at the first deck above the deepest draught at the aft perpendicular, provided that this deck is made watertight to the stern or to the transom.~~ <u>Provided that the aft peak bulkhead extends above the deepest load line, termination of the afterpeak bulkhead on a watertight deck lower than the freeboard deck can be accepted. In order to provide such a watertight deck a tight sealing of the rudder stock shall be fitted in way of this deck or above.</u>

# SECTION 3 COMPARTMENT ARRANGEMENT

## 4        DELETED FORE END COMPARTMENTS

### 4.1        General

#### 4.1.1

The fore peak and other compartments located forward of the collision bulkhead may not be arranged for the carriage of fuel oil or other flammable products.

## 5        DELETED FUEL OIL TANKS

### 5.1        Arrangement of Fuel Oil Tanks

#### 5.1.1

Fuel oil tanks are to be arranged in accordance with the requirements in SOLAS Ch II-2, Reg 4.2 and MARPOL, Annex I, Ch 3, Reg 12A.

## 6        DELETED AFT END COMPARTMENTS

### 6.1        Sterntube

#### 6.1.1

Sterntubes are to be enclosed in a watertight space (or spaces) of moderate volume. Other measures to minimise the danger of water penetrating into the ship in case of damage to the sterntube arrangement may be taken at the discretion of the Society.

# CHAPTER 4
# LOADS

## SECTION 5 EXTERNAL LOADS

### SYMBOLS

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

$\lambda$      : Wave length, in m.

$B_x$      : Moulded breadth at the waterline, in m, at the considered cross section.

$x, y, z$    : X, Y and Z coordinates, in m, of the load point with respect to the reference coordinate system defined in Ch 4, Sec 1, [1.2.1]

$f_{xL}$      : Ratio as defined in Ch 4, Sec 2.

$f_{yB}$      : Ratio between Y-coordinate of the load point and $Bx$, to be taken as:

$$f_{yB} = \frac{|2y|}{B_x}, \text{ but not greater than 1.0.}$$

~~$f_{yB} = 0$~~ $\underline{f_{yB} = 1.0}$ when $B_x = 0$

….

## SECTION 6 INTERNAL LOADS

## 2      PRESSURES AND FORCES DUE TO DRY BULK CARGO

### 2.5      Shear Load

### 2.5.1      Application

For FE strength assessment <u>and FE fatigue assessment</u>, the following shear load pressures are to be considered in addition to the dry bulk cargo pressures defined in [2.4] when the load point elevation, $z$, is lower or equal to $z_c$:

….

## SECTION 8 LOADING CONDITIONS

## 5      STANDARD LOADING CONDITIONS FOR FATIGUE ASSESSMENT

### 5.1      Oil tanker

### 5.1.1

The standard loading conditions to be applied to oil tankers for fatigue assessment as required in Ch 9, Sec 1, [6.2], are defined in Table 22 to Table 24. Where fuel oil tanks, other oil tanks or fresh water tanks are arranged in way of the cargo hold region, the filling level of them are to be taken as full for <u>both simplified stress analysis according to Ch 9, Sec 4 and </u>direct strength analysis according to Ch 7 and Ch 9, Sec 5. ~~For simplified stress analysis according to Ch 9, Sec 4, the filling level of them are to be taken as half height, measured from $z_{top}$ to the lowest point of tank.~~

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## 5.2        Bulk carriers

### 5.2.1

The standard loading conditions to be applied to bulk carriers for fatigue assessment as required in Ch 9, Sec 1, [6.3] are defined in Table 25, to Table 31 according to their additional service feature notations and the location of the assessed details. Where fuel oil tanks, other oil tanks or fresh water tanks are arranged in way of the cargo hold region, the filling level of them are to be taken as full for both simplified stress analysis according to Ch 9, Sec 4 and direct strength analysis according to Ch 7 and Ch 9, Sec 5. For simplified stress analysis according to Ch 9, Sec 4, the filling level of them are to be taken as half height, measured from $z_{top}$ to the lowest point of tank.

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# CHAPTER 8
# BUCKLING

## SECTION 4 BUCKLING REQUIREMENTS FOR DIRECT STRENGTH ANALYSIS

### 5       STRUTS, PILLARS AND CROSS TIES

5.1       Buckling criteria

5.1.1

The compressive buckling strength of struts, pillars and cross ties is to satisfy the following criterion:

$$\eta_{pillar} \leq \eta_{all}$$

The buckling strength of elementary plate panels of cross ties is to satisfy the following criterion:

$$\eta_{plate} \leq \eta_{all}$$

Where:

$\eta_{pillar}$ : Maximum utilisation factor of struts, pillars or cross ties, as defined in Ch 8, Sec 5, [3.1].

$\eta_{plate}$ : Maximum plate utilisation factor calculated according to UP-B, as defined in Ch 8, Sec 5, [2.2].

# SECTION 5 BUCKLING CAPACITY

## SYMBOLS

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$\gamma_{GEB}$      : Stress multiplier factor of global elastic buckling capacity.

## 2  BUCKLING CAPACITY OF PLATES AND STIFFENERS

### 2.1  Overall stiffened panel capacity

**2.1.1**

The elastic stiffened panel limit state is based on the following interaction formula, which sets a precondition for the buckling check of stiffeners in accordance with [2.3.4]:

$$\frac{P_z}{c_f} = 1$$

$$\frac{\gamma}{\gamma_{GEB}} = 1$$

where $c_f$ and $P_z$ are defined in [2.3.4]. where the stress multiplier factor corresponding to global elastic buckling capacity, $\gamma_{GEB}$, is to be calculated based on the following formulae:

$\gamma_{GEB} = \gamma_{GEB,bi+\tau}$      for $\tau \neq 0$ and ($\sigma_x > 0$ or $\sigma_y > 0$)

$\gamma_{GEB} = \gamma_{GEB,bi}$      for $\tau = 0$ and ($\sigma_x > 0$ or $\sigma_y > 0$)

$\gamma_{GEB} = \gamma_{GEB,\tau}$      for $\tau \neq 0$ and ($\sigma_x \leq 0$ and $\sigma_y \leq 0$)

where $\gamma_{GEB,bi+\tau}$, $\gamma_{GEB,bi}$ and $\gamma_{GEB,\tau}$ are stress multiplier factors for different load combinations as defined in [2.1.2], [2.1.3] and [2.1.4], respectively. For the calculation of $\gamma_{GEB,bi+\tau}$, $\gamma_{GEB,bi}$ and $\gamma_{GEB,\tau}$, neither $\sigma_x$ nor $\sigma_y$ shall be taken less than 0.

$\sigma_x$, $\sigma_y$      : Applied normal stresses to the plate panel, in N/mm², to be taken as defined in [2.2.7].

$\tau$            : Applied shear stress, in N/mm$^2$, to be taken as defined in [2.2.7].

**2.1.2**

The stress multiplier factor $\gamma_{GEB,bi}$ for the stiffened panel subjected to biaxial loads is taken as:

$$\gamma_{GEB,bi} = \frac{\pi^2}{L_{B1}^2 L_{B2}^2} \frac{[D_{11}L_{B2}^4 + 2(D_{12} + D_{33})n^2 L_{B1}^2 L_{B2}^2 + n^4 D_{22}L_{B1}^4]}{L_{B2}^2 N_x + n^2 L_{B1}^2 K_{tran}N_y}$$

where:

  $N_x$     : Load per unit length applied on the edge along $x$ axis of the stiffened panel, in N/mm,

taken as

$$N_x = \sigma_{x,av}(t_p s + t_w h_w + t_f b_f)/s$$

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

$$N_y = c\sigma_y t_p$$

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

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

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

$K_{tran}$ : Coefficient taken as 0.9.

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

$$c = 0.5(1 + \Psi) \quad \text{for } 0 \leq \Psi \leq 1$$

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

$\Psi$ : Edge stress ratio for case 2 according to Table 3.

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

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

$$\sigma_{x,av} = \sigma_x \quad \text{for } \sigma_x \leq 0 \text{ or } \sigma_y \leq 0$$

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

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

$I_{eff}$ : Moment of inertia, in cm$^4$, of the stiffener including effective width of attached plating, the same as $I$ defined in [2.3.4].

### 2.1.3

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

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

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

where

$$N_{xy} = \tau t$$

### 2.1.4

The stress multiplier factor $\gamma_{GEB,bi+\tau}$ for the stiffened panel subjected to combined loads is taken as:

$$\gamma_{GEB,bi+\tau} = \frac{1}{2} \gamma_{GEB,\tau}^2 \left[ -\frac{1}{\gamma_{GEB,bi}} + \sqrt{\frac{1}{\gamma_{GEB,bi}^2} + 4 \frac{1}{\gamma_{GEB,\tau}^2}} \right]$$

where $\gamma_{GEB,bi}$ and $\gamma_{GEB,\tau}$ are as defined in [2.1.2] and [2.1.3], respectively.

2.2 Plate capacity

**2.2.7 Applied normal and shear stresses to plate panels**

The normal stresses, $\sigma_x$ and $\sigma_y$, in N/mm², to be applied for the overall stiffened panel capacity and the plate panel capacity calculations, as given in [2.1.1] and [2.2.1] respectively, are to be taken as follows:

- For FE analysis, the reference stresses as defined in Ch 8, Sec 4, [2.4].

- For prescriptive assessment, the axial or transverse compressive stresses calculated according to Ch 8, Sec 3, [2.2.1], at load calculation points of the considered elementary plate panel, as defined in Ch 3, Sec 7, [2].

- For grillage analysis where the stresses are obtained based on beam theory, the stresses taken as:

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

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

where

$\sigma_{xb}$, $\sigma_{yb}$:  Stress, in N/mm², from grillage beam analysis respectively along $x$ or $y$ axis of the attached ~~buckling panel~~ plate of girders.

The shear stress $\tau$, in N/mm², to be applied for the overall stiffened panel capacity and the plate panel capacity calculations, as given in [2.1.1] and [2.2.1] respectively, are to be taken as follows:

- For FE analysis, the reference shear stresses as defined in Ch 8, Sec 4, [2.4].

- For prescriptive assessment of the plate panel capacity, the shear stresses calculated according to Ch 8, Sec 3, [2.2.1], at load calculation points of the considered elementary plate panel, as defined in Ch 3, Sec 7, [2].

- For prescriptive assessment of the overall stiffened panel capacity, the shear stresses calculated according to Ch 8, Sec 3, [2.2.1], at the following load calculation point:

    - At the middle of the full span, $l$, of the considered stiffener.

    - At the intersection point between the stiffener and its attached plating.

- For grillage beam analysis, $\tau = 0$ in the attached ~~buckling panel~~ plate of girders.

## 2.3 Stiffeners

### 2.3.2 Web thickness of flat bar

For accounting the decrease of the stiffness due to local lateral deformation, the effective web thickness of flat bar stiffener, in mm, is to be used in [2.1] and [2.3.4] for the calculation of the net sectional area, $A_S$, the net section modulus, $Z$, and the moment of inertia, $I$, of the stiffener and is taken as:

$$t_{w\_red} = t_w\left(1 - \frac{2\pi^2}{3}\left(\frac{h_w}{s}\right)^2\left(1 - \frac{b_{eff1}}{s}\right)\right)$$

### 2.3.4 Ultimate buckling capacity

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$M_0$: Bending moment, in Nmm, due to the lateral deformation $w$ of stiffener:

~~$M_0 = F_E\left(\frac{P_z w}{c_f - P_z}\right)$ with $c_f - P_z > 0$~~

$$M_0 = F_E\frac{\gamma}{\gamma_{GEB}-\gamma}w_0 \quad \text{with precondition } \gamma_{GEB} - \gamma > 0$$

where $\gamma_{GEB}$ is the stress multiplier factor of global elastic buckling capacity as defined in [2.1].

….

$P_z$ : : Nominal lateral load, in N/mm$^2$, acting on the stiffener due to stresses, $\sigma_x$, $\sigma_y$ and $\tau$, in the attached plating in way of the stiffener mid span:

$$P_z = \frac{t_p}{s}\left(\sigma_{xl}\left(\frac{\pi s}{l}\right)^2 + 2c\gamma\sigma_y + \sqrt{2}\tau_1\right)$$

$$\sigma_{xl} = \gamma\sigma_x\left(1 + \frac{A_s}{st_p}\right) \text{ But not less than 0}$$

$$\tau_1 = \gamma|\tau| - t_p\sqrt{R_{eH_p}E\left(\frac{m_1}{a^2} + \frac{m_2}{b^2}\right)} \geq 0 \text{ but not less than 0}$$

$\sigma_y$ : Stress applied on the edge along $y$ axis of the buckling panel, in N/mm$^2$, but not less than 0.

- For FE analysis, $\sigma_y$ is the FE corrected stress as defined in [2.3.6] in the attached plating in the direction perpendicular to the stiffener axis.
- For prescriptive assessment, $\sigma y$ is the maximum compressive stress calculated according to Sec 3, [2.2.1], at load calculation points of the stiffener attached plating, as defined in Sec 3, [1.2.2].
- For grillage beam analysis, $\sigma y$ is the stress acting along the y-axis of the attached buckling panel.

$\tau$ : Applied shear stress, in N/mm$^2$.

- For FE analysis, $\tau$ is the reference shear stress as defined in Sec 4, [2.4.2] in the attached plating.
- For prescriptive assessment, $\tau$ is the shear stress at the attached plate calculated according to Sec 3, [2.2.1 at the following load calculation point.
  - At the middle of the full span, $l$, of the considered stiffener
  - At the intersection point between the stiffener and its attached plate.
- For grillage beam analysis, $\tau = 0$ in the attached buckling panel.

$m_1$, $m_2$ : Coefficients taken equal to:

$$m_1 = 1.47, m_2 = 0.49 \text{ for } \alpha \geq 2$$

$$m_1 = 1.96, m_2 = 0.37 \text{ for } \alpha < 2$$

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

$$c = 0.5(1 + \Psi) \quad \text{for } 0 \leq \Psi \leq 1$$

$$c = \frac{1}{2(1 + \Psi)} \quad \text{for } \Psi < 0$$

$\Psi$ : Edge stress ratio for case 2 according to Table 3.

$w$ : Deformation of stiffener, in mm:

$$w = w_0 + w_1$$

~~$w_1$~~ ~~: Deformation of stiffener, in mm, at mid-point of stiffener span due to lateral load $P$. In case of uniformly distributed load, $w_1$ is to be taken as:~~

~~$$w_1 = C_i \frac{|P|sl^4}{384 \times 10^7 EI} \quad \text{in general}$$~~

~~$$w_1 = C_i \frac{5|P|sl^4}{384 \times 10^7 EI} \quad \text{for stiffeners sniped at both ends}$$~~

~~$$w_1 = C_i \frac{2|P|sl^4}{384 \times 10^7 EI} \quad \text{for stiffeners sniped at one end and continuous at the other end.}$$~~

~~$c_f$~~ ~~: Elastic support provided by the stiffener, in N/mm²:~~

~~$$c_f = F_E \left(\frac{\pi}{l}\right)^2 (1 + c_p)$$~~

~~$$c_p = \frac{1}{1 + \frac{0.91}{c_{xa}}\left(\frac{12I}{st_p^3}10^4 - 1\right)}$$~~

~~$c_{xa}$~~ ~~: Coefficient to be taken as:~~

~~$$c_{xa} = \left[\frac{l}{2s} + \frac{2s}{l}\right]^2 \quad \text{for } l \geq 2s$$~~

~~$$c_{xa} = \left[1 + \left(\frac{l}{2s}\right)^2\right]^2 \quad \text{for } l < 2s$$~~

$\sigma_w$ : Stress due to torsional deformation, in N/mm², to be taken as:

~~$$\sigma_w = E y_w \left(\frac{t_f}{2} + h_w\right) \Phi_0 \left(\frac{\pi}{l}\right)^2 \left(\frac{1}{1 - \frac{0.4 R_{eH\_S}}{\sigma_{ET}}} - 1\right) \quad \text{for stiffener induced failure (SI).}$$~~

$$\sigma_w = E y_w \left(\frac{t_f}{2} + h_w\right) \Phi_0 \left(\frac{m_{tor}\pi}{l_{tor}}\right)^2 \left(\frac{1}{1 - \frac{\gamma \sigma_a}{\sigma_{ET}}} - 1\right) \quad \text{with precondition } \sigma_{ET} - \gamma \sigma_a$$

$$> 0 \quad \text{for stiffener induced failure (SI).}$$

$\underline{l_{tor}}$ : Stiffener span, distance equal to spacing between primary supporting members, i.e. $l_{tor} = l$. When the stiffener is supported by tripping brackets, $l_{tor}$ should be taken as the maximum spacing between the adjacent primary supporting members and fitted tripping brackets.

$\Phi_0$: Coefficient taken as:

~~$$\Phi_0 = \frac{l}{h_w} 10^{-3}$$~~

$$\Phi_0 = \frac{l_{tor}}{m_{tor} h_w} 10^{-4}$$

$\sigma_{ET}$ : Reference stress for torsional buckling, in N/mm², to be taken as:

~~$$\sigma_{ET} = \frac{E}{I_p}\left[\frac{\varepsilon \pi^2 I_\omega 10^2}{l^2} + 0.385 I_T\right]$$~~

$$\sigma_{ET} = \frac{E}{I_p}\left[\left(\frac{m_{tor}\pi}{l_{tor}}\right)^2 I_w \cdot 10^2 + \frac{1}{2(1+v)} I_T + \left(\frac{l_{tor}}{m_{tor}\pi}\right)^2 \varepsilon \cdot 10^{-4}\right]$$

$I_\omega$ : Net ~~sectional~~ sectorial moment of inertia of the stiffener, in cm$^6$, about point $C$ as shown in Figure 1, as defined in Table 5.

$\underline{m_{tor}}$ : Number of half waves within $l_{tor}$, taken as a positive integer so as to give smallest reference stress for torsional buckling.

$\varepsilon$ : Degree of fixation, in mm$^2$, to be taken as:

$$\varepsilon = 1 + \frac{\left(\frac{l}{\pi}\right)^2 10^{-3}}{\sqrt{I_\omega\left(\frac{0.75s}{t_p^3} + \frac{e_f - 0.5t_f}{t_w^3}\right)}}$$

$$\varepsilon = \left(\frac{3b}{t_p^3} + \frac{2h_w}{t_w^3}\right)^{-1} \quad \text{for bulb, angle, L2 , L3 and T profiles;}$$

$$\varepsilon = \left(\frac{t_p^3}{3b}\right) \quad \text{for flat bars.}$$

**Table5: Moments of inertia**

|  | Flat bars[1] | Bulb, angle, L2, L3 and T profiles |
|---|---|---|
| $I_P$ | $\dfrac{h_w^3 t_w}{3\cdot 10^4}$ | $\left(\dfrac{A_w(e_f - 0.5t_f)^2}{3} + A_f e_f^2\right)10^{-4}$ |
| $I_T$ | $\dfrac{h_w t_w^3}{3\cdot 10^4}\left(1 - 0.63\dfrac{t_w}{h_w}\right)$ | $\dfrac{(e_f - 0.5t_f)t_w^3}{3\cdot 10^4}\left(1 - 0.63\dfrac{t_w}{e_f - 0.5t_f}\right) + \dfrac{b_f t_f^3}{3\cdot 10^4}\left(1 - 0.63\dfrac{t_f}{b_f}\right)$ |
| $I_\omega$ | $\dfrac{h_w^3 t_w^3}{36\cdot 10^6}$ | For bulb, angle, L2 and L3 profiles<br> ~~$\dfrac{A_f e_f^2 b_f^2}{12\cdot 10^6}\left(\dfrac{A_f + 2.6A_w}{A_f + A_w}\right)$~~<br> $\dfrac{A_f^3 + A_w^3}{36\cdot 10^6} + \dfrac{e_f^2}{10^6}\left(\dfrac{A_f b_f^2 + A_w t_w^2}{3} - \dfrac{(A_f b_f + A_w t_w)^2}{4(A_f + A_w)}\right)$<br> For T profiles<br> $\dfrac{b_f^3 t_f e_f^2}{12\cdot 10^6}$ |
| (1) $t_w$ is the net web thickness, in mm. $t_{w\_red}$ as defined in [2.3.2] is not to be used in this table. | | |

### 2.3.6 FE corrected stresses for stiffener capacity

When the reference stresses $\sigma_x$ and $\sigma_y$ obtained by FE analysis according to Ch 8, Sec 4, [2.4] are both compressive, ~~they are~~ $\underline{\sigma_x}$ is to be corrected according to the following ~~formulae~~ formula:

• If $\sigma_x < \nu\sigma_y$:

$\sigma_{xcor} = 0$

~~$\sigma_{ycor} = \sigma_y$~~

~~• If $\sigma_y < \nu\sigma_x$:~~

~~$\sigma_{xcor} = \sigma_x$~~

$\sigma_{ycor} = 0$

• In the other cases:

$\sigma_{xcor} = \sigma_x - \nu\sigma_y$

$\sigma_{ycor} = \sigma_y - \nu\sigma_x$

• If $\sigma_x \geq \nu\sigma_y$:

$\sigma_{xcor} = \sigma_x - \nu\sigma_y$

# APPENDIX 1 STRESS BASED REFERENCE STRESSES

## 2.1.1 Longitudinal stress

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• For <u>overall stiffened panel buckling and</u> stiffener buckling assessment<u>s</u>, $\sigma_x(x)$ applied on the shorter edge of the attached plate is to be taken as:

$$\sigma_x = \frac{\sum_{1}^{n} A_i \sigma_{xi}}{\sum_{1}^{n} A_i}$$

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# CHAPTER 9
# FATIGUE

## SECTION 3 FATIGUE EVALUATION

### 6        Weld improvement Methods

### 6.1      General

#### 6.1.1

Post-weld fatigue strength improvement methods are to be considered as a supplementary means of achieving the required fatigue life, and subjected to quality control procedures and corrosion protection in accordance with Pt 1, Ch 3, Sec 4. The benefit from post-weld treatment can only be applied for corrosion free condition and may only be considered provided that a protective coating is applied after the post-weld treatment and maintained during the design life time.

### 6.4      Applicability

#### 6.4.1

The application of post-weld improvement and fatigue improvement factor provided in this section is subject to following limitations:

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- This benefit can only be achieved in a corrosion free condition and may only be considered provided that a suitable protective coating is applied after the post-weld Treatment and maintained during the design life time.

# CHAPTER 12
# CONSTRUCTION

## SECTION 3 DESIGN OF WELD JOINTS

### 2       TEE OR CROSS JOINT

### 2.4       Partial or full penetration welds

#### 2.4.6    Locations required for partial penetration welding

Partial penetration welding as defined in [2.4.2], is to be used in the following locations (see examples in Figure 3):

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   b) End connection of ~~L~~longitudinal/transverse bulkhead primary supporting member including buttress structure ~~end connections~~ to the double bottom and both end connections of backing bracket, where it is fitted.

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#### 2.5.2

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Table 3       Weld Factors for Miscellaneous Fittings and Equipment

| Item | Connection to | $f_{weld}$ |
|---|---|---|
| Hatch cover | Watertight/oil-tight joints | 0.48[1] |
|  | At ends of stiffeners | 0.38 [2] |
|  | Elsewhere | 0.24 |
| Mast, derrick post, crane pedestal, etc. | Deck / Underdeck reinforced structure | 0.43 |
| Deck machinery seat | Deck | 0.24 |
| Mooring equipment seat | Deck | 0.43 |
| Ring for access hole type cover | Anywhere | 0.43 |
| Stiffening of side shell doors and weathertight doors | Anywhere | 0.24 |
| Frames of shell and weathertight doors | Anywhere | 0.43 |
| Coaming of ventilator and air pipe | Deck | 0.43 |
| Ventilators, etc., fittings | Anywhere | 0.24 |
| Ventilators, air pipes, etc., coaming to deck | Deck | 0.43 |
| Scupper and discharge | Deck | 0.55 |
| Bulwark stay | Deck | 0.24 |
| Bulwark plating | Deck | 0.43 |
| Guard rail, stanchion | Deck | 0.43 |
| Cleats and fittings | Hatch coaming and hatch cover | ~~0.60~~ 0.24[3] |
| (1)   For bulk carrier hatch covers $f_{weld}$ = 0.38 for watertight joints | | |
| (2)   For bulk carrier hatch covers $f_{weld}$ = 0.24 at ends of stiffeners | | |
| (3)   Minimum weld factor. Where $t_{as\text{-}built}$ >11.5 $mm$ $l_{leg}$ need not exceed $0.62 t_{as\text{-}built}$. Penetration welding may be required depending on design. | | |

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# PART 2 SHIP TYPES

## CHAPTER 1
## BULK CARRIERS

## SECTION 2 STRCUTURAL DESIGN PRINCIPLES

### 3        STRUCTURAL DETAIL PRINCIPLES

### 3.3        Deck structures

#### 3.3.5   Protection against wire rope

Wire rope grooving in way of cargo holds openings is to be prevented by fitting suitable protection such as half-round bar on the hatch side girders (i.e. upper portion of topside tank plates) ~~or~~ and hatch end beams in cargo hold and upper portion of hatch coamings.

#### 3.3.6   Protection of cargo hatch opening corners against mechanical damage

Specific measures are to be arranged to prevent the hatch opening corners from mechanical damage incurred by coming into direct contact with the vertical grab wire under normal operations.

## SECTION 5 CARGO HATCH COVERS

### 2        ARRANGEMENTS

### 2.1        DELETED ~~Height of hatch coamings~~

#### ~~2.1.1~~

~~The height of hatch coamings is not to be less than:~~

- ~~600 mm in position 1~~
- ~~450 mm in position 2.~~

#### ~~2.1.2~~

~~The height of hatch coamings in positions 1 and 2 closed by steel covers provided with gaskets and securing devices may be reduced with respect to the above values or the coamings may be omitted entirely, on condition that the Administration is satisfied that the safety of the ship is not thereby impaired in any sea conditions.~~

~~In such cases the scantlings of the covers, their gasketing, their securing arrangements and the drainage of recesses in the deck are considered by the Society on a case-by-case basis.~~

# CHAPTER 2
# OIL TANKERS

## SECTION 1 GENERAL ARRANGEMENT DESIGN

### 2        SEPARATION OF CARGO TANKS

#### 2.1    General

##### 2.1.1

The cargo pump room, cargo tanks, slop tanks and cofferdams are to be positioned forward of machinery spaces. Main cargo control stations, control stations, accommodation and service spaces are to be positioned aft of cargo tanks, slop tanks and spaces which isolate cargo or slop tanks from machinery spaces, but not necessary aft of the oil fuel bunker tanks and ballast tanks.
The designer's attention is to be drawn on the arrangement of the cargo pump room, cargo tanks, slop tanks and cofferdams, main cargo control stations, control stations, accommodation and service spaces as well as on the need to separate the cargo tanks from the machinery space.

##### 2.1.2

A cofferdam is to be provided to separate the cargo tanks from the machinery space. Pump room, ballast tanks or fuel oil tanks may be considered as cofferdam for this purpose.

## SECTION 4 HULL OUTFITTIGS

### 1        SUPPORTING STRUCTURES FOR COMPONENTS USED IN EMERGENCYTOWING ARRANGEMENTSs

#### 1.1    General

##### 1.1.1

It is the responsibility of the designer to provide Eemergency towing arrangements are to be fitted at both the bow and stern of every tanker with a deadweight of 20,000 tonnes or more, as required by SOLAS, as amended.

##### 1.1.2

The designer is reminded that design and construction of the towing arrangements is are to be approved by the Flag Administration or the Society on their behalf.