Common Structural Rules for Double Hull Oil Tankers, January 2006

Corrigenda 2
Rule Editorials and Clarifications

Notes: (1) These Rule Corrigenda enter into force on 1st April 2006.

(2) This document contains a copy of the affected rule along with the editorial change or clarification noted as applicable.

SECTION 1 – INTRODUCTION

1 INTRODUCTION TO COMMON STRUCTURAL RULES FOR OIL TANKERS

1.1 General

1.1.1 Applicability

1.1.1.1 These Rules apply to double hull oil tankers of 150m length, *L*, and upward classed with the Society and contracted for construction[1] on or after 1 April 2006. The definition of the rule length, *L*, is given in *Section 4/1.1.1.1.*

1.1.1.2 Generally, for double hull tankers of less than 150m in length, *L*, the Rules of the individual Classification Society are to be applied.

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Reason for the Rule Clarification:
Clarification of length to be used for determination of applicability of the CSR.

SECTION 2 – RULE PRINCIPLES

5 APPLICATION OF PRINCIPLES

5.6 Application of Rule Requirements

5.6.6 Relationship between the prescriptive scantling requirements and the strength assessment (FEM)

5.6.6.2 The section modulus and/or shear area of a primary support member and/or the cross sectional area of a primary support member cross tie may be reduced to 85% of the prescriptive requirements provided that the reduced scantlings comply with the strength assessment (FEM).

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Reason for the Rule Clarification:
Editorial correction – for consistency with Section 8/2.6.1.4.

5 CALCULATION AND EVALUATION OF SCANTLING REQUIREMENTS

5.3 Calculation and Evaluation of Scantling Requirements for Primary Support Members

5.3.2 Shear requirements of primary support members

5.3.2.3 These requirements are to be evaluated against the actual shear area of the primary support member. The actual shear area of the primary support member is defined in *Section 4/2.5.1*. The effect of brackets may be included in the calculation of effective span, but are not to be included in the calculation of actual shear area.

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Reason for the Rule Clarification:
Editorial correction – definition of shear area in this sub-paragraph is incorrect; reference is made to appropriate section.

5.3.3 Bending requirements of primary support members

5.3.3.1 Requirements for section modulus and moment of inertia of primary support members are given in *Section 8* and *Section 10*, respectively.

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Reason for Rule Clarification:
Editorial correction.

5.3.3.4 Where it is impracticable to fit a primary support member with the required web depth, then it is permissible to fit a member with reduced depth provided that the fitted member has equivalent inertia to the required member. The required equivalent inertia is to be based on an equivalent section given by the effective width of plating at mid span with required plate thickness, web of required depth and thickness and face plate of sufficient width and thickness to satisfy the required mild steel section modulus. All other rule requirements, such as minimum thicknesses, slenderness (s/t) ratio, section modulus and shear area, are to be satisfied for the member of reduced depth.

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Reason for Rule Clarification:
Editorial correction to clarify the name of s/t ratio.

SECTION 4 BASIC INFORMATION

1 DEFINITIONS

1.1 Principal Particulars

1.1.8 Maximum Service Speed

V, the maximum ahead service speed, in knots, means the greatest speed which the ship is designed to maintain in service at her deepest sea-going draught at the maximum propeller RPM and corresponding engine MCR (Maximum Continuous Rating).

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Reason for Rule Clarification:

To avoid the ambiguity created by similar but not exactly the same wording as the intended definition from IACS UR M42 Appendix 1.

2 STRUCTURAL IDEALISATION

2.3 Effective Breadth of Plating

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2.3.2 Effective breadth of attached plate and flanges of primary support members for strength evaluation

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2.3.2.2 At the end of the span where no effective end bracket is fitted, the effective breadth of attached plate, b_{eff}, for calculating the section modulus and/or moment of inertia of a primary support member is to be taken as:

$$b_{eff} = 0.67\,S \sin\left[\frac{\pi}{6}\left(\frac{l_{bdg}(1-\frac{1}{\sqrt{3}})}{2S}\right)\right] \quad \text{m} \qquad \text{for } \left(\frac{l_{bdg}(1-\frac{1}{\sqrt{3}})}{2S}\right) \le 3$$

$$b_{eff} = 0.67S \quad \text{m} \qquad \text{for } \left(\frac{l_{bdg}(1-\frac{1}{\sqrt{3}})}{2S}\right) > 3$$

Where:

S mean spacing of primary support member as defined in 2.2.2 at position considered, in m

l_{bdg} effective bending span, as defined in 2.1.4, in m

Note sin() is to be calculated in radians

Reason for Rule Clarification :

Editorial correction.

2.3.2.3 At mid span, the effective breadth of attached plate, b_{eff}, for calculating the section modulus and/or moment of inertia of a primary support member is to be taken as:

$$b_{eff} = S \sin\left[\frac{\pi}{18}\left(\frac{l_{bdg}}{S\sqrt{3}}\right)\right] \quad \text{m} \qquad \text{for } \left(\frac{l_{bdg}}{S\sqrt{3}}\right) \leq 9$$

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$$b_{eff} = 1.0S \quad \text{m} \qquad \text{for } \left(\frac{l_{bdg}}{S\sqrt{3}}\right) > 9$$

Where:

S mean spacing of primary support member as defined in *2.2.2* at position considered, in m

l_{bdg} effective bending span, as defined in *2.1.4*, in m

Note sin() is to be calculated in radians

Reason for Rule Clarification:
Editorial correction.

2.3.3 Effective breadth of attached plate of local support members for fatigue strength evaluation

2.3.3.3 At mid span, the effective breadth of attached plate, b_{eff}, to be used for calculating the combined section modulus of the stiffener and attached plate is to be taken as:

$$b_{eff} = s \sin\left[\frac{\pi}{18}\left(\frac{1000 l_{bdg}}{s\sqrt{3}}\right)\right] \quad \text{mm} \qquad \text{for } \left(\frac{1000 l_{bdg}}{s\sqrt{3}}\right) \leq 9$$

Deleted: $b_{eff} = s \sin\left[\frac{\pi}{6}\left(\frac{1000 l_{bd}}{s\sqrt{3}}\right.\right.$

$$b_{eff} = 1.0\, s \quad \text{mm} \qquad \text{for } \left(\frac{1000 l_{bdg}}{s\sqrt{3}}\right) > 9$$

Where:

s stiffener spacing, in mm, as defined in *2.2.1*

l_{bdg} effective bending span, as defined in *2.1.1*, in m

Note sin() is to be calculated in radians

Reason for Rule Clarification:
Editorial correction.

2.4 Geometrical Properties of Local Support Members

2.4.1 Calculation of net section properties for local support members

2.4.1.1 The net section modulus, moment of inertia and shear area properties of local support members are to be calculated using the net thicknesses of the attached plate, web and flange.

Reason for Rule Clarification:
Editorial correction.

2.4.2 Effective elastic sectional properties of local support members

2.4.2.2 The effective shear depth of stiffeners, d_{shr}, is to be taken as:

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$$d_{shr} = (h_{stf} + t_{p-net})\sin\varphi_w \quad \text{mm}$$

Where:

h_{stf} stiffener height, including face plate, in mm. See also *2.4.1.2*

t_{p-net} net thickness of attached plate, in mm

φ_w angle between the stiffener web and attached plating, see *Figure 4.2.14*, in degrees. φ_w is to be taken as 90 degrees if the angle is greater than or equal to 75 degrees

Reason for Rule Clarification:
Editorial correction - "shear depth" is more relevant than "web depth" since total depth including the thicknesses of flange and attached plate are to be included.

2.5 Geometrical Properties of Primary Support Members

2.5.1 Effective shear area of primary support members

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Reason for Rule Clarification:
Editorial correction.

3 STRUCTURE DESIGN DETAILS

3.4 Intersections of Continuous Local Support Members and Primary Support Members

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

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3.4.3.3 The load, W_1, transmitted through the shear connection is to be taken as:

$$W_1 = W\left(\alpha_a + \frac{A_{1-net}}{4 f_c A_{w-net} + A_{1-net}}\right) \quad \text{kN}$$

$W_1 = W$ if the web stiffener is not connected to the intersecting stiffener

Where:

W the total load, in kN, as defined in *3.4.3.2*

α_a panel aspect ratio, not to be taken greater than 0.25

$$= \frac{s}{1000 S}$$

S primary support member spacing, in m

s stiffener spacing, in mm

$A_{1\text{-}net}$ effective net shear area of the connection, to be taken as the sum of the components of the connection:

$$A_{1d-net} + A_{1c-net} \quad \text{cm}^2$$

in case of a slit type slot connections area, $A_{1\text{-}net}$, is given by:

$$A_{1-net} = 2 l_d t_{w-net} 10^{-2} \quad \text{cm}^2$$

in case of a typical double lug or collar plate connection area, $A_{1\text{-}net}$, is given by:

$$A_{1-net} = 2 f_1 l_c t_{c-net} 10^{-2} \quad \text{cm}^2$$

$A_{1d\text{-}net}$ net shear connection area excluding lug or collar plate, as given by the following and *Figure 4.3.5*:

$$A_{1d-net} = l_d t_{w-net} 10^{-2} \quad \text{cm}^2$$

l_d length of direct connection between stiffener and primary support member web, in mm

$t_{w\text{-}net}$ net web thickness of the primary support member, in mm

$A_{1c\text{-}net}$ net shear connection area with lug or collar plate, given by the following and *Figure 4.3.5*:

$$A_{1c-net} = f_1 l_c t_{c-net} 10^{-2} \quad \text{cm}^2$$

l_c length of connection between lug or collar plate and primary support member, in mm

$t_{c\text{-}net}$ net thickness of lug or collar plate, not to be taken greater than the net thickness of the adjacent primary support member web, in mm

f_1 shear stiffness coefficient:

= 1.0 for stiffeners of symmetrical cross section

= 140/w for stiffeners of asymmetrical cross section but is not to be taken as greater than 1.0

w the width of the cut-out for an asymmetrical stiffener, measured from the cut-out side of the stiffener web, in mm, as indicated in *Figure 4.3.5*

$A_{w\text{-}net}$ effective net cross-sectional area of the primary support member web stiffener in way of the connection including backing bracket where fitted, as shown in *Figure 4.3.6,* in cm^2. If the primary support member web stiffener incorporates a soft heel ending or soft heel and soft toe ending, $A_{w\text{-}net}$, is to be measured at the throat of the connection, as shown in *Figure 4.3.6*.

f_c the collar load factor defined as follows:

for intersecting stiffeners of symmetrical cross section:

= 1.85 for $A_{w\text{-}net} \le 14$

= $1.85 - 0.0441(A_{w\text{-}net} - 14)$ for $14 < A_{w\text{-}net} \le 31$

= $1.1 - 0.013(A_{w\text{-}net} - 31)$ for $31 < A_{w\text{-}net} \le 58$

$= 0.75$ for $A_{w-net} > 58$

for intersecting stiffeners of asymmetrical cross section:

$$= 0.68 + 0.0172 \frac{l_s}{A_{w-net}}$$

where:

$l_s = l_c$ for a single lug or collar plate connection to the primary support member

$= l_d$ for a single sided direct connection to the primary support member

= mean of the connection length on both sides, i.e., in the case of a lug or collar plus a direct connection, $l_s = 0.5(l_c+l_d)$

Reason for Rule Clarification:

Editorial correction.

Table 4.3.1

Permissible Stresses for Connection between Stiffeners and Primary Support Members

Item	Direct Stress, σ_{perm}, in N/mm²			Shear Stress, τ_{perm}, in N/mm²		
	Acceptance Criteria Set See *3.4.3.2*			Acceptance Criteria Set See *3.4.3.2*		
	AC1	AC2	AC3	AC1	AC2	AC3
Primary support member web stiffener	$0.83\sigma_{yd}$ (3)	σ_{yd}	σ_{yd}	-	-	-
Primary support member web stiffener to intersecting stiffener in way of weld connection:						
double continuous fillet	$0.58\ \sigma_{yd}$ (3)	$0.70\ \sigma_{yd}$ (3)	σ_{yd}	-	-	-
partial penetration weld	$0.83\ \sigma_{yd}$ (2)(3)	σ_{yd} (2)	σ_{yd}	-	-	-
Primary support member stiffener to intersecting stiffener in way of lapped welding	$0.50\ \sigma_{yd}$	$0.60\ \sigma_{yd}$	σ_{yd}	-	-	-
Shear connection including lugs or collar plates:						
single sided connection	-	-	-	$0.71\ \tau_{yd}$	$0.85\ \tau_{yd}$	τ_{yd}
double sided connection	-	-	-	$0.83\ \tau_{yd}$	τ_{yd}	τ_{yd}

Where:

τ_{perm} permissible shear stress, in N/mm²

σ_{perm} permissible direct stress, in N/mm²

σ_{yd} minimum specified material yield stress, in N/mm²

τ_{yd} $\frac{\sigma_{yd}}{\sqrt{3}}$, in N/mm²

Note

1. The stress computation on plate type members is to be performed on the basis of net thicknesses, whereas gross values are to be used in weld strength assessments, see *3.4.3.11*.
2. The root face is not to be greater than one third of the gross thickness of the primary support member stiffener.
3. Allowable stresses may be increased by 5 percent where a soft heel is provided in way of the heel of the primary support member web stiffener.

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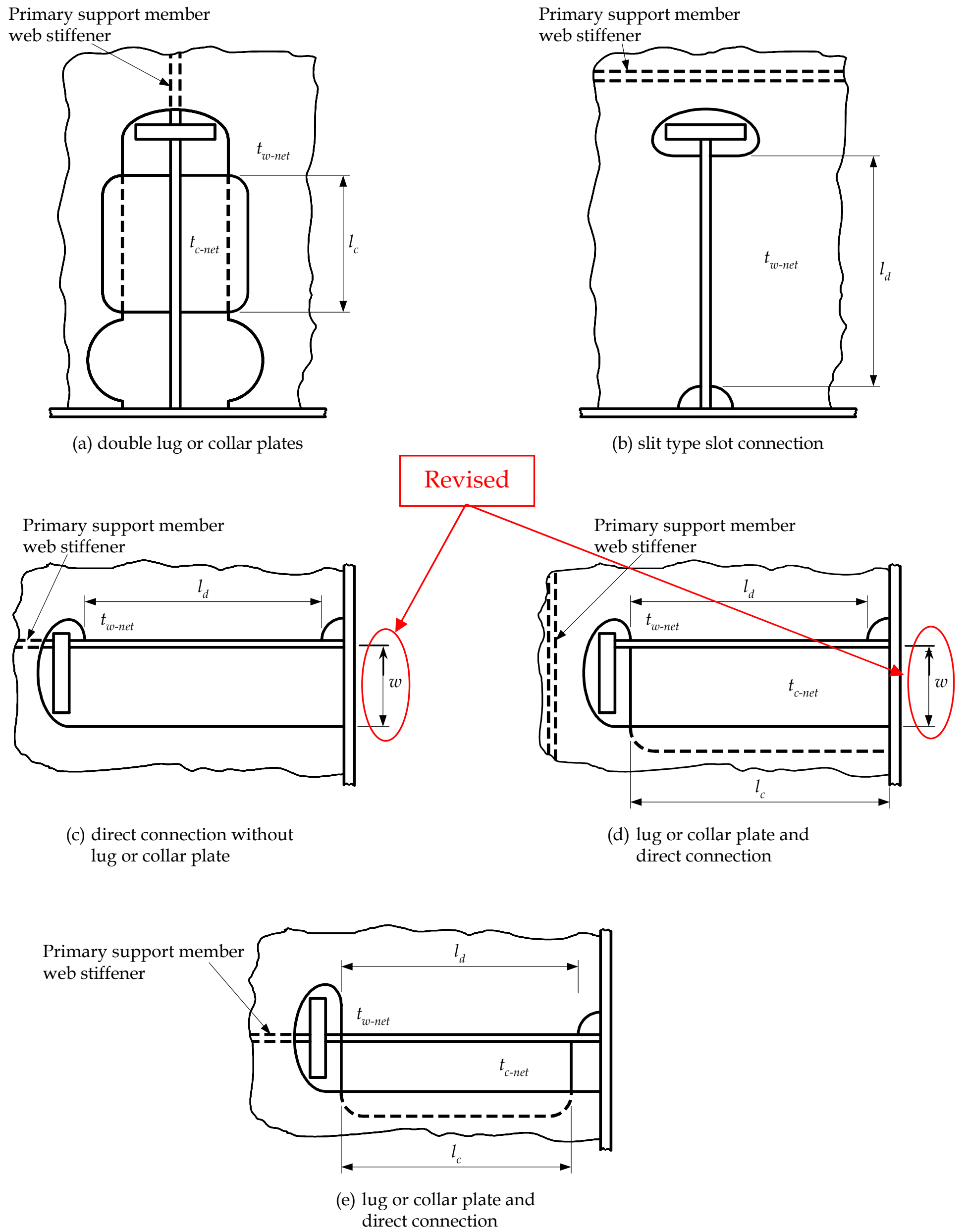
Reason for Rule Clarification:

Editorial correction - Increasing the allowable stress as per “Note 3” is not applicable for the acceptance criteria of σ_{yd}.

Figure 4.3.5
Symmetric and Asymmetric Cut outs



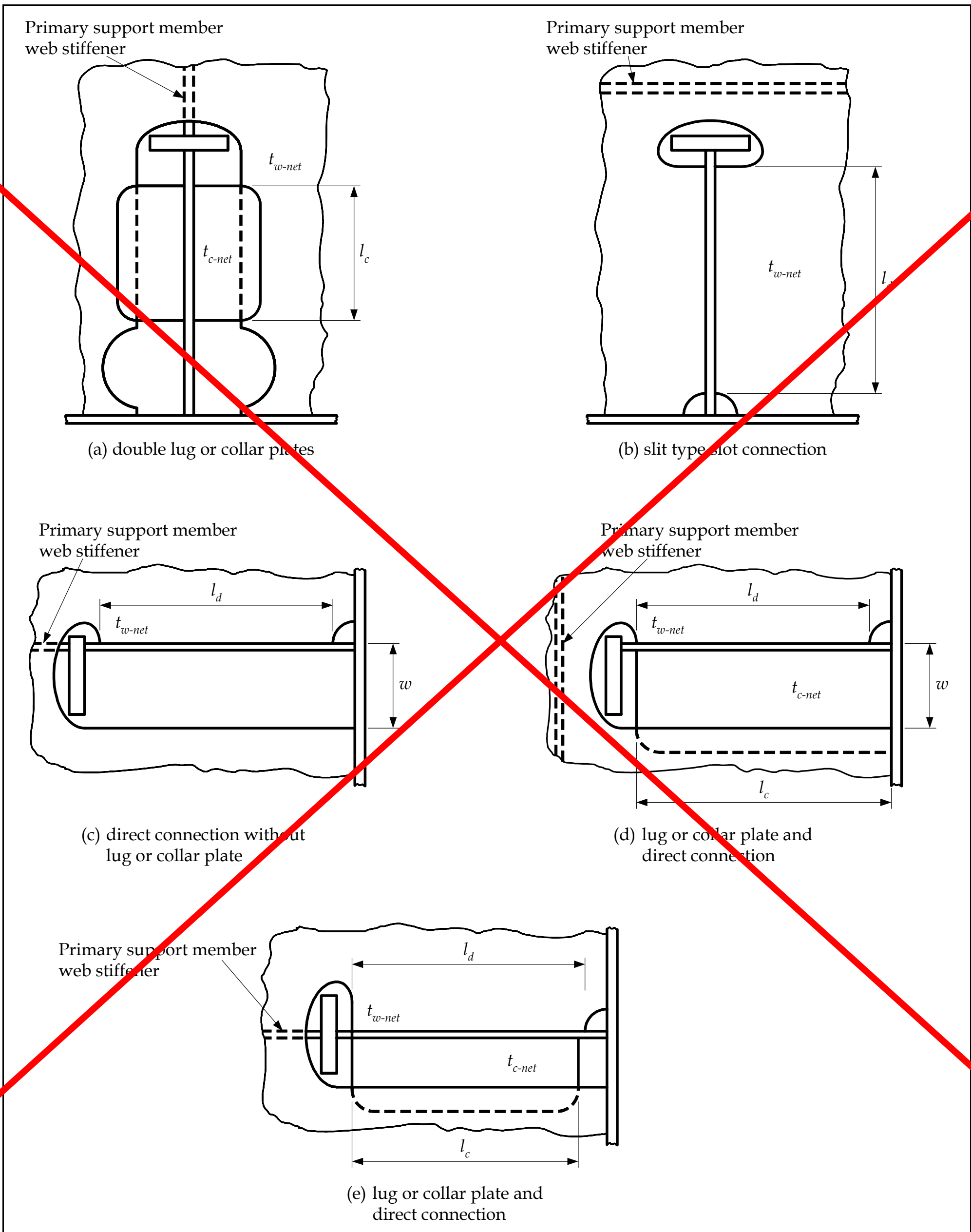
(a) double lug or collar plates

(b) slit type slot connection

(c) direct connection without lug or collar plate

(d) lug or collar plate and direct connection

(e) lug or collar plate and direct connection



Note

The details shown in this figure are only used to illustrate symbols and definitions and are not intended to represent design guidance or recommendations.

Reason for Rule Clarification:

Editorial correction - fix the figure for consistency with the definition of "w" in 3.4.3.3.

3.5 Openings

3.5.4 Manholes and lightening holes requiring reinforcement

3.5.4.1 Manholes and lightening holes are to be stiffened as required by *3.5.4.2* and *3.5.4.3*. The stiffening requirements of *3.5.4.2* and *3.5.4.3* may be modified where alternative arrangements are demonstrated as satisfactory with regards to stress and stability, in accordance with analysis methods described in *Section 9/2*.

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Reason for Rule Clarification:

Editorial correction.

SECTION 5 STRUCTURAL ARRANGEMENT

1 GENERAL

1.1 Introduction

1.1.1 Scope

1.1.1.1 This section covers the general structural arrangement requirements for the ship, which are based on or derived from National and International regulations, see *Sections 2/2.1.1* and *3/3.3*.

Reason for Rule Clarification:

Editorial correction

3 CORROSION ADDITIONS

3.3 Application of Corrosion Additions

3.3.3 Application for scantling assessment of plates and local support members

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3.3.3.1 The required gross thickness for plates and local support members are calculated by adding the full corrosion addition, i.e. $+1.0t_{corr}$, to the net thickness required in accordance with the scantling requirements in *Sections 4/3.4 and 8/2* to *8/7*.

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3.3.3.2 The net sectional properties of local support members are calculated by deducting the full corrosion margin, i.e. $-1.0t_{corr}$, from the web, flange and attached plate gross thicknesses as described in *Section 4/2.4.1* and are to comply with required section modulus, moment of inertia and shear area as given in *Sections 4/3.4 and 8/2* to *8/7*.

Reason for Rule Clarification:

Editorial correction with addition of the requirements of cut-outs in accordance with Section 4/3.4.

4 SLOSHING AND IMPACT LOADS

4.2 Sloshing Pressure in Tanks

4.2.1 Application and limitations

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

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Reason for the Rule Clarification:

Clarification that the need for additional impact calculations is to be based on maximum sloshing length/breadth from all filling heights and not only at filling height giving maximum sloshing pressure.

4.2.2 Sloshing pressure due to longitudinal liquid motion

4.2.2.2 The sloshing pressure due to longitudinal liquid motion, $P_{slh-lng}$, is to be taken as a constant value over the full tank depth and is to be taken as the greater of the sloshing pressures calculated for filling heights from $0.05h_{max}$ to $0.95h_{max}$, in $0.05h_{max}$ increments.

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For tanks with web frames of standard design, e.g. vertical web on a longitudinal bulkhead with lower brackets, the maximum sloshing pressure will be given at a filling height of $0.7h_{max}$. Incremental calculations are typically required in case of tanks arranged with small wash bulkheads in which case the effective sloshing length will increase with increasing filling height and maximum pressure may be given at a filling height greater than $0.7h_{max}$.

Reason for the Rule Clarification:

Clarification that the need for additional impact calculations is to be based on maximum sloshing length/breadth from all filling heights and not only at filling height giving maximum sloshing pressure. Guidance note deleted to avoid confusion.

4.2.3 Sloshing pressure due to transverse liquid motion

4.2.3.2 The sloshing pressure due to transverse liquid motion, P_{slh-t}, is to be taken as a constant value over the full tank depth and is to be taken as the greater of the sloshing pressures calculated for filling heights from $0.05h_{max}$ to $0.95h_{max}$, in $0.05h_{max}$ increments.

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For tanks with webframes of standard design, e.g. vertical web on a longitudinal bulkhead with lower brackets, the maximum sloshing pressure will be given at a filling height of $0.7h_{max}$. Incremental calculations are typically required in case of tanks arranged with small wash bulkheads in which case the effective sloshing length will increase with increasing filling height and maximum pressure may be given at a filling height greater than $0.7h_{max}$.

Reason for the Rule Clarification:

Clarification that the need for additional impact calculations is to be based on maximum sloshing length/breadth from all filling heights and not only at filling height giving maximum sloshing pressure. Guidance note deleted to avoid confusion.

4 SLOSHING AND IMPACT LOADS

4.3 Bottom Slamming Loads

4.3.2 Slamming pressure

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

$$P_{slm-mt} = f_{slm} 130 g c_{slm-mt} e^{c_1} \quad \text{kN/m}^2 \quad \text{for empty ballast tanks}$$

$$P_{slm-full} = f_{slm} 130 g c_{slm-full} e^{c_1} - c_{av} \rho g z_{ball} \quad \text{kN/m}^2 \quad \text{for full ballast tanks}$$

Where:

g acceleration due to gravity, 9.81 m/s²

f_{slm} longitudinal slamming distribution factor, see *Figure 7.4.5*, is to be taken as:

0 at 0.5L

1 at $[0.175 - 0.5(C_{bl} - 0.7)]L$ from F.P.

1 at $[0.1 - 0.5(C_{bl} - 0.7)]L$ from F.P.

0.5 at, and forward of F.P.

intermediate values to be obtained by linear interpolation.

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

c_{slm-mt} slamming coefficient for empty ballast tanks

$$= 5.95 - 10.5\left(\frac{T_{FP-mt}}{L}\right)^{0.2}$$

$c_{slm-full}$ slamming coefficient for full ballast tanks

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

c_1 is to be taken as:

0 for $L \le 180$m

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

T_{FP-mt} design slamming ballast draught at F.P. with ballast tanks within the bottom slamming region empty as defined in *4.3.2.3*, in m

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$T_{FP-full}$ design slamming ballast draught at F.P. with ballast tanks within the bottom slamming region full as defined in *4.3.2.4*, in m

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c_{av} dynamic load coefficient, to be taken as 1.25

L rule length, in m, as defined in *Section 4/1.1.1.1*

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

Reason for Rule Clarification:

Editorial correction – incorrect reference.

4.4 Bow Impact Loads

4.4.2 Bow impact pressure

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

$$P_{im} = 1.025 f_{im} c_{im} V_{im}^2 \sin \gamma_{wl} \quad \text{kN/m}^2$$

Where:

f_{im} 0.55 at 0.1L aft of F.P.

0.9 at 0.0125L aft of F.P.

1.0 at and forward of F.P.

intermediate values to be obtained by linear interpolation

V_{im} impact speed, in m/s

$= 0.514 V_{fwd} \sin \alpha_{wl} + \sqrt{L}$

V_{fwd} forward speed, in knots

= 0.75V but is not to be taken as less than 10

V service speed, in knots, as defined in *Section 4/1.1.8.1*

α_{wl} local waterline angle at the position considered, but is not to be taken as less than 35 degrees, see *Figure 7.4.6*.

γ_{wl} local bow impact angle measured normal to the shell at the position considered but is not to be less than 50 degrees, see *Figure 7.4.6*.

c_{im} 1.0 for positions between draughts T_{bal} and T_{sc}

$= \sqrt{1 + \cos^2 [90 \frac{(h_{fb} - 2h_o)}{h_{fb}}]}$ for positions above draught T_{sc}

h_{fb} vertical distance from the waterline at draught T_{sc} to the highest deck at side, see *Figure 7.4.6,* in m

h_o vertical distance from the waterline at draught T_{sc}, to the position considered, see *Figure 7.4.6*, in m

L rule length, in m, as defined in *Section 4/1.1.1.1*

T_{sc} scantling draught, in m, as defined in *Section 4/1.1.5.5*

T_{bal} minimum design ballast draught, in m, for the normal ballast condition as defined in *Section 4/1.1.5.2*

WL_j waterline at the position considered, see *Figure 7.4.6*

Reason for Rule Clarification:

Editorial correction

6 COMBINATION OF LOADS

6.3 Application of Dynamic Loads

6.3.5 Dynamic wave pressure distribution for a considered dynamic load case

6.3.5.2 The simultaneously acting dynamic wave pressure for the port and starboard side outside the cargo region, $P_{wv\text{-}dyn}$, for a considered dynamic load case is to be obtained by linear interpolation between P_{ctr} and P_{WL}, but not to be taken less than $-\rho_{sw} g (T_{LC} - z)$ below still waterline or less than 0 above still waterline.

$$P_{wv-dyn} = P_{ctr} + \frac{z}{T_{LC}}(P_{WL} - P_{ctr})$$ between bottom centreline and still waterline

$$P_{wv-dyn} = P_{WL} - 10(z - T_{LC})$$ above still waterline

Where:

P_{ctr} dynamic wave pressure at bottom centreline, and is to be taken as:

$f_{ctr} P_{ex-\max}$ kN/m²

P_{WL} dynamic wave pressure at still waterline, and is to be taken as:

$f_{WL} P_{ex-\max}$ kN/m²

$P_{ex\text{-}max}$ envelope maximum dynamic wave pressure, in kN/m², as defined in *3.5.2.2*

f_{WL} dynamic load combination factor for dynamic wave pressure at still waterline for considered dynamic load case, see *6.3.1.2*

f_{ctr} dynamic load combination factor for dynamic wave pressure at centreline for considered dynamic load case, see *6.3.1.2*

T_{LC} draught in the loading condition being considered, in m

z vertical coordinate, in m

ρ_{sw} density of sea water, 1.025tonnes/m³

g acceleration due to gravity, 9.81m/s²

Reason for the Rule Clarification:

Clarification of the dynamic sea pressure above waterline outside the cargo region.

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SECTION 8 – SCANTLING REQUIREMENTS

1 LONGITUDINAL STRENGTH

1.1 Loading Guidance

1.1.2 Loading Manual

1.1.2.9 The following additional loading conditions are to be included in the Loading Manual if the ship is specifically approved and intended to be operated in such conditions:

(a) sea-going ballast conditions including water ballast carried in one or more cargo tanks which are intended for use in emergency situations as allowed by MARPOL Regulation 13. (Ship approved for loading pattern A8 of *Table B.2.3* or B7 of *Table B.2.4*)

(b) seagoing loading conditions where the net static upward load on the double bottom exceeds that given with the combination of an empty cargo tank and a mean ship's draught of $0.9T_{sc}$

(c) seagoing loading conditions with cargo tanks less than 25% full with the combination of mean ship's draught greater than $0.9T_{sc}$

(d) seagoing loading conditions where the net static downward load on the double bottom exceeds that given with the combination of a full cargo tank at a cargo density of 1.025 tonnes/m^3 and a mean ship's draught of $0.6T_{sc}$

(e) for ships arranged with cross ties in the centre cargo tank , seagoing loading conditions showing a non-symmetric loading pattern where the difference in filling level between corresponding port and starboard wing cargo tanks exceeds 25% of the filling height in the wing cargo tank (Ship approved for loading pattern A7 of *Table B.2.3*

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Reason for Rule Clarification:

Editorial corrections and amendment to align with intent of rule as specified in B/2.3.1.3.

1.3 Hull Girder Shear Strength

1.3.3 Shear force correction for longitudinal bulkheads between cargo tanks

1.3.3.1 For longitudinal bulkheads between cargo tanks the effective net plating thickness of the plating above the inner bottom, $t_{sfc\text{-}net50}$ for plate *ij*, used for calculation of hull girder shear strength, $Q_{v\text{-}net50}$, is to be corrected for local shear distribution and is given by:

$$t_{sfc-net50} = t_{grs} - 0.5t_{corr} - t_{\Delta} \quad \text{mm}$$

Where:

t_{grs} gross plate thickness, in mm

t_{corr} corrosion addition, in mm, as defined in *Section 6/3.2*

t_{Δ} thickness deduction for plate *ij*, in mm, as defined in *1.3.3.2*

1.3.3.2 The vertical distribution of thickness reduction for shear force correction is assumed to be triangular as indicated in *Figure 8.1.3*. The thickness deduction, t_Δ, to account for shear force correction is to be taken as:

$$t_\Delta = \frac{\delta Q_3}{h_{blk}\tau_{ij-perm}}\left(1-\frac{x_{blk}}{0.5l_{tk}}\right)\left(2-\frac{2(z_p-h_{db})}{h_{blk}}\right) \quad \text{mm}$$

Where:

δQ_3 shear force correction for longitudinal bulkhead as defined in *1.3.3.3* and *1.3.3.5* for ships with one or two longitudinal bulkheads respectively, in kN.

l_{tk} length of cargo tank, in m

h_{blk} height of longitudinal bulkhead, in m, defined as the distance from inner bottom to the deck at the top of the bulkhead, as shown in *Figure 8.1.3*

x_{blk} the minimum longitudinal distance from section considered to the nearest cargo tank transverse bulkhead, in m. To be taken positive and not greater than $0.5l_{tk}$

z_p the vertical distance from the lower edge of plate *ij* to the base line, in m. Not to be taken as less than h_{db}

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h_{db} height of double bottom, in m, as shown in *Figure 8.1.3*

$\tau_{ij-perm}$ permissible hull girder shear stress, τ_{perm}, in N/mm^2 for plate *ij*

$= 120/k_{ij}$

k_{ij} higher strength steel factor, *k*, for plate *ij* as defined in *Section 6/1.1.4*

Reason for the Rule Clarification:

Clarification that the thickness reduction t_Δ does not apply to the part of the longitudinal bulkhead within the double bottom.

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1.4 Hull Girder Buckling Strength

1.4.2 Buckling assessment

1.4.2.7 The shear buckling strength, of plate panels, is to satisfy the following criteria:

$$\eta \le \eta_{allow}$$

Where:

η buckling utilisation factor

$$\frac{\tau_{hg-net50}}{\tau_{cr}}$$

$\tau_{hg-net50}$ design hull girder shear stress, in N/mm^2, as defined in *1.4.2.5*

τ_{cr} critical shear buckling stress, in N/mm^2, as specified in *Section 10/3.2.1.3*. The critical shear buckling stress is to be calculated for the effects of hull girder shear stress only. The effects of other membrane stresses and lateral pressure are to be ignored. The net thickness given as $t_{grs} - t_{corr}$ as described in *Section 6/3.3.2.2* is to be used for the calculation of τ_{cr}

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η_{allow} allowable buckling utilisation factor

= 0.95

t_{grs} gross plate thickness, in mm

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t_{corr} corrosion addition, in mm, as defined in *Section 6/3.2*

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Reason for the Rule Clarification:

Clarification of which thickness to use for calculation of buckling capacity.

2 CARGO TANK REGION

2.1 General

2.1.4 General scantling requirements

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2.1.4.7 All shell frames and tank boundary stiffeners are in general to be continuous, or are to be bracketed at their ends, except as permitted in *Sections 4/3.2.4* and *4/3.2.5*.

Deleted: See also *Section 4/3.2.*

Reason for the Rule Clarification:

Editorial correction - delete duplicating reference to *Sections 4/3*.

2.2 Hull Envelope Plating

2.2.4 Side shell plating

2.2.4.3 The thickness in *2.2.4.2* is to be applied to the following extent of the side shell plating, see *Figure 8.2.2*:

(a) longitudinal extent:

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- between a section aft of amidships where the breadth at the waterline exceeds 0.9*B*, and a section forward of amidships where the breadth at the waterline exceeds 0.6*B*

(b) vertical extent:

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- between 300mm below the minimum design ballast waterline, T_{bal}, amidships to $0.25T_{sc}$ or 2.2m, whichever is greater, above the draught T_{sc}.

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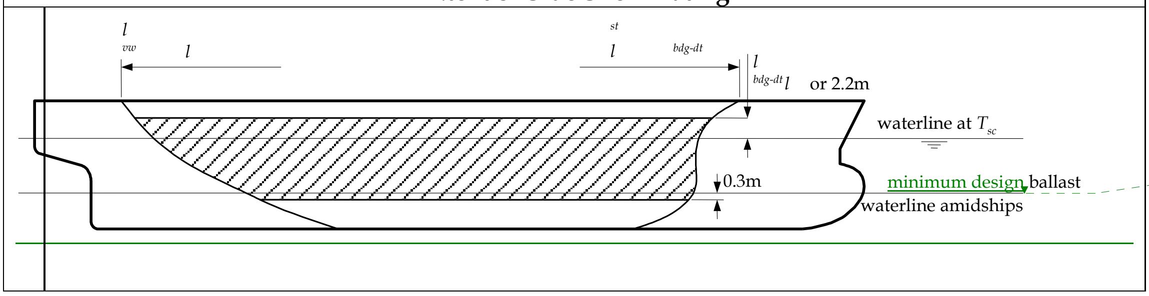
Figure 8.2.2
Extent of Side Shell Plating



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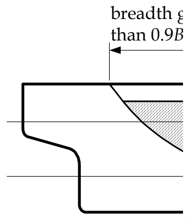
Deleted: 

Reason for Rule Clarification:

Editorial correction to explicitly define draught.

2.5 Bulkheads

2.5.6 Corrugated bulkheads

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2.5.6.1 The scantling requirements relating to corrugated bulkheads defined in *2.5.6* and *2.5.7* are net requirements. The gross scantling requirements are obtained from the applicable requirements by adding the full corrosion additions specified in *Section 6/3*.

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Reason for Rule Clarification:

Editorial correction

2.5.6.3 The global strength of corrugated bulkheads, lower stools and upper stools, where fitted, and attachments to surrounding structures are to be verified with the cargo tank FEM model in the midship region, see *Section 9/2*. The global strength of corrugated bulkheads outside of midship region are to be considered based on results from the cargo tank FEM model and using the appropriate pressure for the bulkhead being considered. Additional FEM analysis of cargo tank bulkheads forward and aft of the midship region may be necessary if the bulkhead geometry, structural details and support arrangement details differ significantly from bulkheads within the mid cargo tank region.

Reason for Rule Clarification:

Editorial correction

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2.5.7 Vertically corrugated bulkheads

2.5.7.2 The net plate thicknesses as required by *2.5.7.5* and *2.5.7.6* are to be maintained for two thirds of the corrugation length, l_{cg}, from the lower end, where l_{cg} is as defined in *2.5.7.3*. Above that, the net plate thickness may be reduced by 20%.

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Reason for Rule Clarification:

Editorial correction

2.5.7.5 The net thicknesses of the flanges of corrugated bulkheads, $t_{f\text{-}net}$, for two thirds of the corrugation length from the lower end are to be taken as the greatest value calculated for all applicable design load sets, as given in *Table 8.2.7*, and given by the following. This requirement is not applicable to corrugated bulkheads without a lower stool, see *2.5.7.9*.

Reason for Rule Clarification:

Clarification that the buckling based flange thickness requirement is applicable for two thirds of the corrugation length from the lower end.

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2.5.7.6 The net section modulus at the lower and upper ends and at the mid length of the corrugation ($l_{cg}/2$) of a unit corrugation, $Z_{cg\text{-}net}$, are to be taken as the greatest value calculated for all applicable design load sets, as given in *Table 8.2.7*, and given by the following. This requirement is not applicable to corrugated bulkheads without a lower stool, see *2.5.7.9*.

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Reason for Rule Clarification:

Editorial correction – unnecessary duplication

2.5.7.8 For ships with a moulded depth, see *Section 4/1.1.4*, equal to or greater than 16m, a lower stool is to be fitted in compliance with the following requirements:

(c) stool side plating and internal structure:

- within the region of the corrugation depth from the stool top plate the net thickness of the stool side plate is not to be less than 90% of that required by *2.5.7.2* for the corrugated bulkhead flange at the lower end and is to be of at least the same material yield strength
- the net thickness of the stool side plating and the net section modulus of the stool side stiffeners is not to be less than that required by *2.5.2*, *2.5.4* and *2.5.5* for transverse or longitudinal bulkhead plating and stiffeners
- the ends of stool side vertical stiffeners are to be attached to brackets at the upper and lower ends of the stool
- continuity is to be maintained, as far as practicable, between the corrugation web and supporting brackets inside the stool. The bracket net thickness is not to be less than 80% of the required thickness of the corrugation webs and is to be of at least the same material yield strength
- scallops in the diaphragms in way of the connections of the stool sides to the inner bottom and to the stool top plate are not permitted.

Reason for Rule Clarification:

Editorial correction

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

(c) supporting structure:

- within the region of the corrugation depth below the inner bottom the net thickness of the supporting double bottom floors or girders is not to be less than the net thickness of the corrugated bulkhead flange at the lower end and is to be of at least the same material yield strength
- the upper ends of vertical stiffeners on supporting double bottom floors or girders are to be bracketed to adjacent structure
- brackets/carlings arranged in line with the corrugation web are to have a depth of not less than 0.5 times the corrugation depth and a net thickness not

less than 80% of the net thickness of the corrugation webs and are to be of at least the same material yield strength

- cut outs for stiffeners in way of supporting double bottom floors and girders in line with corrugation flanges are to be fitted with full collar plates
- where support is provided by gussets with shedder plates, the height of the gusset plate, see h_g in *Figure 8.2.3*, is to be at least equal to the corrugation depth, and gussets with shedder plates are to be arranged in every corrugation. The gusset plates are to be fitted in line with and between the corrugation flanges. The net thickness of the gusset and shedder plates are not to be less than 100% and 80%, respectively, of the net thickness of the corrugation flanges and are to be of at least the same material yield strength. Also see *2.5.7.11*.
- scallops in brackets, gusset plates and shedder plates in way of the connections to the inner bottom or corrugation flange and web are not permitted.

Reason for Rule Clarification:

Editorial correction

Table 8.2.5
Section Modulus Requirements for Stiffeners

The minimum net section modulus, Z_{net}, is to be taken as the greatest value calculated for all applicable design load sets, as given in *Table 8.2.7*, and given by:

$$Z_{net} = \frac{|P| s\, l_{bdg}^{2}}{f_{bdg}\, C_s\, \sigma_{yd}} \quad \text{cm}^3$$

Where:

- P — design pressure for the design load set being considered and calculated at the load calculation point defined in *Section 3/5.2*, in kN/m²
- f_{bdg} — bending moment factor:
  for continuous stiffeners and where end connections are fitted consistent with idealisation of the stiffener as having as fixed ends:
  = 12 for horizontal stiffeners
  = 10 for vertical stiffeners
  for stiffeners with reduced end fixity see *Sub-section 7.*
- l_{bdg} — effective bending span, in m, as defined in *Section 4/2.1.1*
- s — as defined in *Section 4/2.2*, in mm
- σ_{yd} — specified minimum yield stress of the material, see also *Section 3/5.2.6.5*, in N/mm²
- C_s — permissible bending stress coefficient for the design load set being considered, to be taken as:

Sign of Hull Girder Bending Stress, σ_{hg}	Side Pressure Acting On	Acceptance Criteria
Tension (+ve)	Stiffener side	$C_s = \beta_s - \alpha_s \frac{\lvert\sigma_{hg}\rvert}{\sigma_{yd}}$ but not to be taken greater than C_{s-max}
Compression (-ve)	Plate side	
Tension (+ve)	Plate side	$C_s = C_{s-max}$
Compression (-ve)	Stiffener side	

Acceptance Criteria Set	Structural Member	β_s	α_s	C_{s-max}
AC1	Longitudinal strength member	0.85	1.0	0.75
	Transverse or vertical member	0.75	0	0.75
AC2	Longitudinal strength member	1.0	1.0	0.9
	Transverse or vertical member	0.9	0	0.9
	Watertight boundary Stiffeners	0.9	0	0.9

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- σ_{hg} — hull girder bending stress for the design load set being considered and calculated at the reference point defined in *Section 3/5.2.2.5*

$$= \left(\frac{(z - z_{NA-net50})\, M_{v-total}}{I_{v-net50}} - \frac{y\, M_{h-total}}{I_{h-net50}} \right) 10^{-3} \quad \text{N/mm}^2$$

- $M_{v-total}$ — design vertical bending moment at longitudinal position under consideration for the design load set being considered, in kNm.
  $M_{v-total}$ is to be calculated in accordance with *Table 7.6.1* using the permissible hogging or sagging still water bending moment, $M_{sw-perm}$, to be taken as:

Stiffener Location	$M_{sw-perm}$	
	Pressure acting on Plate Side	**Pressure acting on Stiffener Side**
Above Neutral Axis	Sagging SWBM	Hogging SWBM
Below Neutral Axis	Hogging SWBM	Sagging SWBM

- $M_{h-total}$ — design horizontal bending moment at longitudinal position under consideration for the design load set being considered, see *Table 7.6.1*, in kNm
- $I_{v-net50}$ — net vertical hull girder moment of inertia, at the longitudinal position being considered, as defined in *Section 4/2.6.1*, in m⁴
- $I_{h-net50}$ — net horizontal hull girder moment of inertia, at the longitudinal position being considered, as defined in *Section 4/2.6.2*, in m⁴
- y — transverse coordinate of the reference point defined in *Section 3/5.2.2.5*, in m
- z — vertical coordinate of the reference point defined in *Section 3/5.2.2.5*, in m
- $z_{NA-net50}$ — distance from the baseline to the horizontal neutral axis, as defined in *Section 4/2.6.1*, in m

Reason for Rule Clarification:

Editorial correction

Table 8.2.6
Web Thickness Requirements for Stiffeners

The minimum net web thickness, $t_{w\text{-}net}$, is to be taken as the greatest value calculated for all applicable design load sets, as given in *Table 8.2.7*, and given by:

$$t_{w-net} = \frac{f_{shr} \left| P \right| s\, l_{shr}}{d_{shr}\, C_t\, \tau_{yd}} \quad \text{mm}$$

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Where:

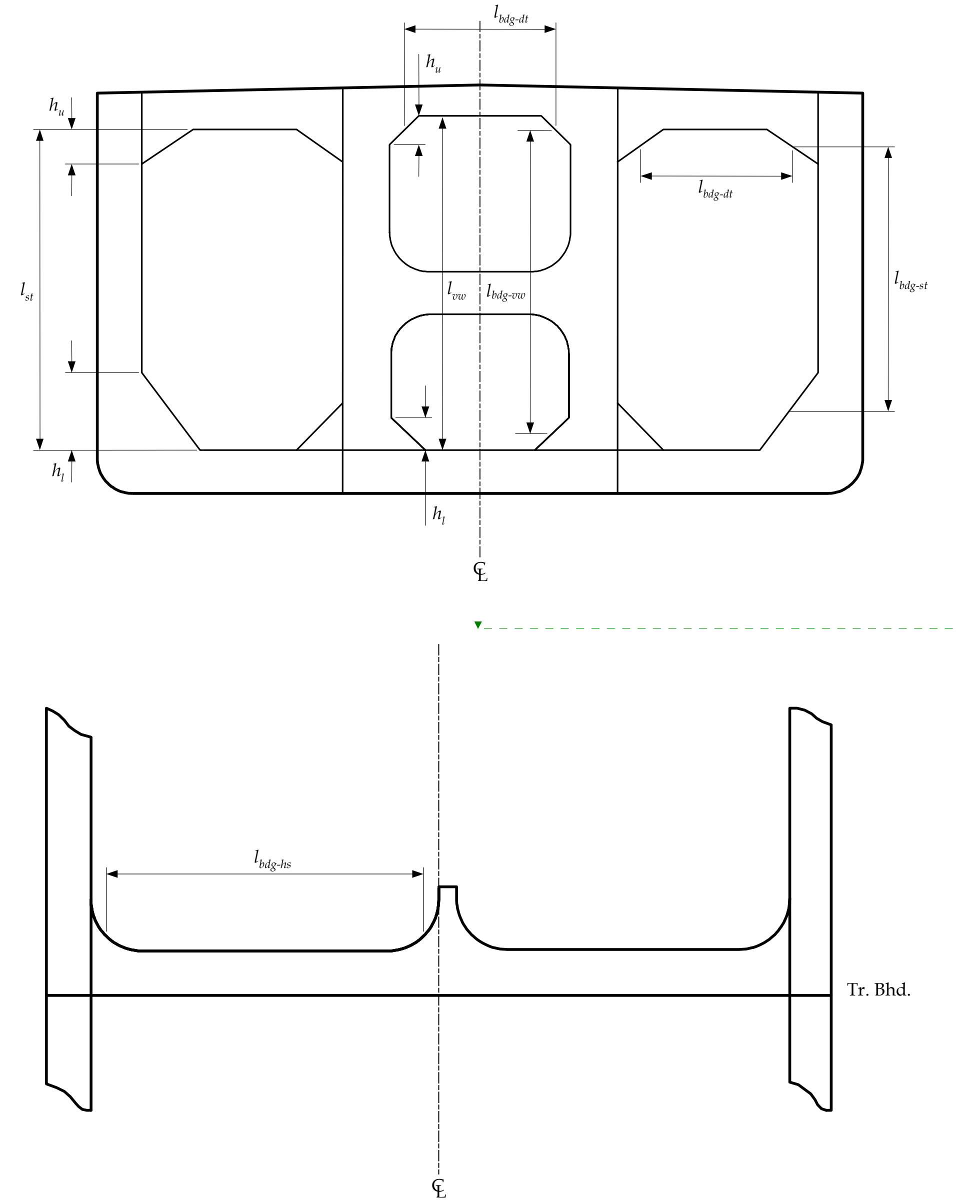
P	design pressure for the design load set being considered and calculated at the load calculation point defined in *Section 3/5.1*, in kN/m^2
f_{shr}	shear force distribution factor: for continuous stiffeners and where end connections are fitted consistent with idealisation of the stiffener as having as fixed ends: = 0.5 for horizontal stiffeners = 0.7 for vertical stiffeners for stiffeners with reduced end fixity, see *Sub-section 7*
d_{shr}	as defined in *Section 4/2.4.2.2*, in mm
C_t	permissible shear stress coefficient for the design load set being considered, to be taken as: = 0.75 for acceptance criteria set AC1 = 0.90 for acceptance criteria set AC2
s	as defined in *Section 4/2.2,* in mm
l_{shr}	effective shear span, in m, see *Section 4/2.1.2*
τ_{yd}	$= \frac{\sigma_{yd}}{\sqrt{3}}$ N/mm^2
σ_{yd}	specified minimum yield stress of the material, in N/mm^2

Reason for Rule Clarification:

Editorial correction

2.6 Primary Support Members

Figure 8.2.7 (Continued)
Definition of Spans of Deck, Side Transverses, Vertical Web Frames on Longitudinal Bulkheads and Horizontal Stringers on Transverse Bulkheads



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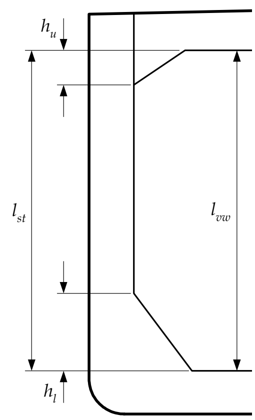

Reason for Rule Clarification:

Editorial correction - "lvw" was moved to centre tank; since it is more appropriate to measure "lvw" in centre tank where vertical web is located.

2.6.5 Side transverses

2.6.5.1 The net shear area, $A_{shr-net50}$, of side transverses is not to be less than:

$$A_{shr-net50} = \frac{10Q}{C_{t-pr}\,\tau_{yd}} \quad \text{cm}^2$$

Where:

Q design shear force as follows, in kN:

$= Q_u$ for upper part of the side transverse

$= Q_l$ for lower part of the side transverse

Q_u $= S[c_u\, l_{st}\, (P_u + P_l) - h_u\, P_u]$

where a cross tie is fitted in a wing cargo tank and l_{st-ct} is greater than $0.7l_{st}$, then l_{st} in the above formula is to be taken as l_{st-ct}.

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Q_l to be taken as the greater of the following:

$S[c_l\, l_{st}\, (P_u + P_l) - h_l\, P_l]$

$0.35\, c_l\, S\, l_{st}\, (P_u + P_l)$

$1.2\, Q_u$

where a cross tie is fitted in a wing cargo tank and l_{st-ct} is greater than $0.7l_{st}$, then l_{st} in the above formula is to be taken as l_{st-ct}.

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P_u design pressure for the design load set being considered, in kN/m^2, calculated at mid tank as follows:

where deck transverses are fitted below deck, P_u is to be calculated at mid height of upper bracket of the side transverse, h_u

where deck transverses are fitted above deck, P_u is to be calculated at the elevation of the deck at side, except in cases where item (c) applies

where deck transverses are fitted above deck and the inner hull longitudinal bulkhead is arranged with a top wing structure as follows:

- the breadth at top of the wing structure is greater than 1.5 times the breadth of the double side and
- the angle along a line between the point at base of the slope plate at its intersection with the inner hull longitudinal bulkhead and the point at the intersection of top wing structure and deck is 30 degrees or more to vertical

P_u is to be calculated at mid depth of the top wing structure

P_l corresponding design pressure for the design load set being considered, calculated at mid height of bilge hopper, h_l, located at mid tank, in kN/m^2.

l_{st} length of the side transverse, in m, and is to be taken as follows:

where deck transverses are fitted below deck, l_{st} is the length between the flange of the deck transverse and the inner bottom, see *Figure 8.2.7*

where deck transverses are fitted above deck, l_{st} is the length between the elevation of the deck at side and the inner bottom

l_{st-ct} length of the side transverse, in m, and is to be taken as follows:

where deck transverses are fitted below deck, l_{st} is the length between the flange of the deck transverse and mid depth of cross tie, where fitted in wing cargo tank

where deck transverses are fitted above deck, l_{st} is the length between the elevation of the deck at side and mid depth of the cross tie, where fitted in wing cargo tank

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

h_u effective length of upper bracket of the side transverse, in m, and is to be taken as follows:

(a) where deck transverses are fitted below deck, h_u is as shown in Figure 8.2.7 and as described in *Section 4/2.1.5*.

(b) where deck transverses are fitted above deck, h_u is to be taken as 0.0, except in cases where item (c) applies.

(c) where deck transverses are fitted above deck and the inner hull longitudinal bulkhead is arranged with a top wing structure as follows:

- the breadth at top of the wing structure is greater than 1.5 times the breadth of the double side, and
- the angle along a line between the point at base of the slope plate at its intersection with the inner hull longitudinal bulkhead and the point at the intersection of top wing structure and the deck is 30 degrees or more to vertical

h_u is to be taken as the distance between the deck at side and the lower end of slope plate of the top wing structure

h_l height of bilge hopper, in m, as shown in *Figure 8.2.7*

c_u and c_l as defined in *Table 8.2.13*

C_{t-pr} permissible shear stress coefficient for primary support member as given in *Table 8.2.10*

τ_{yd} $= \frac{\sigma_{yd}}{\sqrt{3}}$ N/mm²

σ_{yd} specified minimum yield stress of the material, in N/mm²

Reason for Rule Clarification:

The original intent was that, where $l_{st\text{-}ct}$ is greater than $0.7l_{st}$, $l_{st\text{-}ct}$ is to be used for l_{st} in association with the relevant coefficients for $l_{st\text{-}ct}$ *(rather than 'may be used').*

2.6.6 Vertical web frames on longitudinal bulkhead

2.6.6.2 The net section modulus, Z_{net50}, of the vertical web frame is not to be less than:

$$Z_{net50} = \frac{1000M}{C_{s-pr}\,\sigma_{yd}} \quad \text{cm}^3$$

Where:

M design bending moment, in kNm, as follows:

$= c_u P S l_{bdg-vw}{}^2$ for upper part of the web frame

$= c_l P S l_{bdg-vw}{}^2$ for lower part of the web frame

where a cross tie is fitted and $l_{bdg\text{-}vw\text{-}ct}$ is greater than $0.7l_{bdg\text{-}vw}$, then $l_{bdg\text{-}vw}$ in the above formula is to be taken as $l_{bdg\text{-}vw\text{-}ct}$.

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P design pressure for the design load set being considered, calculated at mid point of the effective bending span, $l_{bdg\text{-}vw}$, of the vertical web frame located at mid tank, in kN/m^2

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

$l_{bdg\text{-}vw\text{-}ct}$ effective bending span of the vertical web frame on longitudinal bulkhead, between the deck transverse and mid depth of the cross tie on ships with two longitudinal bulkheads, in m, see *Section 4/2.1.4*

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

$C_{s\text{-}pr}$ permissible bending stress coefficient as given in *Table 8.2.10*

σ_{yd} specified minimum yield stress of the material, in N/mm^2

c_u and c_l as defined in *Table 8.2.14*

<u>*Reason for Rule Clarification:*</u>

The original intent was that, where $l_{bdg\text{-}vw\text{-}ct}$ is greater than $0.7\,l_{bdg\text{-}vw}$, $l_{bdg\text{-}vw\text{-}ct}$ is to be used for $l_{bdg\text{-}vw}$ in association with the relevant coefficients for $l_{bdg\text{-}vw\text{-}ct}$ *(rather than 'may be used').*

Table 8.2.14
Values of c_u and c_l for Vertical Web Frame on Longitudinal Bulkheads

Structural Configuration			c_u	c_l
Ships with a centreline longitudinal bulkhead			0.057	0.071
Ships with two longitudinal bulkheads	Cross tie in centre cargo tank	M based on $l_{bdg-vw-ct}$	0.057	0.071
		M based on l_{bdg-vw}	0.012	0.028
	Cross ties in wing cargo tanks	M based on $l_{bdg-vw-ct}$	0.057	0.071
		M based on l_{bdg-vw}	0.016	0.032

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Reason for the Rule Clarification:
On ships with two longitudinal bulkheads, the row in *Table 8.2.14* for "Cross tie in centre cargo tank" should be separated to two rows, e.g. M based on "$l_{bdg-vw-ct}$" and "M based on l_{bdg-vw}". When "M" is determined based on the span to the cross tie, the same coefficients as that used for ships with a centreline longitudinal bulkhead are to be used (similarly to the one for "Cross ties in wing cargo tanks")

2.6.6.4 The net shear area, $A_{shr-net50}$, of the vertical web frame is not to be less than:

$$A_{shr-net50} = \frac{10Q}{C_{t-pr}\,\tau_{yd}} \quad \text{cm}^2$$

Where:

Q design shear force as follows, in kN:
$= Q_u$ for upper part of the web frame
$= Q_l$ for lower part of the web frame

Q_u $= S\ [c_u\, l_{vw}\, (P_u + P_l) - h_u\, P_u]$

where a cross tie is fitted in a centre or wing cargo tank and l_{vw-ct} is greater than $0.7l_{vw}$, then l_{vw} in the above formula is to be taken as l_{vw-ct}.

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Q_l to be taken as the greater of the following:

(a) $S[c_l\, l_{vw}\, (P_u + P_l) - h_l\, P_l]$

(b) $c_w\, S\, c_l\, l_{vw}\, (P_u + P_l)$

(c) $1.2\,Q_u$

where a cross tie is fitted in a centre or wing cargo tank and l_{vw-ct} is greater than $0.7l_{vw}$, then l_{vw} in the above formula is to be taken as l_{vw-ct}.

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P_u design pressure for the design load set being considered, calculated at mid height of upper bracket of the vertical web frame, h_u, located at mid tank, in kN/m^2

P_l design pressure for the design load set being considered, calculated at mid height of lower bracket of the vertical web frame, h_l, located at mid tank, in kN/m^2

l_{vw}	length of the vertical web frame, in m, between the flange of the deck transverse and the inner bottom, see *Figure 8.2.7*
l_{vw-ct}	length of the vertical web frame, in m, between the flange of the deck transverse and mid depth of the cross tie, where fitted
S	primary support member spacing, in m, as defined in *Section 4/2.2.2*
h_u	effective length of upper bracket of the vertical web frame, in m, as shown in *Figure 8.2.7* and as described in *Section 4/2.1.5*
h_l	effective length of lower bracket of the vertical web frame, in m, as shown in *Figure 8.2.7* and as described in *Section 4/2.1.5*
c_u and c_l	as defined in *Table 8.2.15*
χ_ω	0.57 for ships with a centreline longitudinal bulkhead 0.50 for ships with two longitudinal bulkheads
C_{t-pr}	permissible shear stress coefficient for primary support member as given in *Table 8.2.10*
τ_{yd}	$= \frac{\sigma_{yd}}{\sqrt{3}}$ N/mm^2
σ_{yd}	specified minimum yield stress of the material, in N/mm^2

Reason for Rule Clarification:

The original intent was that, where l_{vw-ct} is greater than 0.7 l_{vw}, l_{vw-ct} is to be used for l_{vw} in association with the relevant coefficients for l_{vw-ct} *(rather than 'may be used').*

3 FORWARD OF THE FORWARD CARGO TANK

3.9 Scantling Requirements

3.9.2 Plating and local support members

3.9.2.1 For plating subjected to lateral pressure, the net plating thickness, t_{net}, is to be taken as the greatest value calculated for all applicable design load sets, as given in *Table 8.3.8*, and given by:

$$t_{net} = 0.0158\alpha_p s\sqrt{\frac{|P|}{C_a\sigma_{yd}}} \quad \text{mm}$$

Where:

α_p	correction factor for the panel aspect ratio
	$= 1.2 - \frac{s}{2100 l_p}$, but not to be greater than 1.0
P	design pressure for the design load set being considered, calculated at the load calculation point defined in *Section 3/5.1.2*, in kN/m^2
s	stiffener spacing, in mm , as defined in *Section 4/2.2*
l_p	length of plate panel, to be taken as the spacing of primary support members, unless carlings are fitted, in m
C_a	permissible bending stress coefficient for the acceptance criteria set being considered, as given in *Table 8.3.2*
σ_{yd}	specified minimum yield stress of the material, in N/mm^2

Reason for the Rule Clarification:
Clarification that panel aspect ratio factor is not to be greater than 1.0

3.9 Scantling Requirements

3.9.3 Primary support members

3.9.3.3 For primary support members subjected to lateral pressure, the effective net shear area, $A_{w-net50}$, is to be taken as the greatest value for all applicable design load sets, as given in *Table 8.3.8*, and given by:

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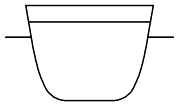
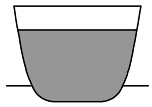
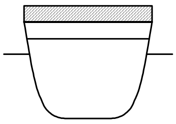
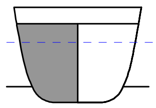
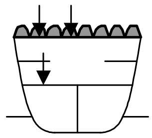
Reason for Rule Clarification:

Editorial correction

Table 8.3.8 Design Load Sets for Plating, Local Support Members and Primary Support Members					
Type of Local Support and Primary Support Member	**Design Load Set (1)**	**Load Component**	**External Draught**	**Comment**	**Diagrammatic Representation**
Shell Envelope	1	P_{ex}	T_{sc}	Sea pressure only	
	2	P_{ex}	T_{sc}		
	5	P_{in}	T_{bal}	Tank pressure only. Sea pressure to be ignored	
	6	P_{in}	$0.25T_{sc}$		
External Decks	1	P_{ex}	T_{sc}	Green sea pressure only	
Tank Boundaries and/or Watertight Boundaries	5	P_{in}	T_{bal}	Pressure from one side only Full tank with adjacent tank empty	
	6	P_{in}	$0.25T_{sc}$		
	11	$P_{in\text{-}flood}$	-		
Internal and External Decks or Flats	9	P_{dk}	T_{bal}	Distributed or concentrated loads only. Adjacent tanks empty. Green sea pressure may be ignored	
	10	P_{dk}	T_{bal}		

Where:

T_{sc} scantling draught, in m, as defined in *Section 4/1.1.5.5*

T_{bal} minimum design ballast draught, in m, as defined in *Section 4/1.1.5.2*

Notes

1. The specification of design load combinations and other load parameters for the design load sets are given in *Table 8.2.8*

2. When the ship's configuration cannot be described by the above, then the applicable Design Load Sets to determine the scantling requirements of structural boundaries are to be selected so as to specify a full tank on one side with the adjacent tank or space empty. The boundary is to be evaluated for loading from both sides. Design Load Sets are to be selected based on the tank or space contents and are to maximise the pressure on the structural boundary, the draught to use is to be taken in accordance with the Design Load Set and this table. Design Load Sets covering the S and S+D design load combinations are to be selected. See Note 4 on *Table 8.2.7* and *Table 8.2.8*.

3. The boundaries of void and dry space not forming part of the hull envelope are to be evaluated using Design Load Set 11. See Note 2.

Reason for the Rule Clarification:

Editorial clean up by combining the two rows as the two categories of structure are assessed with the same load sets.

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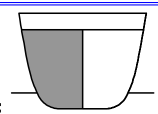
Full tank with adjacent tank empty

Deleted: 

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4 Machinery Space

4.1 General

4.1.3 Structural continuity

4.1.3.4 All shell frames and tank boundary stiffeners are to be continuous throughout, or are to be bracketed at their ends, except as permitted in *Sections 4/3.2.4* and *4/3.2.5*.

Deleted: See also *Section 4/3.2.*

Reason for Rule Clarification:

Editorial correction - delete duplicating reference to *Sections 4/3*

4.2.2 Bottom shell plating

4.2.2.1 The keel plate breadth is to comply with the requirements in *Section 8/2.2.1.1*.

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4.2.2.2 The thickness of the bottom shell plating (including keel plating) is to comply with the requirements in *4.8.1.1*.

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Reason for Rule Clarification:

Editorial - the reference to thickness should be to breadth and the keel plating is to be included with the requirement for the bottom plating .

5 Aft End

5.1 General

5.1.3 Structural continuity

5.1.3.4 All shell frames and tank boundary stiffeners are in general to be continuous, or are to be bracketed at their ends, except as permitted in *Sections 4/3.2.4* and *4/3.2.5*.

Deleted: See also *Section 4/3.2.*

Rule for Rule Clarification:

Editorial correction - delete duplicating reference to *Sections 4/3*

6 Evaluation of Structure for Sloshing and Impact Loads

6.2 Sloshing in Tanks

6.2.2 Application of sloshing pressure

6.2.2.5 The design sloshing pressure due to transverse liquid motion, $P_{shl\text{-}t}$, as defined in *Section 7/4.2.3.1,* is to be applied to the following members as shown in *Figure 8.6.2*:

(a) longitudinal tight bulkhead

(b) longitudinal wash bulkhead

(c) horizontal stringers and vertical webs on longitudinal tight and wash bulkheads

(d) plating and stiffeners on the transverse tight bulkheads including stringers and deck which are between the longitudinal bulkhead and the first girder from the bulkhead or the bulkhead and $0.25b_{slh}$ whichever is lesser.

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Deleted: and inner bottom

Reason for Rule Clarification:
Correction for to ensure consistency with 6.2.2.2 and Figure 8.6.1. Sloshing assessment is not relevant for the inner bottom as it will only occur at very low filling levels and in any case not be the dimensioning load.

6.4 Bow Impact

6.4.2 Extent of strengthening

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

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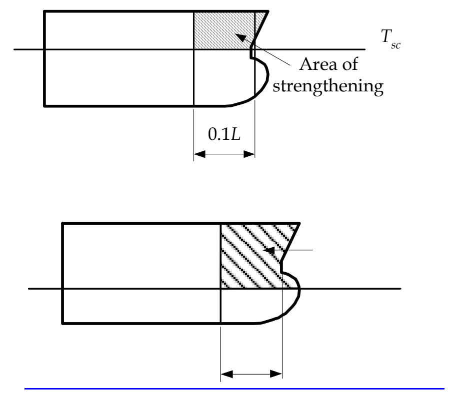
Figure 8.6.6
Extent of Strengthening Against Bow Impact



Reason for the Rule Clarification:
Correction of the Rule to ensure consistency with Section 7/4.4.1.1

6.4.7 Primary support members

6.4.7.5 The net section modulus of each primary support member, Z_{net50}, is not to be less than:

cm^3

$$Z_{net50} = 1000 \frac{f_{bdg-pt} P_{im} b_{slm} f_{slm} l_{bdg}^{2}}{f_{bdg} C_s \sigma_{yd}}$$

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Where:

f_{bdg-pt} correction factor for the bending moment at the ends and considering the patch load

$= 3 f_{slm}^{3} - 8 f_{slm}^{2} + 6 f_{slm}$

f_{slm} patch load modification factor

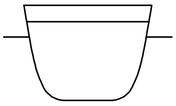
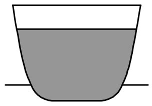
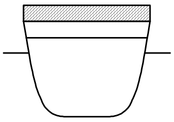
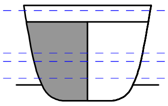
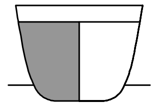
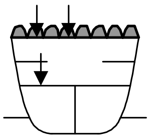
$= \frac{l_{slm}}{l_{bdg}}$

l_{slm}	extent of bow impact load area along the span $= \sqrt{A_{slm}}$ m, but not to be taken as greater than l_{bdg}
A_{slm}	bow impact load area, in m^2, as defined in *6.4.6.1*
l_{bdg}	effective bending span, as defined in *Section 4/2.1.4*, in m
P_{im}	bow impact pressure as given in *Section 7/4.4* and calculated at the load calculation point defined in *Section 3/5.3.3*, in kN/m^2
b_{slm}	breadth of impact load area supported by the primary support member, to be taken as the spacing between primary support members as defined in *Section 4/2.2.2*, but not to be taken as greater than l_{slm}, in m
f_{bdg}	bending moment factor = 12 for primary support members with end fixed continuous face plates, stiffeners or where stiffeners are bracketed in accordance with *Section 4/3.3* at both ends
C_s	permissible bending stress coefficient = 0.8 for acceptance criteria set AC3
σ_{yd}	specified minimum yield stress of the material, in N/mm^2

Reason for the Rule Clarification:
Correction of error in unit conversion factor in formula.

7 APPLICATION OF SCANTLING REQUIREMENTS TO OTHER STRUCTURE

Table 8.7.2
Design Load Sets for Plating, Local Support Members and Primary Support Members

Type of Local Support and Primary Support Member	Design Load Set (1)	Load Component	External Draught	Comment	Diagrammatic Representation
Shell Envelope	1	P_{ex}	T_{sc}	Sea pressure only	
	2	P_{ex}	T_{sc}		
	5	P_{in}	T_{bal}	Tank pressure only. Sea pressure to be ignored	
	6	P_{in}	$0.25T_{sc}$		
External Decks	1	P_{ex}	T_{sc}	Green sea pressure only	
Cargo Tank Boundaries	3	P_{in}	$0.6T_{sc}$	Pressure from one side only Full tank with adjacent tank empty	
	4	P_{in}			
	11	$P_{in\text{-}flood}$	-		
Other Tank Boundaries or Watertight Boundaries	5	P_{in}	T_{bal}	Pressure from one side only Full tank with adjacent tank empty	
	6	P_{in}	$0.25T_{sc}$		
	11	$P_{in\text{-}flood}$	-		
Internal and External Decks or Flats	9	P_{dk}	T_{bal}	Distributed or concentrated loads only. Adjacent tanks empty. Green sea pressure may be ignored	
	10	P_{dk}	T_{bal}		

Where:

T_{sc} scantling draught, in m, as defined in *Section 4/1.1.5.5*

T_{bal} minimum design ballast draught, in m, as defined in *Section 4/1.1.5.2*

Notes

1. The specification of design load combinations, and other load parameters for the design load sets are given in *Table 8.2.8*

2. When the ship's configuration cannot be described by the above, then the applicable Design Load Sets to determine the scantling requirements of structural boundaries are to be selected so as to specify a full tank on one side with the adjacent tank or space empty. The boundary is to be evaluated for loading from both sides. Design Load Sets are to be selected based on the tank or space contents and are to maximise the pressure on the structural boundary, the draught to use is

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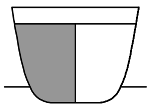
Deleted: 
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	to be taken in accordance with the Design Load Set and this table. Design Load Sets covering the S and S+D design load combinations are to be selected. See Note 4 on *Table 8.2.7* and *Table 8.2.8*.
3.	The boundaries of void and dry space not forming part of the hull envelope are to be evaluated using Design Load Set 11. See Note 2.

Reason for the Rule Clarification:
Table 8.7.2 should be applicable for cargo oil tanks as well as other tanks. However, cargo oil tank is not included in the current table, while ballast tank is included in this table. Consequently the table is modified to cover "Cargo Tank Boundaries" and "Other Tank Boundaries or Watertight Boundaries" separately. Also re-arrange the conditions to keep similar conditions together.

SECTION 9 DESIGN VERIFICATION

1 HULL GIRDER ULTIMATE STRENGTH

1.4 Partial Safety Factors

Table 9.1.1
Partial Safety Factors

Design load combination	Definition of Still Water Bending Moment, M_{sw}	γ_S	γ_W	γ_R
a)	Permissible sagging still water bending moment, $M_{sw\text{-}perm\text{-}sea}$, in kNm, see *Section 7/2.1.1*	1.0	1.2	1.1
b)	Maximum sagging still water bending moment for operational seagoing homogeneous full load condition, $M_{sw\text{-}full}$, in kNm, see note 1	1.0	1.3	1.1

Where:

γ_S partial safety factor for the sagging still water bending moment

γ_W partial safety factor for the sagging vertical wave bending moment covering environmental and wave load prediction uncertainties

γ_R partial safety factor for the sagging vertical hull girder bending capacity covering material, geometric and strength prediction uncertainties

Notes

1 The maximum sagging still water bending moment is to be taken from the departure condition with the ship homogeneously loaded at maximum draught and corresponding arrival and any mid-voyage conditions.

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Reason for the Rule Clarification:

Clarification that bending moments used for combination b) are to based on operational seagoing conditions and hence do not include additional pure strength conditions required by IACS URS11. Such additional conditions will be covered by the a) combination.

2 STRENGTH ASSESSMENT (FEM)

2.3 Local Fine Mesh Structural Strength Analysis

2.3.1 Objective and scope

2.3.1.4 Where the geometry can not be adequately represented in the cargo tank finite element model, a fine mesh analysis may be used to demonstrate satisfactory scantlings. In such cases the average stress within an area equivalent to that specified in the cargo tank analysis (typically s by s) is to comply with the requirement given in *Table 9.2.1*. See also Note 1 of *Table 9.2.3*.

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Reason for the Rule Clarification:

Clarification of acceptance criteria for fine mesh analysis of areas where the standard mesh size is not suitable for representing the actual geometry.

2.4 Application of Scantlings in Cargo Tank Region

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

2.4.5.2 The plate thickness of side shell, longitudinal bulkheads and inner hull longitudinal bulkheads, including hopper plating, outside 0.15*D* from the deck may vary along the length and height of a tank. The plate thickness away from the transverse bulkheads is not to be less than that required for the corresponding location of the middle tanks of the cargo tank finite element model required by *Appendix B/1.1.1.5*. These scantlings are to be maintained for all tanks within the cargo region, other than the fore-most and aft-most cargo tanks. For the fore-most and aft-most cargo tanks, the minimum net thickness of the side shell, longitudinal bulkheads or inner hull longitudinal bulkheads (including hopper plating) plating outside 0.15*D* from the deck is given by:

$$t_{net} = t_{net-mid} \frac{s}{s_{mid}} \quad \text{mm}$$

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Where:

$t_{net-mid}$ required net thickness for corresponding location in the midship tank, in mm

s spacing between longitudinal stiffeners at location under consideration, in mm

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s_{mid} spacing between longitudinal stiffeners at corresponding location in midship tank, in mm

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Reason for Rule Clarification:

Editorial correction

2 STIFFNESS AND PROPORTIONS

2.2 Plates and Local Support Members

2.2.2 Stiffness of stiffeners

2.2.2.1 The minimum net moment of inertia about the neutral axis parallel to the attached plate, I_{net}, of each stiffener with effective breadth of plate equal to 80% of the stiffener spacing s, is given by:

$$I_{net} = Cl_{stf}^2 A_{net} \frac{\sigma_{yd}}{235} \quad \text{cm}^4$$

Where:

l_{stf} length of stiffener between effective supports, in m

A_{net} net sectional area of stiffener including attached plate assuming effective breadth of 80% of stiffener spacing s, in cm^2

s stiffener spacing, in mm, as defined in *Section 4/2.2.1*

σ_{yd} specified minimum yield stress of the material of the attached plate, in N/mm^2

C slenderness coefficient:

= 1.43 for longitudinals subject to hull girder stresses

= 0.72 for other stiffeners

Reason for the Rule Clarification:

Clarification that reference yield stress is to be taken for the attached plate. The purpose of the stiffener is to stabilize the plate, and the higher yield stress of the plate which allows higher compressive stresses in the panel should result in the higher moment of inertia to keep the panel in shape.

2.3 Primary Support Members

2.3.1 Proportions of web plate and flange/face plate

2.3.1.1 The net thicknesses of the web plates and face plates of primary support members are to satisfy the following criteria:

(a) web plate

$$t_{w-net} \geq \frac{s_w}{C_w} \sqrt{\frac{\sigma_{yd}}{235}}$$

(b) flange/face plate

$$t_{f-net} \geq \frac{b_{f-out}}{C_f} \sqrt{\frac{\sigma_{yd}}{235}}$$

Where:

s_w plate breadth, in mm, taken as the spacing between the web stiffeners. For web plates with stiffening parallel to the attached plate the spacing may be corrected in accordance with *Appendix D/Fig. 5.6.*

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$t_{w\text{-}net}$ net web thickness, in mm

$b_{f\text{-}out}$ breadth of flange outstand, in mm

$t_{f\text{-}net}$ net flange thickness, in mm

C_w slenderness coefficient for the web plate

= 100

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C_f slenderness coefficient for the flange/face plate

= 12

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σ_{yd} specified minimum yield stress of the material, in N/mm^2

Reason for the Rule Clarification:

Clarification that correction of panel breadth due to attached intersection stiffeners as described for the advanced buckling assessment is also applicable for the simplified buckling assessment.

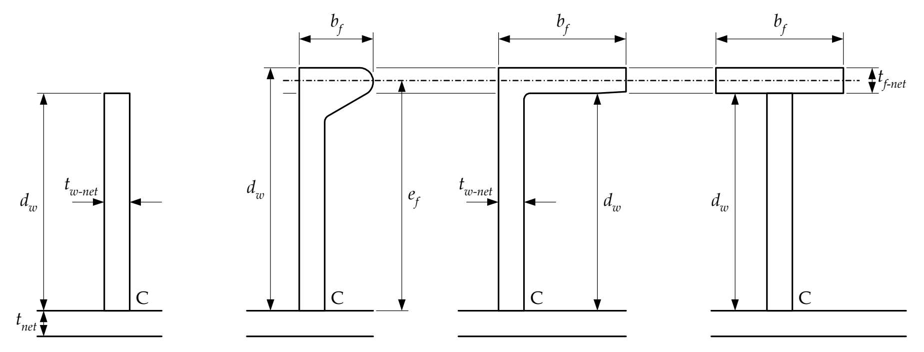
Editorial correction on slenderness coefficients - a similar definition is used in Section 10/2.2.1.1.

3 Prescriptive Buckling Requirements

3.3 Buckling of Stiffeners

3.3.3 Torsional buckling mode

Figure 10.3.1
Stiffener cross sections



Note:

1. Measurements of breadth and depth are based on gross scantlings as described in *Section 4/2.4.1.2.*
2. Characteristic flange data for bulb profiles are given in *Appendix C/Table C.1.2*

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Reason for the Rule Clarification:

Correction of reference to point to elastic properties of bulb profiles instead of plastic properties of bulb profiles.

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4 EQUIPMENT

4.2 Anchors and Mooring Equipment

4.2.4 Documentation

The following plans and particulars are to be submitted for approval:

(a) equipment number calculations

(b) list of equipment including type of anchor, grade of anchor chain, type and breaking load of steel and fibre ropes

(c) anchor design, if different from standard or previously approved anchor types, including material specification

(d) windlass design; including material specifications for cable lifters, shafts, couplings and brakes

(e) chain stopper design and material specification

(f) emergency towing, towing and mooring arrangement plans and applicable Safe Working Load data, and other information related to emergency towing and mooring arrangements that will be available onboard the ship for the guidance of the Master.

Reason for Rule Clarification:

Editorial correction.

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2 Cargo Tank Structural Strength Analysis

2.3 Loading Conditions

2.3.1.3 For tankers with two oil-tight longitudinal bulkheads and a cross tie arrangement in the centre cargo tanks, loading patterns A7 and A12 in *Table B.2.3* are to be examined for the possibility that unequal filling levels in transversely paired wing cargo tanks would result in a more onerous stress response. Loading pattern A7 is required to be analysed only if such a non-symmetric seagoing loading condition is included in the ship loading manual. Loading patterns A7 and A12 need not be examined for tankers without a cross tie arrangement in the centre cargo tanks.

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Reason for Rule Clarification:

Clarification that requirement for inclusion of the loading pattern is linked to seagoing conditions only.

2.3.1.6 For loading patterns A1, A2, B1, B2 and B3, with cargo tank(s) empty, a minimum ship draught of $0.9T_{sc}$ is to be used in the analysis. If conditions in the ship loading manual specify greater draughts for loading patterns with empty cargo tank(s), then the maximum specified draught for the actual condition is to be used.

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Reason for Rule Clarification:

Correction of text to ensure consistency with 8/1.1.2.9 b).

3 Local Fine Mesh Structural Strength Analysis

3.1 General

3.1.6 Screening criteria for Fine Mesh Analysis

Table B.3.1 **Fine Mesh Analysis Screening Criteria for Openings in Primary Support Members**		
A fine mesh finite element analysis is to be carried out where:		
$\lambda_y > 1.7$	(load combination S + D)	
$\lambda_y > 1.36$	(load combination S)	
Where:		
λ_y	yield utilisation factor	
	$= 0.85C_h\left(\left\lvert\sigma_x + \sigma_y\right\rvert + \left(2 + \left(\frac{l_0}{2r}\right)^{0.74} + \left(\frac{h_0}{2r}\right)^{0.74}\right)\left\lvert\tau_{xy}\right\rvert\right)\frac{k}{235}$	
C_h	$= 1.0 - 0.23\left(\frac{h_0}{h}\right) + 2.12\left(\frac{h_0}{h}\right)^2$	for openings in vertical web and horizontal girder of wing ballast tank, double bottom floor and girder and horizontal stringer of

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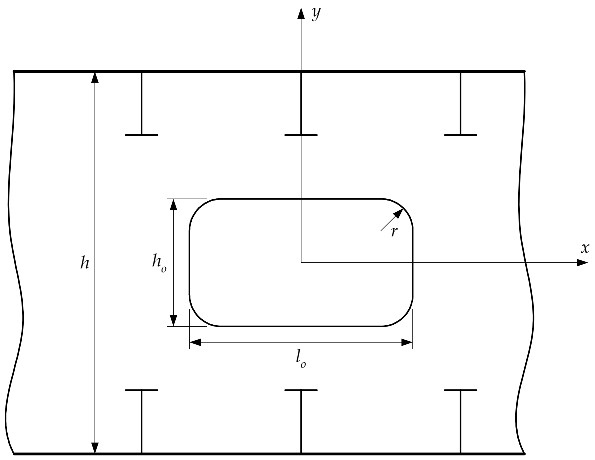
		transverse bulkhead
	= 1.0	for opening in web of main bracket and buttress (see figures below)
r	radius of opening, in mm	
h_0	height of opening parallel to depth of web, in mm	
l_0	length of opening parallel to girder web direction, in mm	
h	height of web of girder in way of opening, in mm	
σ_x	axial stress in element x direction determined from cargo tank FE analysis according to the coordinate system shown, in N/mm²	
σ_y	axial stress in element y direction determined from cargo tank FE analysis according to the coordinate system shown, in N/mm²	
τ_{xy}	element shear stress determined from cargo tank FE analysis, in N/mm², (2)	
k	higher strength steel factor, as defined in *Section 6/1.1.4* but not to be taken as less than 0.78 for load combination S + D	



Reason for Rule Clarification:

Editorial correction of symbol. r_0 corrected to r.

4 EVALUATION OF HOT SPOT STRESS FOR FATIGUE ANALYSIS

4.5 Result Evaluation

4.5.2 Hopper knuckle connection

4.5.2.2 The component stress ranges are to be obtained by eliminating the stress induced by hull girder vertical and horizontal bending moments from the component stress determined from load cases L1 to L7 in *Table B.4.1* as follows:

$$S_{c\_i} = \left| s_{c\_i} - M_{V\_i}\, s_{VBM} - M_{H\_i}\, s_{HBM} \right|$$

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Where:

S_{c_i}	S_{e1}, S_{e2}, S_{ix}, S_{iy} or S_{iz}, component stress range after correction for bending moment effects
s_{c_i}	s_{e1}, s_{e2}, s_{ix}, s_{iy} or s_{iz}, component stress (with proper sign convention) including vertical and horizontal bending moment effects obtained from load cases L1 to L7, see *Table B.4.1*
M_{V_i}	is the vertical hull girder bending moment due to loads applied to the cargo tank FE model obtained from load case L1, L2, L3, L4, L5, L6 or L7. The bending moment is to be calculated at the longitudinal position where the centroid of shell element under evaluation is located
M_{H_i}	is the horizontal hull girder bending moment due to loads applied to the cargo tank FE model obtained from load case L1, L2, L3, L4, L5, L6 or L7. The bending moment is to be calculated at the longitudinal position where the centroid of shell element under evaluation is located
s_{VBM}	stress due to unit vertical bending moment obtained from load case C1, see *Table B.4.1*
s_{HBM}	stress due to unit horizontal bending moment obtained from load case C2, see *Table B.4.1*

Reason for Rule Clarification:

Editorial correction of formulae.

Appendix C – Fatigue Strength Assessment

1 NOMINAL STRESS APPROACH

1.4 Fatigue Damage Calculation

1.4.4 Definition of stress components

1.4.4.11 The stress amplitude produced by bending of stiffeners between girder supports (e.g. frames, bulkheads), σ_{2A}, is to be taken as:

$$\sigma_{2A} = K_n K_d \frac{M}{Z_{net50}} 10^3 \text{ N/mm}^2$$

Deleted: $\sigma_{2A} = K_n K_d \frac{M}{Z_{net50}} 10^6$

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Where:

K_n stress factor for unsymmetrical profiles, as defined in *1.4.4.15*

K_d stress factor for bending stress in longitudinal stiffeners caused by relative deformation between supports, may be determined by FE analysis of the cargo hold model where the actual relative deformation is taken into account or taken as follows:

1.0 at frame connections

1.15 for all longitudinals at transverse bulkhead connections including wash bulkheads except:

(a) in full load condition:

1.3 for side and bilge longitudinals at mid position between lowest side stringer and deck corner

1.15 for side and bilge longitudinals at lowest side stringer and deck corner

to be linearly interpolated between these two positions

1.5 for bottom longitudinals at mid position between longitudinal bulkhead, bottom girders or buttress structure

1.15 for bottom longitudinals at longitudinal bulkhead, bottom girders or buttress structure

to be linearly interpolated between these two positions

See *Figure C.1.4*

(b) in ballast condition:

1.5 for bottom longitudinals in the mid position between longitudinal bulkhead, bottom girders or buttress structure

1.15 for bottom longitudinals at longitudinal bulkhead, bottom girders or buttress structure

to be linearly interpolated between these two positions

M moment at stiffener support adjusted to weld toe location at the stiffener (e.g. at bracket toe), in kNm:

$$= \frac{Ps\, l_{bdg}^2\, 10^{-3}}{12} r_p$$

Deleted: $= \frac{Ps\, l_{bdg}^2\, 10^{3}}{12} r_p$

s	stiffener spacing, in mm
l_{bdg}	effective bending span, of longitudinal stiffener, as shown in *Figure C.1.5*, in m. See also *Figure 4.2.1* and *4.2.2* in *Section 4* for soft toe brackets. Top stiffeners with a soft toe are to be treated the same as flat bars with a soft toe bracket. The span point is to be taken at the point where the depth of the end bracket, measured from the face of the member, is equal to half the depth of the member
Z_{-net50}	section modulus of longitudinal stiffener with associated effective plate flange b_{eff}, in cm^3, calculated based on gross thickness minus the corrosion addition $0.5t_{corr}$.
b_{eff}	as defined in *Section 4/2.3.3*
r_p	moment interpolation factor, for interpolation to weld toe location along the stiffener length: $= \left| 6\left(\frac{x}{l_{bdg}}\right)^2 - 6\left(\frac{x}{l_{bdg}}\right) + 1.0 \right|$ where $0 \le x \le l_{bdg}$ where x is the distance to the hot spot, in m. See *Figure C.1.5*.
P	lateral dynamic pressure amplitude at the mid-span between the frame considered and the neighbouring frame, in kN/m^2. $P_{in\text{-}amp}$ for dynamic tank pressure, is to be taken as defined in *1.3.7* $P_{ex\text{-}amp}$ for dynamic wave pressure, is to be taken as defined in *1.3.6*

Reason for the Rule Clarification:

Editorial correction due to error in unit conversion.

Table C.1.7
Classification of Structural Details

Notes

1. Where the attachment length is less than or equal to 150mm, the S-N curve is to be upgraded one class from those specified in the table. For example, if the class shown in the table is F2, upgrade to F. Attachment length is defined as the length of the weld attachment on the longitudinal stiffener face plate without deduction of scallop.
2. Where the longitudinal stiffener is a flat bar and there is a stiffener/bracket welded to the face, the S-N curve is to be downgraded by one class from those specified in the table. For example, if the class shown in the table is F, downgrade to F2; if the class shown in the table is F2, downgrade to G. This also applies to unsymmetrical profiles where there is less than 8mm clearance between the edge of the stiffener flange and the face of the attachment, e.g. bulb or angle profiles where the stated clearance cannot be achieved.

   Deleted: there is less than 10mm minimum clearance between the edge of the stiffener flange and the face of the attachment e.g. where

3. Lapped connections (attachments welded to the web of the longitudinals) should not be adopted and therefore these are not covered by the table.
4. For connections fitted with a soft heel, class F may be used if it is predominantly subjected to axial loading. Stiffeners fitted on deck and within 0.1D below deck at side are considered to satisfy this condition.

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5. For connections fitted with a tight collar around the face plate, class F may be used if subjected to axial loading. Stiffeners fitted on deck and within 0.1D below deck at side are considered to satisfy this condition

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6. ID32 is applicable in cases where web stiffeners are omitted or are not connected to the longitudinal stiffener face plate. In the dynamic wave wetted zone at side and below, in way of bottom and in way of inner hull below 0.1D from the deck at side, a water-tight collar or alternatively a detail design for cut-outs as shown in *Figure C.1.11* or equivalent is to be adopted. Other designs are subject to a satisfactory fatigue assessment by using comparative FEM based hot spot stress. For detail design of cut-outs as shown in *Figure C.1.11* or equivalent, the S-N curve may be upgraded to E for the dynamic wave wetted zone at side and below, in way of bottom and in way of inner hull below 0.1D from the deck at side.

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7. In way of other areas besides what is mentioned in Note 6, i.e. side above wave wetted zone, deck, inner hull areas within 0.1D from the deck at side, in cases where web stiffeners are omitted or not connected to the longitudinal stiffener face plate, conventional slot configurations are permitted and an F class is in general to be applied, as described in ID 32. E class may however be applied with combined global and local stress ranges provided 25 years is achieved applying F class considering global stress range only. Stress range combination factors for deck may be used to obtain the global stress range in this instance.

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Reason for Rule Clarification:

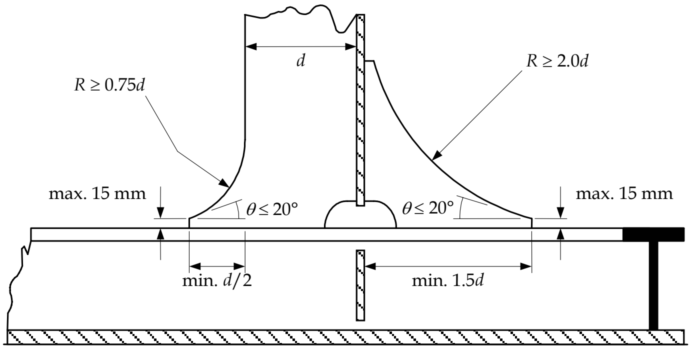
Editorial correction. Clarification of applicability of downgrade of SN curves as specified in Note 2 including differentiation between flatbar longitudinals and longitudinals of rolled profiles. Clarification of requirements for pillar-less connections within 0.1D fro deck.

1.5 Classification of Structural Details

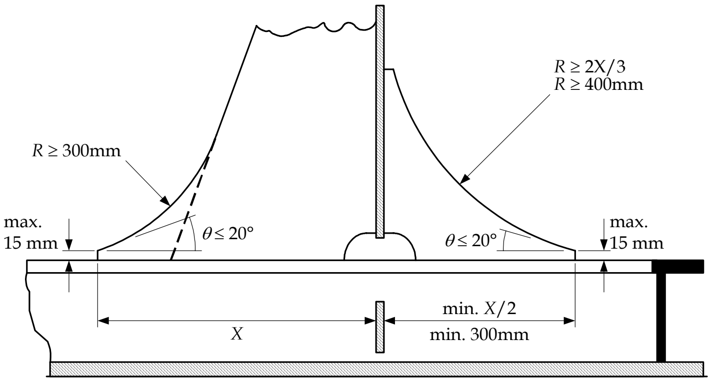
1.5.1 General

1.5.1.1 The joint classification of structural details is to be made using *Table C.1.7* where the design of soft toes and backing brackets corresponds to those shown in *Figure C.1.10*. When alternative designs are proposed, the adequacy in terms of fatigue strength is to be demonstrated using a suitable finite element analysis. See *2.1.1.3*.

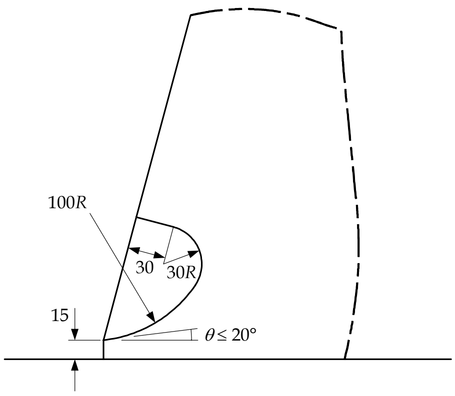
Figure C.1.10
Detail Design for Soft Toes and Backing Brackets



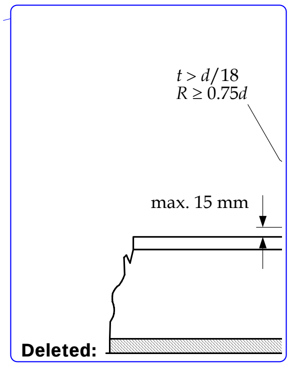
Recommended Design of Soft Toes and Backing Bracket of Pillar Stiffeners



Recommended Design of Soft Toes and Backing Bracket of Tripping Brackets



Recommended Alternative Design of Soft Toes of Tripping Brackets



Reason for Rule Clarification:

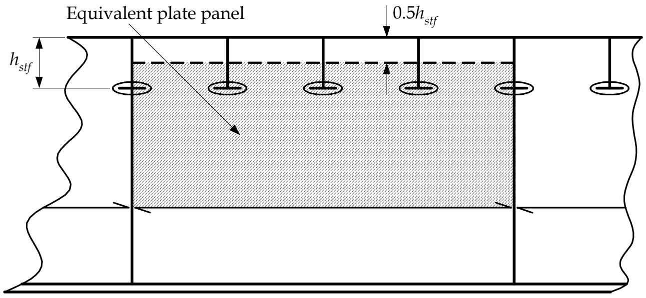
Thickness for the recommended design are removed as they are bucking requirements. Thickness of attached stiffener and bracket is to comply with relevant buckling requirements give in Section 10.

5 STRENGTH ASSESSMENT (FEM) – BUCKLING PROCEDURE

5.2 Structural Modelling and Capacity Assessment Method

5.2.3 Un-stiffened panels

Figure D.5.6
Capacity Model for Web Plate



Note
The correction of panel breadth is applicable also for other slot configurations with or without collar plates provided the web/collar plate is attached to the passing stiffener.

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Reason for the Rule Clarification:
The note is added to avoid ambiguity as to whether the correction of panel breadth only applies to slit type connections or also to other slot configurations.

Technical Background - Corrigenda 2, Appendix C / Table C.1.7, Note 2.

1. Corrigenda 2 Text

ORIGINAL: CSR/Tanker, January 2006
Appendix C / Table C.1.7, Note 2

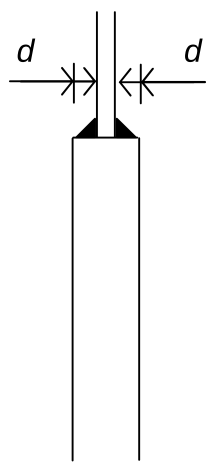
2. Where there is less than 10mm minimum clearance between the edge of the stiffener flange and the face of the attachment e.g. where the longitudinal stiffener is a flat bar, the S-N curve is to be downgraded by one class from those specified in the table. For example, if the class shown in the table is F, downgrade to F2; if the class shown in the table is F2, downgrade to G. This also applies to unsymmetrical profiles, e.g. bulb or angle profiles where the stated clearance cannot be achieved.

REVISED: CSR/Tanker, Corrigenda 2
Appendix C / Table C.1.7, Note 2

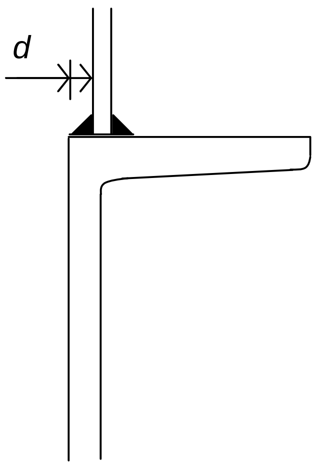
2. Where ~~there is less than 10mm minimum clearance between the edge of the stiffener flange and the face of the attachment e.g. where~~ the longitudinal stiffener is a flat bar and there is a stiffener/bracket welded to the face, the S-N curve is to be downgraded by one class from those specified in the table. For example, if the class shown in the table is F, downgrade to F2; if the class shown in the table is F2, downgrade to G. This also applies to unsymmetrical profiles where there is less than 8mm clearance between the edge of the stiffener flange and the face of the attachment, e.g. bulb or angle profiles where the stated clearance cannot be achieved.

2. Background for the correction

ORIGINAL
The original Rule text mixed together the flatbar and rolled section requirement to downgrade the fatigue class (e.g. F2 to G class) for the case where the weld bead could be applied at the extreme edge or corner of the stiffener flange. If the weld bead is applied at the extreme corner notches could be formed which may adversely affect the fatigue performance of the detail. The following sketches illustrate the application intended in the original text, where the downgrade was required when the clearance distance, *d*, is less than 10mm.



Flatbar longitudinal



Rolled longitudinal

REVISED
The revised Rule text clarifies that the fatigue class downgrade is to be made for all flatbar sections. And it is to be made for rolled sections where the weld bead could be applied at the extreme edge or corner of the stiffener flange where the clearance distance, *d*, is less than 8mm. The reason for changing the distance from 10mm to 8mm was due to the separation of the flatbar and rolled section applications.

3. Reference

The basic criteria in Appendix C / Table C.1.7, Note 2 are based on recommendations contained in the U.K. Department of Energy Offshore Installations: Guidance on design, construction and certification, Fourth edition, 1990. The requirement is made to limit the possibility of local stress concentrations occurring at unwelded edges as a result, for example, of undercut, weld spatter, or accidental overweave in manual fillet welding. When the welds are on or adjacent to the edge of the stressed member, the stress concentration is increased and the fatigue performance is reduced and this must be separately assessed and included in the calculation of applied stress or the detail reclassified.

4. Conclusion

The basic intent of the rule is the same between the original and the revised text. The Corrigenda 2 text a clarification of the original intended requirement and is made to clear up any confusion. Therefore the change will not result in any major change in scantling requirements even taking into account the slight difference in the distance criteria from 10mm to 8mm for rolled sections.