Common Structural Rules for Bulk Carriers, January 2006

Corrigenda 4
Rule Editorials

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

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

CHAPTER 2 – GENERAL ARRANGEMENT DESIGN

SECTION 1 SUBDIVISION ARRANGEMENT

2. Collision bulkhead

2.1 Arrangement of collision bulkhead

2.1.2

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

Where any part of the ship below the waterline extends forward of the forward perpendicular, e.g. a bulbous bow, the distances, in metres, stipulated in [2.1.1] are to be measured from a point either:

• at the mid-length of such extension, or

• at a distance 1.5 per cent of the length L_{LL} of the ship forward of the forward perpendicular, or

• at a distance 3 metres forward of the forward perpendicular,

<u>*, whichever gives the smallest measurement.*</u>

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

This editorial correction is made to be in accordance with SOLAS Ch II-1, Regulation 11.

CHAPTER 3 – STRUCTURAL DESIGN PRINCIPLES

SECTION 1 MATERIAL

2. Hull structural steel

2.3 Grades of steel

Table 3 Material grade requirements for classes I, II and III

Class	**I**		**II**		**III**	
As-built ~~T~~thickness (mm)	NSS	HSS	NSS	HSS	NSS	HSS
$t \le 15$	*A*	*AH*	*A*	*AH*	*A*	*AH*
$15 < t \le 20$	*A*	*AH*	*A*	*AH*	*B*	*AH*
$20 < t \le 25$	*A*	*AH*	*B*	*AH*	*D*	*DH*
$25 < t \le 30$	*A*	*AH*	*D*	*DH*	*D*	*DH*
$30 < t \le 35$	*B*	*AH*	*D*	*DH*	*E*	*EH*
$35 < t \le 40$	*B*	*AH*	*D*	*DH*	*E*	*EH*
$40 < t \le 50$	*D*	*DH*	*E*	*EH*	*E*	*EH*
Notes : NSS : Normal strength steel HSS : Higher strength steel						

Table 4 Application of material classes and grades

Structural member category	Material class: Within 0.4*L* amidship	Material class: Outside 0.4*L* amidship
SECONDARY		
Longitudinal bulkhead strakes, other than that belonging to the Primary category	I	*A/AH*
Deck Plating exposed to weather, other than that belonging to the Primary or Special category		
Side plating [(7)]		
PRIMARY		
Bottom plating, including keel plate	II	*A/AH*
Strength deck plating, excluding that belonging to the Special category		
Continuous longitudinal members above strength deck, excluding hatch coamings		
Uppermost strake in longitudinal bulkhead		
Vertical strake (hatch side girder) and uppermost sloped strake in top wing tank		
SPECIAL		
Sheer strake at strength deck [(1), (6)]	III	II (I outside 0.6*L* amidships)
Stringer plate in strength deck [(1), (6)]		
Deck strake at longitudinal bulkhead [(6)]		
Strength deck plating at corners of cargo hatch openings in bulk carriers, ore carriers, combination carriers and other ships with similar hatch openings configuration [(2)]		
Bilge strake [(3), (4), (6)]		
Longitudinal hatch coamings of length greater than 0.15*L* [(5)]		
Lower bracket of side frame of single side bulk carriers having additional service feature **BC-A** or **BC-B** [(5)]		
End brackets and deck house transition of longitudinal cargo hatch coamings [(5)]		

Notes:

(1) Not to be less than grade *E/EH* within 0.4*L* amidships in ships with length exceeding 250 m.

(2) Not to be less than class III within 0.6*L* amidships and class II within the remaining length of the cargo region.

(3) May be of class II in ships with a double bottom over the full breadth and with length less than 150 m.

(4) Not to be less than grade *D/DH* within 0.4*L* amidships in ships with length exceeding 250 m.

(5) Not to be less than grade *D/DH*.

(6) Single strakes required to be of class III or of grade *E/EH* and within 0.4*L* amidships are to have breadths, in m, not less than ~~0.8 + 0.05*L*~~ 0.8 + 0.005*L*, need not be greater than 1.8 m, unless limited by the geometry of the ship's design.

(7) For **BC-A** and **BC-B** ships with single side skin structures, side shell strakes included totally or partially between the two points located to 0.125ℓ above and below the intersection of side shell and bilge hopper sloping plate are not to be less than grade *D/DH*, ℓ being the frame span.

2.3.5

The steel grade is to correspond to the as-built ~~gross~~ thickness ~~when this is greater than the gross thickness obtained from the net thickness required by the Rules~~.

2.3.6

Steel grades of plates or sections of as-built~~gross~~ thickness greater than the limiting thicknesses in Tab 3 are considered by the Society on a case by case basis.

~~2.3.11~~

~~In highly stresses area, the Society may require that plates of gross thickness greater than 20*mm* are of grade *D/DH* or *E/EH*.~~

Table 6 Material grade requirements for class I at low temperature

As-built ~~T~~thickness (mm)	-20 / -25 °C		-26 / -35 °C		-36 / -45 °C		-45 / -55 °C	
	NSS	HSS	NSS	HSS	NSS	HSS	NSS	HSS
$t \leq 10$	*A*	*AH*	*B*	*AH*	*D*	*DH*	*D*	*DH*
$10 < t \leq 15$	*B*	*AH*	*D*	*DH*	*D*	*DH*	*D*	*DH*
$15 < t \leq 20$	*B*	*AH*	*D*	*DH*	*D*	*DH*	*E*	*EH*
$20 < t \leq 25$	*D*	*DH*	*D*	*DH*	*D*	*DH*	*E*	*EH*
$25 < t \leq 30$	*D*	*DH*	*D*	*DH*	*E*	*EH*	*E*	*EH*
$30 < t \leq 35$	*D*	*DH*	*D*	*DH*	*E*	*EH*	*E*	*EH*
$35 < t \leq 45$	*D*	*DH*	*E*	*EH*	*E*	*EH*	-	*FH*
$45 < t \leq 50$	*E*	*EH*	*E*	*EH*	-	*FH*	-	*FH*
Note: ”NSS” and “HSS” mean, respectively “Normal Strength Steel” and “Higher Strength Steel”								

Table 7 Material grade requirements for class II at low temperature

As-built ~~T~~hickness (mm)	-20 / -25 °C		-26 / -35 °C		-36 / -45 °C		-45 / -55 °C	
	NSS	HSS	NSS	HSS	NSS	HSS	NSS	HSS
$t \leq 10$	*B*	*AH*	*D*	*DH*	*D*	*DH*	*E*	*EH*
$10 < t \leq 20$	*D*	*DH*	*D*	*DH*	*E*	*EH*	*E*	*EH*
$20 < t \leq 30$	*D*	*DH*	*E*	*EH*	*E*	*EH*	-	*FH*
$30 < t \leq 40$	*E*	*EH*	*E*	*EH*	-	*FH*	-	*FH*
$40 < t \leq 45$	*E*	*EH*	-	*FH*	-	*FH*	-	-
$45 < t \leq 50$	*E*	*EH*	-	*FH*	-	*FH*	-	-
Note: ”NSS” and “HSS” mean, respectively “Normal Strength Steel” and “Higher Strength Steel”								

Table 8 Material grade requirements for class III at low temperature

As-built ~~T~~thickness (mm)	-20 / -25 °C		-26 / -35 °C		-36 / -45 °C		-45 / -55 °C	
	NSS	HSS	NSS	HSS	NSS	HSS	NSS	HSS
$t \leq 10$	*D*	*DH*	*D*	*DH*	*E*	*EH*	*E*	*EH*
$10 < t \leq 20$	*D*	*DH*	*E*	*EH*	*E*	*EH*	-	*FH*
$20 < t \leq 25$	*E*	*EH*	*E*	*EH*	-	*FH*	-	*FH*
$25 < t \leq 30$	*E*	*EH*	*E*	*EH*	-	*FH*	-	*FH*
$30 < t \leq 40$	*E*	*EH*	-	*FH*	-	*FH*	-	-
$40 < t \leq 45$	*E*	*EH*	-	*FH*	-	*FH*	-	-
$45 < t \leq 50$	-	*FH*	-	*FH*	-	-	-	-
Note: ”NSS” and “HSS” mean, respectively “Normal Strength Steel” and “Higher Strength Steel”								

2.4 Structures exposed to low air temperature

2.4.6

Single strakes required to be of class III or of grade *E /EH* and *FH* are to have breadths not less than the values, in m, given by the following formula, but need not to be greater than 1.8 m:

~~$b = 0.05L + 0.8$~~ <u>$b = 0.005L + 0.8$</u>

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

The editorial correction is made to clarify the plate thickness for the application of steel grade, i.e., thickness is replaced by "as-built thickness".

As the grades of steel in highly stressed area specified in requirement of 2.3.11 are covered by Table 4 and the requirement of 2.3.2, the requirement of 2.3.11 is not necessary.

Note (6) of Table 4 and the formula in 2.4.6 are typo.

SECTION 2 NET SCANTLING APPROACH

3. Net scantling approach

3.1 Net scantling definition

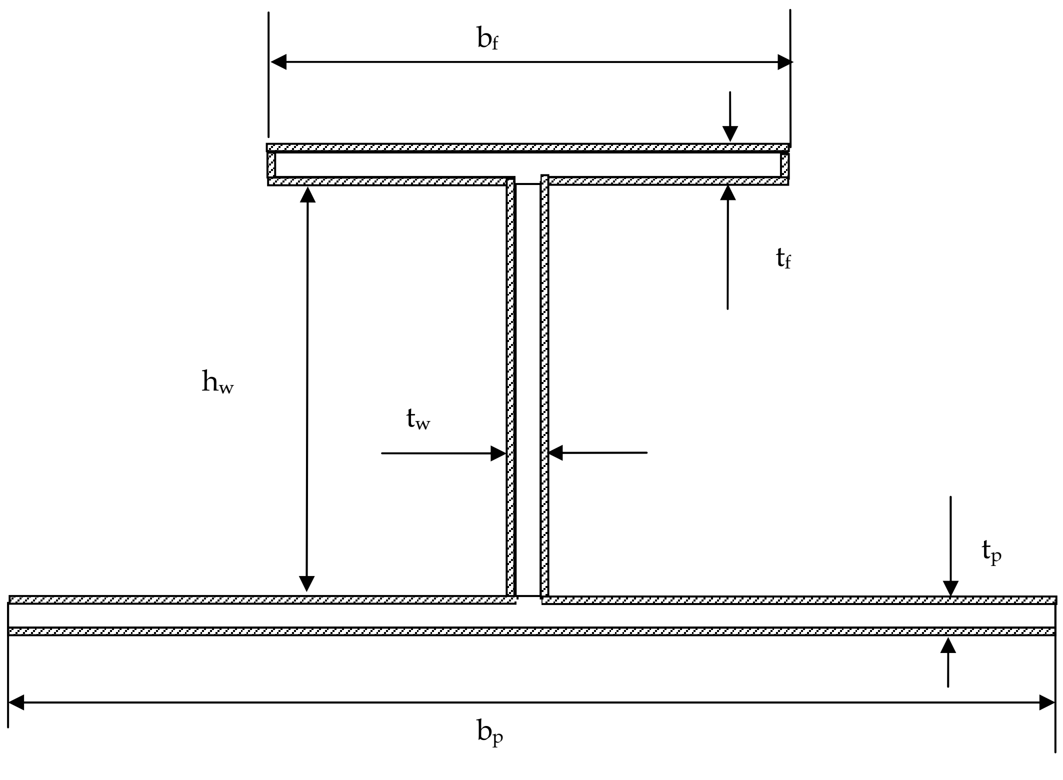
3.1.4 Net section modulus for stiffener

The net transverse section scantling is to be obtained by deducting t_C from the gross thickness offered of the elements which constitute the stiffener profile as shown in Fig.1.

For bulb profiles, an equivalent angle profile, as specified in Ch 3, Sec 6 [4.1.1], may be considered.

The net strength characteristics are to be calculated for the net transverse section.

In assessing the net strength characteristics of stiffeners reflecting the hull girder stress and stress due to local bending of the local structure such as double bottom structure, the section modulus of hull girder or rigidity of structure is obtained by deducting $0.5t_C$ from the gross thickness offered of the related elements.



Shadow area is corrosion addition.

For attached plate, the half of the considered corrosion addition specified in 3.2 is deducted from both sides of the attached plate.

Fig. 1 Net scantling of stiffener

Reason for the Rule Clarification:

To clarify the requirement that the net transverse section scantling is to be obtained by deducting t_C from the gross thickness offered of the elements which constitute the stiffener profile, the figure indicating how to deduct the corrosion additions from the gross thickness is added.

SECTION 4 LIMIT STATES

2. Strength criteria

2.4 Accidental limit state

2.4.3 Bulkhead structure

Bulkhead structure in cargo hold flooded condition is to be assessed in accordance with Ch. 6 ~~Sec4~~ Sec 1, Sec 2 and Sec 3.

Reason for the Rule Clarification:
Reference number is corrected

SECTION 5 CORROSION PROTECTION

1. General

1.1 Structures to be protected

1.1.2

Void double side skin spaces in cargo length area for vessels having a length (L_{LL}) of not less than 150 m are to be coated in accordance with [1.2].

1.2 Protection of seawater ballast tanks and void double skin spaces

1.2.1

All dedicated seawater ballast tanks anywhere on the ship (excluding ballast hold) for vessels having a length (L) of not less than 90m and void double side skin spaces in the cargo length area for vessels having a length (L_{LL}) of not less than 150m are to have an efficient corrosion prevention system, such as hard protective coatings or equivalent, applied in accordance with the manufacturer's recommendation.

The coatings are to be of a light colour, i.e. a colour easily distinguishable from rust which facilitates inspection.

Where appropriate, sacrificial anodes, fitted in accordance with [2], may also be used.

Reason for the Rule Clarification:

This editorial correction is made to clarify the extent of void double skin spaces.

SECTION 6 STRUCTURAL ARRANGEMENT PRINCIPLES

2. General principles

2.2 Structural continuity

2.2.5 Platings

A change in plating thickness in as-built is not to exceed 50% of thicker plate thickness for load carrying direction. The butt weld preparation is to be in accordance with the requirements of Ch 11, Sec 2, [2.2].

Reason for the Rule Clarification:
Clarification of the plate thickness

10. Bulkhead structure

10.4 Corrugated bulkhead

10.4.2 Construction

The main dimensions a, R, c, d, t, φ and s_C of corrugated bulkheads are defined in Fig 28.

The bending radius is not to be less than the following values, in mm:

$R = 3.0t$

where :

t : As-built ~~Net~~ thickness, in mm, of the corrugated plate.

The corrugation angle φ shown in Fig 28 is to be not less than 55°.

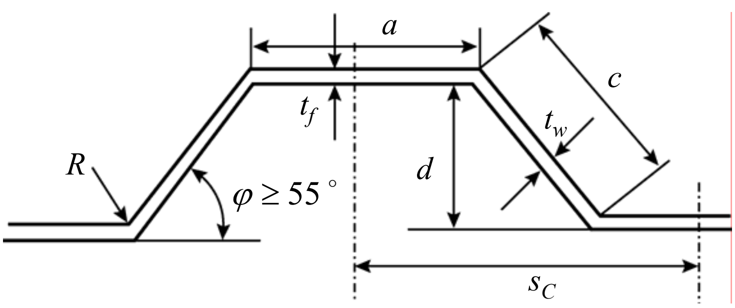
The thickness of the lower part of corrugations is to be maintained for a distance from the inner bottom (if no lower stool is fitted) or the top of the lower stool not less than $0.15\ell_C$.

The thickness of the middle part of corrugations is to be maintained for a distance from the deck (if no upper stool is fitted) or the bottom of the upper stool not greater than $0.3\ell_C$.

The section modulus of the corrugations in the remaining upper part of the bulkhead is to be not less than 75% of that required for the middle part, corrected for different minimum yield stresses.

When welds in a direction parallel to the bend axis are provided in the zone of the bend, the welding procedures are to be submitted to the Society for approval.

Fig.28 Dimensions of a corrugated bulkhead



Reason for the Rule Clarification:
This correction is made to be in line with IACS UR S18.

CHAPTER 4 – DESIGN LOADS

SECTION 5 EXTERNAL PRESSURES

3. External pressures on superstructures and deckhouses

3.4 Superstructure end bulkheads and deckhouse walls

3.4.1

Table 9: Minimum lateral pressure $p_{A\min}$

	$p_{A\min}$, in kN/m^2	
L	**Lowest tier of unprotected fronts**	**Elsewhere** (1)
$90 < L \le 250$	$25 + \frac{L}{10}$	~~$12.5 + \frac{L}{10}$~~ $12.5 + \frac{L}{20}$
$L > 250$	50	25
(1) For the 4th tier and above, $p_{A\min}$ is to be taken equal to 2.5 kN/m^2.		

Reason for the Rule Clarification:
This correction is made to be in line with IACS UR S3 Table 1.

SECTION 6 INTERNAL PRESSURES AND FORCES

1. Lateral pressure due to dry bulk cargo

1.3 Inertial pressure due to dry bulk cargo

1.3.1

The inertial pressure induced by dry bulk cargo p_{CW}, in kN/m^2, for each load case is given by the following formulae.

- for load case H: $p_{CW} = \rho_C \left[0.25 a_X (x - x_G) + K_C\, a_Z (h_C + h_{DB} - z) \right]$
- for load case F: $p_{CW} = 0$
- for load cases R and P: $p_{CW} = \rho_C \left[0.25 a_Y (y - y_G) + K_C\, a_Z (h_C + h_{DB} - z) \right]$

(x-xG) is to be taken as $0.25\ell_H$ in the load case H1 or $-0.25\ell_H$ in the load case H2 for local strength by Ch 6 and fatigue check for longitudinal stiffeners by Ch 8.

The total pressure (p_{CS} + p_{CW}) is not to be negative.

2. Lateral pressure due to liquid

2.2 Inertial pressure due to liquid

2.2.1

The inertial pressure due to liquid p_{BW}, in kN/m^2, for each load case is given as follows. When checking ballast water exchange operations by means of the flow through method, the inertial pressure due to ballast water is not to be considered for local strength assessments and direct strength analysis.

- for load case H: $p_{BW} = \rho_L\, [a_Z (z_{TOP} - z) + a_X (x - x_B)]$

  (x-x_B) is to be taken as $0.75\ell_H$ in the load case H1 or $-0.75\ell_H$ in the load case H2 for local strength by Ch 6 and fatigue check for longitudinal stiffeners by Ch 8
- for load case F: $p_{BW} = 0$
- for load cases R and P: $p_{BW} = \rho_L\, [a_Z (z_B - z) + a_Y (y - y_B)]$

where:

x_B : X co-ordinate, in m, of the aft end of the tank when the bow side is downward, or of the fore end of the tank when the bow side is upward, as defined in Fig 3

y_B : Y co-ordinate, in m, of the tank top located at the most lee side when the weather side is downward, or of the most weather side when the weather side is upward, as defined in Fig 3

z_B : Z co-ordinate of the following point:

- for completely filled spaces: the tank top
- for ballast hold: the top of the hatch coaming

The reference point B is defined as the upper most point after rotation by the angle φ between the vertical axis and the global acceleration vector $\vec{A}_G$ shown in Fig 3. φ is obtained from the following formulae:

- load cases H1 and H2:

$$\varphi = \tan^{-1}\left(\frac{|a_X|}{g\cos\Phi + a_Z}\right)$$

- load cases R1(P1) and R2(P2):

$$\varphi = \tan^{-1}\left(\frac{|a_Y|}{g\cos\theta + a_Z}\right)$$

where:

θ : Single roll amplitude, in deg, defined in Ch4, Sec 2, 2.1.1.

Φ : Single pitch amplitude, in deg, defined in Ch4, Sec 2, 2.2.1

The total pressure (p_{BS} + p_{BW}) is not to be negative.

Reason for the Rule Clarification:

The total internal pressure obtained by adding the static internal pressure to inertial internal pressure is not to be negative that is the same manner for the external pressure specified in Ch 4 Sec 5 1.1.1.

The editorial correction is made to reflect the original intention on the treatment of the total internal pressure.

CHAPTER 6 – HULL SCANTLINGS

SECTION 1 PLATING

2. General requirements

2.2 Minimum net thickness

2.2.1

The net thickness of plating is to be not less than the values given in Table 2. In addition, in the cargo area, the net thickness of side shell plating, from the normal ballast draught to 0.25 T_S (minimum 2.2 *m*) above T_S, is to be not less than the value obtained, in *mm*, from the following formula:

~~$t = 28(s + 0.7)\frac{(BT)^{0.25}}{\sqrt{R_{eH}}}$~~

$$t = 28(s + 0.7)\frac{(BT_S)^{0.25}}{\sqrt{R_{eH}}}$$

Reason for the Rule Clarification:

This editorial correction is made to clarify the definition of draft as scantling basis.

SECTION 2 ORDINARY STIFFENERS

4. Web stiffeners of primary supporting members

4.1 Net scantlings

4.1.3 Connection ends of web stiffeners

Where the web stiffeners of primary supporting members are welded to ordinary stiffener face plates, Tthe stress at ends of web stiffeners of primary supporting members in water ballast tanks, in N/mm², is to comply with the following formula when no bracket is fitted:

$\sigma \le 175$

where:

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

K_{con} : Coefficient considering stress concentration, taken equal to:

$K_{con} = 3.5$ for stiffeners in the double bottom or double side space (see Fig 8)

$K_{con} = 4.0$ for other cases (e.g. hopper tank, top side tank, etc.) (see Fig 8)

K_{longi} : Coefficient considering shape of cross section of the longitudinal, taken equal to:

$K_{longi} = 1.0$ for symmetrical profile of stiffener (e.g. T-section, flat bar)

$K_{longi} = 1.3$ for asymmetrical profile of stiffener (e.g. angle section, bulb profile)

K_{stiff} : Coefficient considering the shape of the end of the stiffener, taken equal to:

$K_{stiff} = 1.0$ for standard shape of the end of the stiffener (see Fig 9)

$K_{stiff} = 0.8$ for the improved shape of the end of the stiffener (see Fig 9)

θ : As given in Fig 10

$\Delta\sigma$: Stress range, in N/mm², transferred from longitudinals into the end of web stiffener, as obtained from the following formula:

$$\Delta\sigma = \frac{2W}{0.322 h' \left[(A_{w1}/\ell_1) + (A_{w2}/\ell_2) \right] + A_{s0}}$$

W : Dynamic load, in N, as obtained from the following formula:

$$W = 1000(\ell - 0.5s)sp$$

p : Maximum inertial pressure due to liquid according to Ch 4 Sec 6 [2.2.1], in kN/m², of the probability level of 10^{-4}. ,calculated at mid-span of the ordinary stiffener

ℓ : Span of the longitudinal, in m

s : Spacing of the longitudinal, in m

A_{s0} , A_{w1} , A_{w2} : Geometric parameters as given in Fig 10, in mm²

ℓ_1 , ℓ_2 : Geometric parameters as given in Fig 10, in mm

h' : As obtained from following formula, in mm:

$$h' = h_s + h_0'$$

h_s : As given in Fig 10, in mm

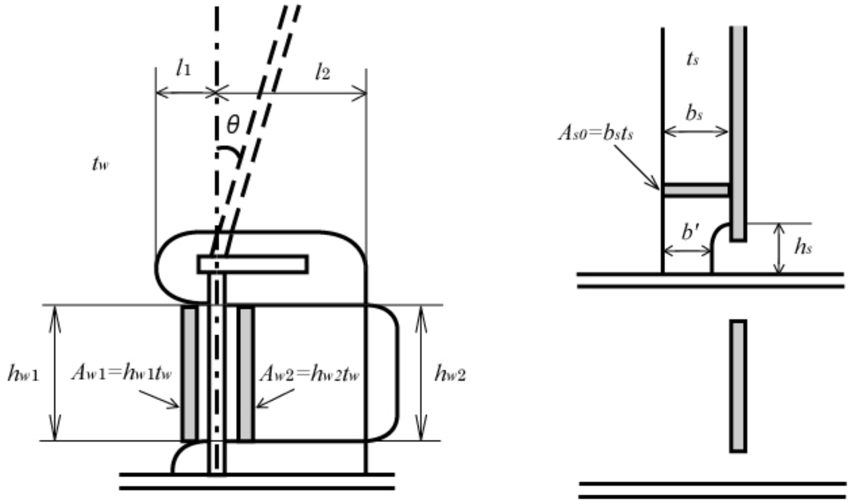
h_0' : As obtained from the following formula, in mm

$h_0' = 0.636b'$ for $b' \le 150$

$h_0' = 0.216b' + 63$ for $150 < b'$

b' : Smallest breadth at the end of the web stiffener, in mm, as shown in Fig 9~~10~~

Fig. 10 Definition of geometric parameters



Note:

t_s: net thickness of the web stiffener, in *mm*.

t_w: net thickness of the collar plate, in *mm*.

Reason for the Rule Clarification:

This requirement is also based on the net scantling approach. In addition, the application of this requirement and the pressure to be considered is clarified in order to respond to the industry comment.

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

3. Buckling criteria of elementary plate panel

3.1 Plates

3.1.2 Verification of elementary plate panel in a transverse section analysis

Each elementary plate panel is to comply with the following criteria, taking into account the loads defined in [2.1]:

- longitudinally framed plating

$$\left(\frac{|\sigma_x| \cdot S}{\kappa_x \cdot R_{eH}}\right)^{e1} + \left(\frac{|\tau| \cdot S \cdot \sqrt{3}}{\kappa_\tau \cdot R_{eH}}\right)^{e3} \le 1{,}0$$

for stress combination 1 with $\sigma_x = \sigma_n$ and $\tau = 0{,}7\,\tau_{SF}$

$$\left(\frac{|\sigma_x| \cdot S}{\kappa_x \cdot R_{eH}}\right)^{e1} + \left(\frac{|\tau| \cdot S \cdot \sqrt{3}}{\kappa_\tau \cdot R_{eH}}\right)^{e3} \le 1{,}0$$

for stress combination 2 with $\sigma_x = 0{,}7\sigma_n$ and $\tau = \tau_{SF}$

- transversely framed plating

$$\left(\frac{|\sigma_y| \cdot S}{\kappa_y \cdot R_{eH}}\right)^{e2} + \left(\frac{|\tau| \cdot S \cdot \sqrt{3}}{\kappa_\tau \cdot R_{eH}}\right)^{e3} \le 1{,}0$$

for stress combination 1 with $\sigma_y = \sigma_n$ and $\tau = 0{,}7\,\tau_{SF}$

~~$\left(\frac{|\sigma_x| \cdot S}{\kappa_y \cdot R_{eH}}\right)^{e2} + \left(\frac{|\tau| \cdot S \cdot \sqrt{3}}{\kappa_\tau \cdot R_{eH}}\right)^{e3} \le 1{,}0$~~ $\left(\frac{|\sigma_y| \cdot S}{\kappa_y \cdot R_{eH}}\right)^{e2} + \left(\frac{|\tau| \cdot S \cdot \sqrt{3}}{\kappa_\tau \cdot R_{eH}}\right)^{e3} \le 1{,}0$ for stress combination 2 with $\sigma_y = 0{,}7\sigma_n$ and $\tau = \tau_{SF}$

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

Editorial correction. The index of the compression stress in the fourth formula has to be “y”.

APPENDIX 1 BUCKLING & ULTIMATE STRENGTH

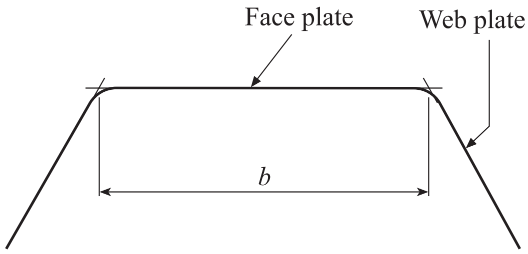
1. Application of Ch 6, Sec 3

1.3 Additional application to FEM analysis

1.3.4 Buckling assessment of corrugated bulkhead

The transverse elementary plate panel (face plate) is to be assessed using the normal stress parallel to the corrugation. The slanted elementary plate panel (web plate) is to be assessed using the combination of normal and shear stresses. The plate panel breadth b is to be measured according to Fig 8.

Fig. 8 Measuring *b* of corrugated bulkheads



a) Face plate assessment

- ~~F_1 = 1.1 is to be used~~
- The buckling load case 1, according to Ch 6, Sec 3, Tab 2, is to be used
- The size of the buckling field to be considered is b times b ($\alpha = 1$)
- $\psi = 1.0$
- The maximum vertical stress in the elementary plate panel is to be considered in applying the criteria
- The plate thickness t to be considered is the one at the location where the maximum vertical stress occurs

b) Web plate assessment

- ~~F_1 = 1.1 is to be used~~
- The buckling load cases 1 and 5, according to Ch 6, Sec 3, Tab 2, are to be used.
- The size of the buckling field to be considered is 2b times b ($\alpha = 2$)
- $\psi = 1.0$
- The following two stress combinations are to be considered:
  - The maximum vertical stress in the elementary plate panel plus the shear stress and longitudinal stress at the location where maximum vertical stress occurs
  - The maximum shear stress in the elementary plate panel plus the vertical stress and longitudinal stress at the location where maximum shear stress occurs
- The plate thickness t to be considered is the one at the location where the maximum vertical/shear stress occurs.

Reason for the Rule Clarification:

Correction factor F1 is not used for the buckling load cases 1 and 5 specified in Ch 6 Sec 3 Table 2 as mentioned in the second sentences.

CHAPTER 7 – DIRECT STRENGTH ANALYSIS

SECTION 4 HOT SPOT STRESS ANALYSIS FOR FATIGUE STRENGTH ASSESSMENT

3. Hot Spot Stress

3.2 Evaluation of hot spot stress

3.2.1

The hot spot stress in a very fine mesh is to be obtained using a linear extrapolation. The surface stresses located at 0.5 times and 1.5 times the net plate thickness are to be linearly extrapolated at the hot spot location, as described in Fig 3 and Fig.4.

The principal stress at the hot spot location having an angle with the assumed fatigue crack greater than 45° is to be considered as the hot spot stress.

Reason for the Rule Clarification:

Editorial correction is made for the clarification of the stress obtained by FEA.

APPENDIX 2 DISPLACEMENT BASED BUCKLING ASSESSMENT IN FINITE ELEMENT ANALYSIS

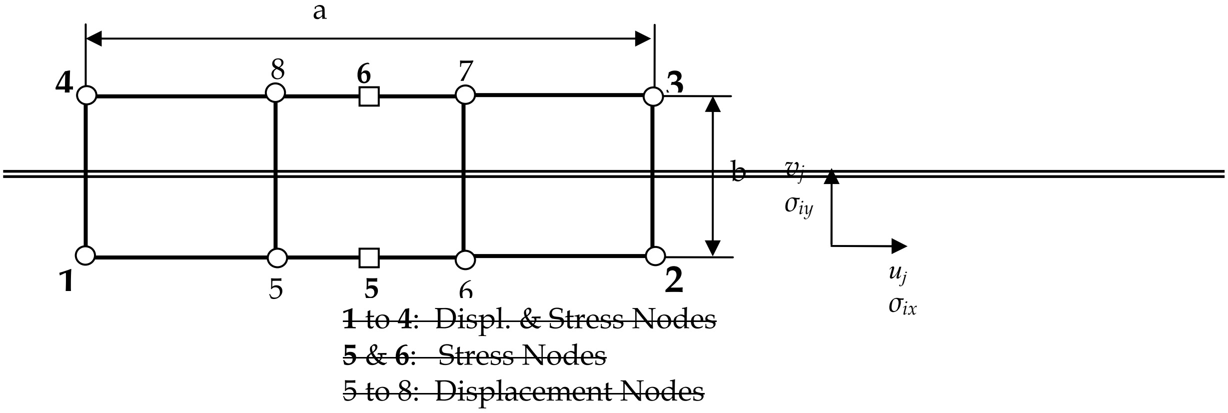
2. Displacement method

2.2 Calculation of buckling stresses and edge stress ratios

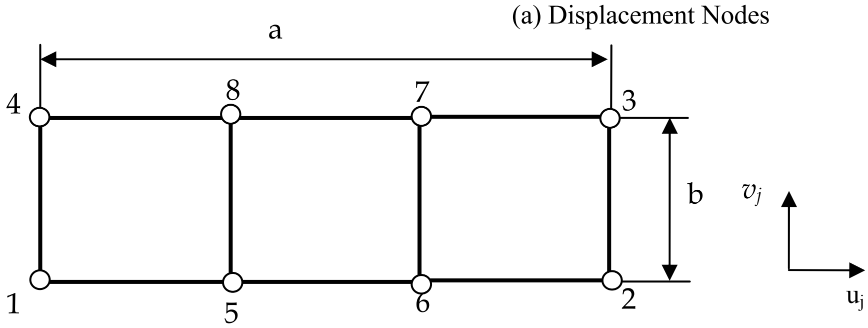
2.2.3 8-node buckling panel

Stress displacement relationship for a 8-node buckling panel (compressive stresses are positive)

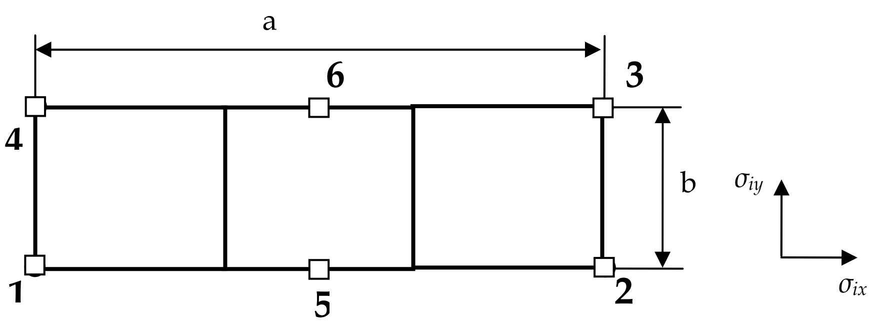
Fig.2 8-node buckling panel



(a) Displacement Nodes



(b) Stress Nodes



<u>Reason for the Rule Clarification:</u>
This correction is to clarify the figure.

CHAPTER 8 – FATIGUE CHECK OF STRUCTURAL DETAILS

SECTION 5 STRESS ASSESSMENT OF HATCH CORNERS

2. Nominal stress range

2.1 Nominal stress range due to wave torsional moment

2.1.1

The nominal stress range, in N/mm², due to cross deck bending induced by wave torsion moments is to be obtained from the following formula:

$$\Delta\sigma_{WT} = \frac{2}{1000} F_S F_L \frac{Q \cdot B_H}{W_Q}$$

where:

$$Q = \frac{1000\,u}{\dfrac{(B_H + b_s)^3}{12 E I_Q} + \dfrac{2.6 B_H}{E A_Q}}$$

u : Displacement of hatch corner in longitudinal direction, in m, taken equal to:

$$u = \frac{31.2}{1000} \frac{M_{WT}\,\omega}{I_T E\ DOC}$$

DOC : Deck opening coefficient, taken equal to:

$$DOC = \frac{L_C B}{\sum_{i=1}^{n} L_{H,i} B_{H,i}}$$

M_{WT} : Maximum wave torsional moment, in kN.m, defined in Ch 4, Sec 3, [3.4.1], with $f_p = 0.5$

F_S : Stress correction factor, taken equal to:

$$F_S = 5$$

F_L : Correction factor for longitudinal position of hatch corner, taken equal to:

$$F_L = 1.75 \frac{x}{L} \quad \text{for } 0.57 \le x/L \le 0.85$$

$$F_L = 1.0 \quad \text{for } x/L < 0.57 \text{ and } x/L > 0.85$$

B_H : Breadth of hatch opening, in m

W_Q : Section modulus of the cross deck about z-axis, in m^3, including upper stool, near hatch corner (see Fig 2)

I_Q : Moment of inertia of the cross deck about z-axis, in m^4, including upper stool, near the hatch corner (see Fig 2)

A_Q : Shear area of the cross deck, in m^2, including upper stool, near the hatch corner (see Fig 2)

b_S : Breadth of remaining deck strip on one side, in m, beside the hatch opening

I_T : Torsion moment of inertia of ships cross section, in m^4, calculated within cross deck area by neglecting upper and lower stool of the bulkhead (see Fig 1). It may be calculated according to App 1

ω : Sector coordinate, in m^2, calculated at the same cross section as I_T and at the Y and Z location of the hatch corner (see Fig 1) It may be calculated according to App 1

L~~C~~$_C$: Length of cargo area, in m, being the distance between engine room bulkhead and collision bulkhead

$B_{H,i}$: Breadth of hatch opening of hatch i, in m

$L_{H,i}$: Length of hatch opening of hatch i, in m

n : Number of hatches.

Elements to be considered for the determination of A_Q, W_Q and I_Q

Reason for the Rule Clarification:

Editorial correction for typo

Editorial corrections of the definition of symbols are made for clarification

APPENDIX 1 CROSS SECTIONAL PROPERTIES FOR TORSION

1. Calculation formulae

1.4 Computation of cross sectional properties for the entire cross section

Asymmetric cross section:	Symmetric cross section (only half of the section is modeled)
$A = \sum A$	$A = 2\sum A$
$y_s = \dfrac{\sum S_z}{\sum A}$	$y_s = \dfrac{\sum S_z}{\sum A}$
$z_s = \dfrac{\sum S_y}{\sum A}$	$z_s = \dfrac{\sum S_y}{\sum A}$
$I_y = \sum I_y - \sum A z_s^2$	$I_y = 2\left(\sum I_y - \sum A z_s^2\right)$
$I_z = \sum I_z - \sum A y_s^2$	$I_z = 2\left(\sum I_z - \sum A y_s^2\right)$
$I_{yz} = \sum I_{yz} - \sum A y_s z_s$	
$I_T =$ ~~$\sum \dfrac{st^3}{3}$~~ $\sum \dfrac{st^3}{3} + \sum_{Cell\ i} \left(2 A_{yi} \Phi_i\right)$	$I_T = 2\left[\sum \dfrac{st^3}{3} + \sum_{Cell\ i} \left(2 A_{yi} \Phi_i\right)\right]$
$\omega_0 = \dfrac{\sum S_\omega}{\sum A}$	
$I_{\omega y} = \sum I_{\omega y} - \sum A y_s \omega_0$	$I_{\omega y} = 2\sum I_{\omega y}$
$I_{\omega z} = \sum I_{\omega z} - \sum A z_s \omega_0$	
$y_M = \dfrac{I_{\omega z} I_z - I_{\omega y} I_{yz}}{I_y I_z - I_{yz}^2}$	
$z_M = \dfrac{I_{\omega z} I_{yz} - I_{\omega y} I_y}{I_y I_z - I_{yz}^2}$	$z_M = -\dfrac{I_{\omega y}}{I_z}$
~~$I_\omega = \sum I_\omega - \sum A \omega_0^2 + z_m I_{\omega y} - y_M I_{\omega z}$~~ $I_\omega = \sum I_\omega - \sum A \omega_0^2 + z_M I_{\omega y} - y_M I_{\omega z}$	~~$I_\omega = 2\sum I_\omega + z_m I_{\omega y}$~~ $I_\omega = 2\sum I_\omega + z_M I_{\omega y}$

I_y, I_z, I_{yz} are to be computed with relation to the centre of gravity.

~~S~~ $S_x, S_y, S_\omega, I_\omega, I_{\omega y}$ *and* $I_{\omega z}$ ~~, I_ω~~ are to be computed with relation to shear centre *M*

The sector-coordinate ω has to be transformed with respect to the location of the shear centre *M*. For cross sections of type **A**, ω_0 is to be added to each ω_i and ω_k as defined in [1.3]

For cross sections of type **B** and **C**, $\Delta\omega$ can be calculated as follows:

~~$\Delta\omega_i = \omega - \omega_O - z_M(y_i) - y_M(z_i)$~~ $\Delta\omega_i = z_M y_i$

where:

ω_O : Calculated sector co-ordinate with respect to the centre of the coordinate system (O) selected for the calculation according to the formulae for ω_k given in [1.3]

ω : Transformed sector co-ordinate with respect to shear centre *M*

y_M, z_M : Distance between shear centre *M* and centre of the coordinate system B.

The transformed values of ω can be obtained by adding $\Delta\omega$ to the values of ω_O obtained according to the formulae in [1.3].

The transformed value for ω is to be equal to zero at intersections of the cross section with the line of symmetry (centreline for ship-sections).

Reason for the Rule Clarification:

Editorial correction and clarification

CHAPTER 9 – OTHER STRUCTURES

SECTION 3 MACHINERY SPACE

2. Double bottom

2.1 Arrangement

2.1.8 Floors stiffeners

In addition to the requirements in Ch 3, Sec 6, floors are to have web stiffeners sniped at the ends and spaced not more than approximately 1 m apart.

The section modulus of web stiffeners is to be not less than 1.2 times that required in Ch 6, Sec 2, ~~[4]~~ 4.1.2

Reason for the Rule Clarification:

Editorial correction of the reference number

CHAPTER 10 – HULL OUTFITTING

SECTION 3 EQUIPMENT

2. Equipment number

2.1 Equipment number

Table 1: Equipment

Equipment number EN $A < EN \le B$		Stockless anchors		Stud link chain cables for anchors			
		N (1)	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Grade 1	Grade 2	Grade 3
50	70	2	180	220.0	14.0	12.5	
70	90	2	240	220.0	16.0	14.0	
90	110	2	300	247.5	17.5	16.0	
110	130	2	360	247.5	19.0	17.5	
130	150	2	420	275.0	20.5	17.5	
150	175	2	480	275.0	22.0	19.0	
175	205	2	570	302.5	24.0	20.5	
205	240	3	660	302.5	26.0	22.0	20.5
240	280	3	780	330.0	28.0	24.0	22.0
280	320	3	900	357.5	30.0	26.0	24.0
320	360	3	1020	357.5	32.0	28.0	24.0
360	400	3	1140	385.0	34.0	30.0	26.0
400	450	3	1290	385.0	36.0	32.0	28.0
450	500	3	1440	412.5	38.0	34.0	30.0
500	550	3	1590	412.5	40.0	34.0	30.0
550	600	3	1740	440.0	42.0	36.0	32.0
600	660	3	1920	440.0	44.0	38.0	34.0
660	720	3	2100	440.0	46.0	40.0	36.0
720	780	3	2280	467.5	48.0	42.0	36.0
780	840	3	2460	467.5	50.0	44.0	38.0
840	910	3	2640	467.5	52.0	46.0	40.0
910	980	3	2850	495.0	54.0	48.0	42.0
980	1060	3	3060	495.0	56.0	50.0	44.0
1060	1140	3	3300	495.0	58.0	50.0	46.0
1140	1220	3	3540	522.5	60.0	52.0	46.0
1220	1300	3	3780	522.5	62.0	54.0	48.0
1300	1390	3	4050	522.5	64.0	56.0	50.0
1390	1480	3	4320	550.0	66.0	58.0	50.0
1480	1570	3	4590	550.0	68.0	60.0	52.0
1570	1670	3	4890	550.0	70.0	62.0	54.0
1670	1790	3	5250	577.5	73.0	64.0	56.0
1790	1930	3	5610	577.5	76.0	66.0	58.0

Equipment number EN $A < EN \le B$		Stockless anchors		Stud link chain cables for anchors			
		N (1)	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Grade 1	Grade 2	Grade 3
1930	2080	3	6000	577.5	78.0	68.0	60.0
2080	2230	3	6450	605.0	81.0	70.0	62.0
2230	2380	3	6900	605.0	84.0	73.0	64.0
2380	2530	3	7350	605.0	87.0	76.0	66.0
2530	2700	3	7800	632.5	90.0	78.0	68.0
2700	2870	3	8300	632.5	92.0	81.0	70.0
2870	3040	3	8700	632.5	95.0	84.0	73.0
3040	3210	3	9300	660.0	97.0	84.0	76.0
3210	3400	3	9900	660.0	100.0	87.0	78.0
3400	3600	3	10500	660.0	102.0	90.0	78.0
3600	3800	3	11100	687.5	105.0	92.0	81.0
3800	4000	3	11700	687.5	107.0	95.0	84.0
4000	4200	3	12300	687.5	111.0	97.0	87.0
4200	4400	3	12900	715.0	114.0	100.0	87.0
4400	4600	3	13500	715.0	117.0	102.0	90.0
4600	4800	3	14100	715.0	120.0	105.0	92.0
4800	5000	3	14700	742.5	122.0	107.0	95.0
5000	5200	3	15400	742.5	124.0	111.0	97.0
5200	5500	3	16100	742.5	127.0	111.0	97.0
5500	5800	3	16900	742.5	130.0	114.0	100.0
5800	6100	3	17800	742.5	132.0	117.0	102.0
6100	6500	3	18800	742.5		120.0	107.0
6500	6900	3	20000	770.0		124.0	111.0
6900	7400	3	21500	770.0		127.0	114.0
7400	7900	3	23000	770.0		132.0	117.0
7900	8400	3	24500	770.0		137.0	122.0
8400	8900	3	26000	770.0		142.0	127.0
8900	9400	3	27500	770.0		147.0	132.0
9400	10000	3	29000	770.0		152.0	132.0
10000	10700	3	31000	770.0			137.0
10700	11500	3	33000	770.0			142.0
11500	12400	3	35500	770.0			147.0
12400	13400	3	38500	770.0			152.0
13400	14600	3	42000	770.0			157.0
14600	16000	3	46000	770.0			162.0

(1) See [3.2.4].

2.1.2

The equipment number EN is to be obtained from the following formula:

$EN = \Delta$ ~~2/3~~ $^{2/3} + 2\,h\,B + 0.1\,A$

where:.

Δ : Moulded displacement of the ship, in t, to the summer load waterline

h : Effective height, in m, from the summer load waterline to the top of the uppermost house, to be obtained in accordance with the following formula:

$h = a + \Sigma h_n$

When calculating h, sheer and trim are to be disregarded

a : Freeboard amidships from the summer load waterline to the upper deck, in m

h_n : Height, in m, at the centreline of tier "*n*" of superstructures or deckhouses having a breadth greater than *B*/4. Where a house having a breadth greater than *B*/4 is above a house with a breadth of *B*/4 or less, the upper house is to be included and the lower ignored

A : Area, in m^2, in profile view, of the parts of the hull, superstructures and houses above the summer load waterline which are within the length *L* and also have a breadth greater than *B*/4

Fixed screens or bulwarks 1.5 m or more in height are to be regarded as parts of houses when determining *h* and *A*. In particular, the hatched area shown in Fig 1 is to be included.

The height of hatch coamings and that of any deck cargo, such as containers, may be disregarded when determining *h* and *A*.

3.7 Windlass

3.7.9 Forces in the securing devices of windlasses due to green sea loads

Forces in the bolts, chocks and stoppers securing the windlass to the deck are to be calculated by considering the green sea loads specified in [3.7.8].

The windlass is supported by *N* bolt groups, each containing one or more bolts (see also Fig 3).

The axial force R_i in bolt group (or bolt) *i*, positive in tension, is to be obtained, in kN, from the following formulae:

- ~~$R_{xi} = P_x h_{xi} A_i / I_x$~~ $R_{xi} = P_x hx_i A_i / I_x$
- ~~$R_{yi} = P_y h_{yi} A_i / I_y$~~ $R_{yi} = P_y hy_i A_i / I_y$
- $R_i = R_{xi} + R_{yi} - R_{si}$

where:

Px : Force, in kN, acting normal to the shaft axis

Py : Force, in kN, acting parallel to the shaft axis, either inboard or outboard, whichever gives the greater force in bolt group *i*

~~*H*~~ *h* : Shaft height, in cm, above the windlass mounting

x_i, y_i : *X* and *Y* co-ordinates, in cm, of bolt group *i* from the centroid of all *N* bolt groups, positive in the direction opposite to that of the applied force

A_i : Cross-sectional area, in cm^2, of all bolts in group *I*

I_x, I_y : Inertias, for *N* bolt groups, equal to:

$I_x = \Sigma A_i x_i^2$

$I_y = \Sigma A_i y_i^2$

~~R_i~~ R_{si} : Static reaction force, in kN, at bolt group *i*, due to weight of windlass.

Shear forces F_{xi} , F_{yi} applied to the bolt group *i*, and the resultant combined force F_i are to be obtained, in kN, from the following formulae:

- ~~$F_{xi} = (P_x - \alpha g M) / N$~~ $F_{xi} = (P_x - \alpha g M) / N$
- $F_{yi} = (P_y - \alpha g M) / N$
- $F_i = (F_{xi}^2 + F_{yi}^2)^{0,5}$

where:

α : Coefficient of friction, to be taken equal to 0.5

M : Mass, in *t*, of windlass

N : Number of bolt groups.

Axial tensile and compressive forces and lateral forces calculated according to these requirements are also to be considered in the design of the supporting structure.

Reason for the Rule Clarification:

Editorial correction – correction of error in formula

CHAPTER 11 – CONSTRUCTION AND TESTING

SECTION 1 CONSTRUCTION

1. Structural details

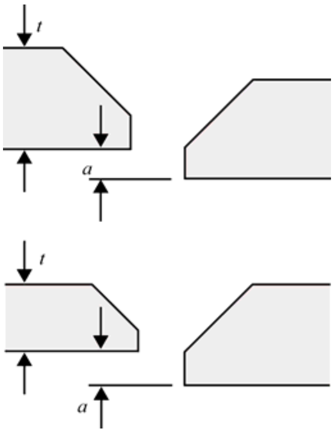
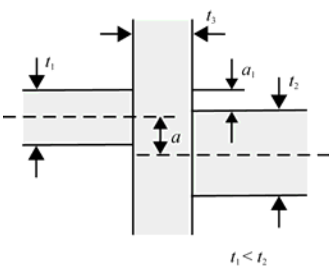
1.2 Cold forming

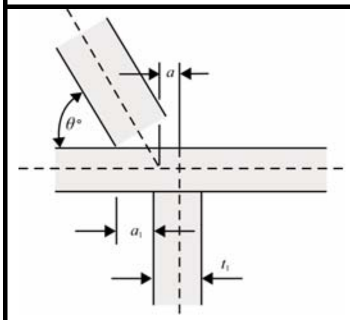
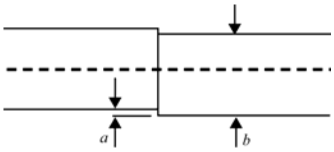
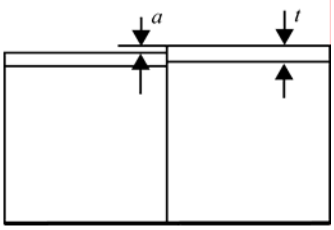
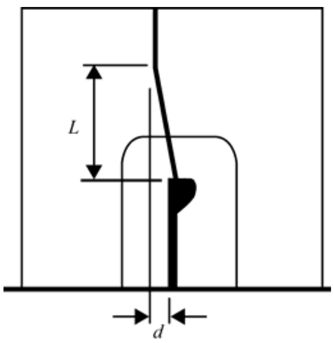
1.2.1

For cold forming (bending, flanging, beading) of plates the minimum average bending radius is to be not less than $3t$ (t = ~~gross plate thickness~~ as-built thickness).

In order to prevent cracking, flame cutting flash or sheering burrs are to be removed before cold forming. After cold forming all structural components and, in particular, the ends of bends (plate edges) are to be examined for cracks. Except in cases where edge cracks are negligible, all cracked components are to be rejected. Repair welding is not permissible.

Table 1 Alignment (t, $t1$, and $t2$: as-built thickness)

Detail	Standard	Limit	Remarks
Alignment of butt welds  	$a \le 0.15t$ strength $a \le 0.2t$ other	$a \le 3.0$ mm	
Alignment of fillet welds  	a) Strength and higher tensile steel $a \le t_1 / 4$ measured on the median $a \le (5t_1 - 3t_2) / 6$ measured on the heel line b) Other $a \le t_1 / 2$ measured on the median $a \le (2\,t_1 - t_2) / 2$ measured on the heel line		Where t_2 is less than t_1, then t_2 should be substituted for t_1.
Alignment of fillet welds	a) Strength and higher tensile steel $a \le t_1 / 3$ measured on the median		

Detail	Standard	Limit	Remarks
	b) Other $a \le t_1 / 2$ measured on the heel line		
Note: "strength" means the following elements: strength deck, inner bottom, bottom, lower stool, lower part of transverse bulkhead, bilge hopper and side frames of single side bulk carriers.			
Alignment of face plates of T longitudinal 	$a \le 0.04b$ strength	$a = 8.0$ mm	
Alignment of height of T-bar, L-angle bar or bulb 	$a \le 0.15\ t$ for primary supporting members $a \le 0.2\ t$ for ordinary stiffeners	3.0 mm	
Alignment of panel stiffener 	$d \le L / 50$		
Note: "strength" means the following elements: strength deck, inner bottom, bottom, lower stool, lower part of transverse bulkhead, bilge hopper and side frames of single side bulk carriers.			

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

Editorial correction for clarification of the thickness

SECTION 2 WELDING

2. Types of welded connection

2.2 Butt welding

2.2.2 Welding of plates with difference thicknesses

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

Reason for the Rule Clarification:
Editorial correction for clarification of the thickness

2.6 Fillet welds

2.6.1 Kinds and size of fillet welds and their applications

Kinds and size of fillet welds for as-built thickness of abutting plating up to 50 mm are classed into 5 categories as given in Tab 1 and their application to hull construction is to be as required by Tab 2.

In addition, for zones "*a*" and "*b*" of side frames as shown in Ch 3, Sec 6, Fig 19, the weld throats are to be respectively $0.44t$ and $0.4t$, where t is as-built thickness of the thinner of two connected members.

Table 1 Categories of fillet welds

Category	Kinds of fillet welds	As-built ~~gross~~ thickness of abutting plate, t, in mm (1)	Leg length of fillet weld, in mm (2)	Length of fillet welds, in mm	Pitch, in mm
F0	Double continuous weld	t	$0.7t$	-	-
F1	Double continuous weld	$t \le 10$	$0.5t + 1.0$	-	-
		$10 \le t < 20$	$0.4t + 2.0$	-	-
		$20 \le t$	$0.3t + 4.0$	-	-
F2	Double continuous weld	$t \le 10$	$0.4t + 1.0$	-	-
		$10 \le t < 20$	$0.3t + 2.0$	-	-
		$20 \le t$	$0.2t + 4.0$	-	-
F3	Double continuous weld	$t \le 10$	$0.3t + 1.0$	-	-
		$10 \le t < 20$	$0.2t + 2.0$		
		$20 \le t$	$0.1t + 4.0$		
F4	Intermittent weld	$t \le 10$	$0.5t + 1.0$	75	300
		$10 \le t < 20$	$0.4t + 2.0$		
		$20 \le t$	$0.3t + 4.0$		

(1) t is as-built thickness of the thinner of two connected members

(2) Leg length of fillet welds is made fine adjustments corresponding to the corrosion addition t_C specified in Ch 3, Sec 3, Tab 1 as follows:
+ 1.0 mm for $t_C > 5$
+ 0.5 mm for ~~$5 \ge t_C \ge 4$~~ $5 \ge t_C > 4$
- 0.5 mm for ~~$t_C < 4$~~ $t_C \le 3$

Table 2 Application of fillet welds

Hull area	Connection: Of		Connection: To		Category
General, unless otherwise specified in the table	Watertight plate		Boundary plating		F1
	Brackets at ends of members				F1
	Ordinary stiffener and collar plates		Deep tank bulkheads		F3
			~~Cut-out in way of primary supporting members~~ Web of primary supporting members and collar plates		F2
	Web of ordinary stiffener		Plating (Except deep tank bulkhead)		F4
			Face plates of built-up stiffeners	At ends (15% of span)	F2
				Elsewhere	F4
	End of primary supporting members and ordinary stiffeners		Deck plate, shell plate, inner bottom plate, bulkhead plate		F0
Bottom and double bottom	Ordinary stiffener		Bottom and inner bottom plating		F3
	Center girder		Shell plates in strengthened bottom forward		F1
			Inner bottom plate and shell plate except the above		F2
	Side girder including intercostal plate		Bottom and inner bottom plating		F3
	Floor		Shell plates and inner bottom plates	At ends, on a length equal to two frame spaces	F2
			Center girder and side girders in way of hopper tanks		F2
			Elsewhere		F3
	Bracket on center girder		Center girder, inner bottom and shell plates		F2
	Web stiffener		Floor and girder		F3
Side and inner side in double side structure	Web of primary supporting members		Side plating, inner side plating and web of primary supporting members		F2
Side frame of single side structure	Side frame and end bracket		Side shell plate		~~F1~~ See Ch 3 Sec 6 Fig. 19
	Tripping bracket		Side shell plate and side frame		F1
Deck	Strength deck	$t \geq 13$	Side shell plating within 0.6L midship		Deep penetration
			Elsewhere		F1
		$t < 13$	Side shell plating		F1
	Other deck		Side shell plating		F2
			Ordinary stiffeners		F4
	Ordinary stiffener and intercostal girder		Deck plating		F3
	Hatch coamings		Deck plating	At corners of hatchways for 15% of the hatch length	F1
				Elsewhere	F2
	Web stiffeners		Coaming webs		F4

Hull area	Connection			Category
	Of	To		
Bulkheads	Non-watertight bulkhead structure	Boundaries	Swash bulkheads	F3
	Ordinary stiffener	Bulkhead plating	At ends (25% of span), where no end brackets are fitted	F1
Primary supporting members	Web plate and girder plate	Shell plating, deck plating, inner bottom plating, bulkhead	At end (15% of span)	F1
			Elsewhere	F2
		Face plate	In tanks, and located within 0.125L from fore peak	F2
			Face area exceeds 65 cm^2	F2
			Elsewhere	F3
After peak	Internal members	Boundaries and each other		F2
Seating	Girder and bracket	Bed plate	In way of main engine, thrust bearing, boiler bearers and main generator engines	F1
		Girder plate	In way of main engine and thrust bearing	F1
		Inner bottom plate and shell	In way of main engine and thrust bearing	F2
Super-structure	External bulkhead	Deck		F1
Pillar	Pillar	Heel and head		F1
Ventilator	Coaming	Deck		F1
Rudder	Rudder frame	Vertical frames forming main piece		F1
		Rudder plate		F3
		Rudder frames except above		F2

Reason for the Rule Clarification:

(1) Editorial correction for clarification of the thickness

(2) Editorial error for the threshold of corrosion addition. This correction is made to be in line with the technical background.

(3) The requirement for weld of side frame is in accordance with IACS UR S12.