Related to Part C of the Rules

Amended Rules and Guidance

Rules for the Survey and Construction of Steel Ships Part C
Guidance for the Survey and Construction of Steel Ships Part N

Reason for Amendment

A comprehensive review of Part C of the Rules began in late 2017 and resulted in a comprehensive revision of Part C (hereinafter referred to as the “new Part C). This new Part C was formally approved by the ClassNK Technical Committee at its first meeting of 2022. A thorough impact assessment and review of the new Part C was subsequently conducted in cooperation with shipyards, and this assessment identified some requirements that shipyards felt still needed some brushing up.

Accordingly, relevant requirements in the new Part C as well as relevant requirements in Part N of the Guidance are amended in response to the aforementioned feedback received from shipyards.

Outline of Amendment

Amends requirements related to matters pointed out in the feedback received from shipyards who participated in the thorough impact assessment and review of the new Part C.

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

Part C HULL CONSTRUCTION AND EQUIPMENT

Part 1 GENERAL HULL REQUIREMENTS

Chapter 1 GENERAL

1.1 General

1.1.2 Application

1.1.2.1 General

Sub-paragraph -1 has been amended as follows.

1 The requirements in **Part C** apply to ships constructed of welded steel structures, composed of stiffened plate panels, ~~and~~ having a length ~~L_C~~ L (as defined in **2.1.2, Part A**) of not less than 90 *m*, and intended for unrestricted service.

1.4 Symbols and Definitions

1.4.2 Primary Symbols and Units

1.4.2.2 Ship's Main Data

Unless otherwise specified, the symbols of a ship's main data and their units used in **Part C** are those defined in **Table 1.4.2-2.**

Table 1.4.2-2 has been amended as follows.

Table 1.4.2-2 Ship's Main Data

Symbol	Meaning	Unit
L_C	Ship length, but to be taken as 90 *m* where not greater than 90 *m* (*See* **1.4.3.1-1**)	*m*
(Omitted)		

1.4.3 Definitions

1.4.3.1 Principal Particulars

Sub-paragraph -1 has been amended as follows.

1 The ship length L_C is to be in accordance with the following **(1)** to **(3)**, but is to be taken as 90 m in cases where not greater than 90 m:

(1) The ship length L_C (m) is to be the distance measured on the waterline at the scantling draught T_{SC} from the forward side of the stem to the after side of the rudder post for ships with a rudder post or to the centre of the rudder stock for ships without a rudder post. L_C is to be not less than 96 % but need not exceed 97 % of the extreme length on the waterline at the scantling draught T_{SC}.

(2) In ships without a rudder stock (e.g., ships fitted with azimuth thrusters), the ship length L_C is to be taken as equal to 97 % of the extreme length on the waterline at the scantling draught T_{SC}.

(3) In ships with an unusual stem or stern arrangements, the ship length is to be deemed appropriate by the Society on a case-by-case basis.

Chapter 3 STRUCTURAL DESIGN PRINCIPLES

3.3 Net Scantling Approach

3.3.3 Corrosion Model for Strength Assessment

3.3.3.1

Table 3.3.3-1 has been amended as follows.

Table 3.3.3-1 Assessment of Corrosion Applied to the Gross Scantlings

Structural requirement	Property/analysis type	Applied corrosion addition
(Omitted)		
Strength assessment by cargo hold analysis	FE model(1)	$0.5\ t_c$
	Buckling strength	t_c
(Omitted)		
Torsional strength assessment by whole ship analysis	FE model(~~2~~1)	$0.5\ t_c$
	Buckling strength	t_c
(Omitted)		
Fatigue strength assessment (finite element analysis)	Finite element model(1)	$0.25\ t_c$
Torsional fatigue strength assessment by whole ship analysis	Finite element model(~~2~~1)	$0.25\ t_c$
Whole ship analysis (other than torsional yield strength assessment and fatigue strength assessment)	Finite element model(~~2~~1)	$0.5\ t_c$

(Notes)
~~(1) No consideration of corrosion addition is required for cargo holds other than the target hold.~~
(~~2~~1) No consideration of corrosion addition is required for members not affecting strength assessment results.

3.5 Minimum Requirements

3.5.2 Slenderness Requirements

Paragraph 3.5.2.1 has been amended as follows.

3.5.2.1 Application

1 All structural members are to meet the slenderness requirements specified in~~. Where structural members are deemed by the Society as having effectiveness equivalent to those compliant with the requirements in **3.5.2**, such structural members are to be deemed compliant with **3.5.2**.~~ <u>**3.5.2**, except for those listed below:</u>

- <u>Bilge plates within the cylindrical part of the ship and the radius gunwale</u>
- <u>Structure members in superstructures and deck houses in cases where such members do not contribute to longitudinal strength.</u>

<u>Pillars in superstructures and deckhouses are to comply with the applicable slenderness and proportion requirements specified in **3.5.2**.</u>

<u>**2** Where structural members are deemed by the Society as having an effectiveness equivalent to those compliant with **3.5.2**, such members are to be deemed compliant with **3.5.2**.</u>

~~**2**~~<u>**3**</u> Notwithstanding **-1** above, thickness of shell plating, ~~watertight~~ <u>deck,</u> bulkhead and web of girder and stiffness of stiffener need not to comply with **3.5.2**, provided that buckling strength requirements specified in **5.3** and **8.6.2** are satisfied.

3.5.2.2 Thickness of Various Structural Members

1 The thickness t (*mm*) of various structural members is to satisfy the following criteria:

$$t \geq \frac{b}{C}\sqrt{\frac{\sigma_Y}{235}}$$

b: For plating, b is to be taken as the plate breadth (*mm*)
For webs, b is to be taken as the web depth (*mm*). However, where the stiffener is provided on the web, b may be taken as the maximum breadth taking the stiffener into account.
For face plates, b is to be taken as the half breadth of the face plate (*mm*)
For circular section pillars, b is to be taken as their mid-thickness radius (*mm*)

C: Slenderness coefficient as specified in **Table 3.5.2-1**

Table 3.5.2-1 has been amended as follows.

Table 3.5.2-1 Slenderness Coefficients

Type of structural member	C
Shell plating~~, watertight bulkheads and girder webs~~	100
Upper decks	
Inner bottom plating	
Girder webs	
Watertight[(1)] and ~~N~~non-tight bulkheads	125
Watertight decks[(1)]	
Non-watertight decks within cargo hold regions	
Non-watertight decks outside cargo hold regions	150
Angles and T-section stiffener webs	75
Webs of bulb sections	45
Webs of pillars	35
Flat bars	22
Face plates of stiffeners and girders	15
Face plates of pillars	12
Circular section pillars	50
Note: (1) This includes deep tank boundaries.	

Paragraph 3.5.2.4 has been amended as follows.

3.5.2.4 Stiffness of Stiffeners

The scantlings of stiffeners are to comply with one of the following **(1)** to **(3)** as applicable depending on the structure:

(1) For longitudinal stiffeners

The value of the moment of inertia I_{st} (cm^4) is to satisfy the following:

$$I_{st} \geq 1.43\ell^2 A_{eff}\frac{\sigma_Y}{235}$$

A_{eff}: Sectional area (cm^2) of stiffeners with attached plating, taking into account the effective breadth specified in **3.6.3**

σ_Y: Specified minimum yield stress (N/mm^2) of attached plating

(2) For non-longitudinal stiffeners attached to watertight members

The value of the moment of inertia I_{st} (cm^4) is to satisfy the following:

$$I_{st} \geq 0.72\ell^2 A_{eff}\frac{\sigma_Y}{235}$$

A_{eff}: Sectional area (cm^2) as specified in **(1)** above

σ_Y: Specified minimum yield stress (N/mm^2) as specified in **(1)** above

(3) For non-longitudinal stiffeners attached to a non-watertight member

The value of the moment of inertia I_{st} (cm^4) is to satisfy **(2)** above. However, in the case of flat bar stiffeners, it is also acceptable if gross scantling depth h_{w-gr} (mm) ~~of flat bar stiffeners~~ satisfies the following~~, where the stiffener may be a flanged stiffener with an equivalent moment of inertia~~:

$$h_{w-gross} \geq \frac{\ell}{12} \times 10^3$$

3.5.2.9 Edge Reinforcement in Way of Openings

Sub-paragraph -1 has been amended as follows.

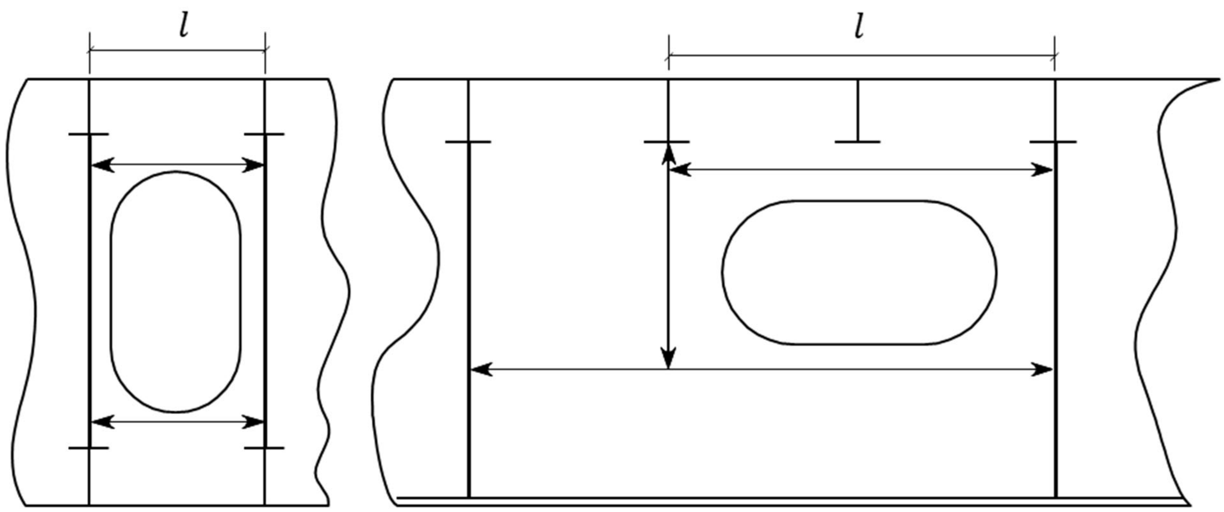
1 The depth of web h_{w-gr} (*mm*) of edge stiffeners fitted in way of openings (*See* **Fig. 3.5.2-1**) is to satisfy the following:

$$h_{w-gr} \geq \max\left(50, 0.05l\sqrt{\frac{\sigma_Y}{235}}\right)$$

l: Length of edge stiffener in way of opening as defined in **Fig. 3.5.2-1** (*m*)

2 The thickness of the web and flange of the edge stiffener are to satisfy in **3.5.2.2** and **3.5.2.3**.

Fig. 3.5.2-1 Typical Edge Reinforcements



Chapter 4 LOADS

4.4 Loads to be Considered in Local Strength

4.4.2 Maximum Load Condition

4.4.2.4 Internal Pressure Due to Liquid Loaded

1 Static pressure P_{ls} (kN/m^2) acting on tanks or ballast holds loaded with liquids is to be as specified in **Table 4.4.2-5**.

Table 4.4.2-5 has been amended as follows.

Table 4.4.2-5 Internal Static Pressure P_{ls} in Tanks and Ballast Holds Loaded with Liquids

Type of tank or hold	Static pressure P_{ls} (kN/m^2)	
	$z \le z_{top}$	$z > z_{top}$
Cargo tanks fully loaded with liquid cargo (excluding liquefied gas)	$\rho_L g(z_{top} - z) + P_{PV}$	0
Cargo tanks fully loaded with liquefied gas and liquefied gas fuel tanks	$\rho_L g(z_{top} - z) + P_0$	0
Ballast holds	$\rho_L g(z_{top} - z)$	0
Ballast tanks and other tanks	$\rho_L g(z_{top} - z \cancel{+ 0.5h_{air}}) - P_{BAL}$	0

Notes:

ρ_L: Density of liquid loaded (t/m^3), as specified in **Table 4.4.2-6**

z_{top}: Z coordinate of the highest point (m) of the tank, excluding small hatchways ~~(m)~~

~~h_{air}: Height of air pipe or overflow pipe above the top of the tank (m)~~

P_{PV}: Design vapour pressure (kN/m^2), but not to be taken less than 25 kN/m^2

P_0: Design vapour pressure (kN/m^2). For cargo tanks, this value is not to be less than the *MARVS* specified in **1.1.4, Part N**. For liquefied gas fuel tanks, this value is not to be less than the *MARVS* specified in **2.2.1, Part GF**.

P_{BAL}: Hydrostatic pressure (kN/m^2) at ballast draught T_{BAL} (m) considered as a component for offsetting internal pressure, as specified in **Table 4.4.2-7**. For members subject to simultaneous external and internal pressures, the actual hydrostatic pressure value is to be considered. For other members ~~other than it~~, the value is to be taken as 0.

Paragraph 4.4.3 has been amended as follows.

4.4.3 Testing Condition

4.4.3.1 External Pressure

~~External pressure~~ $\cancel{P_{ST-ex}}$ ~~(kN/m^2) acting on the hull is to be the hydrostatic pressure corresponding to the draught described in the test plan approved by the Society in accordance with the requirements in **2.1.5, Part B**.~~ The following **(1)** and **(2)** are to be considered as external pressure acting on the hull.

(1) Case 1 (P_{ST-ex1}): Hydrostatic pressure (kN/m^2) corresponding to the draught described in the test plan at Classification Surveys during Construction approved by the Society in accordance with **2.1.5, Part B**.

(2) Case 2 (P_{ST-ex2}): Hydrostatic pressure (kN/m^2) corresponding to the draught T_{BAL} or $0.33T_{SC}$, whichever is smaller. However, where the draught of pressure tests at Special Surveys is given in the loading manual, the hydrostatic pressure corresponding to said draught may be considered instead.

4.4.3.2 Internal Pressure

1 Internal pressure $\cancel{P_{ST-in}}$ P_{ST-in1} and P_{ST-in2} (kN/m^2) acting on the hull and tanks is to be in accordance with **Table 4.4.3-1**.

2 When a hydrostatic test is conducted under a condition exceeding the pressure specified in **-1**

above, the actual pressure which occurs in the test is to be used.

3 When external pressure is considered as a component offsetting the internal pressure in a member subjected to simultaneous internal and external pressures, the external pressure specified in **4.4.3.1** may be considered, identical cases are to be combined.

Table 4.4.3-1 Internal Pressure ~~P_{ST-in}~~ P_{ST-in1} and P_{ST-in2} in Testing Condition

Position under consideration		Internal pressure ~~P_{ST-in}~~ P_{ST-in1} and P_{ST-in2} (kN/m^2)
Case 1	$z \leq z_{ST}$	~~$P_{ST-in} = \rho g(z_{ST} - z)$~~ $P_{ST-in1} = \rho g(z_{ST} - z)$
	$z > z_{ST}$	0
Case 2[(1)]	$z \leq z_{top}$	$P_{ST-in2} = \rho g(z_{top} + h_{air} - z) + 25$
	$z > z_{top}$	0
Notes: z_{ST}: Height (m) of water head ~~(m)~~ ~~in~~for hydrostatic test, as specified in **Table 4.4.3-2** z_{top}: Z coordinate of the highest point (m) of the tank, excluding small hatchways h_{air}: Height (m) of air pipe or overflow pipe above the top of the tank		
(1) Compartments to be assessed are ballast tanks only.		

Table 4.4.3-2 Design Testing Water Head Height z_{ST}
(Omitted)

4.4.3.3 Vertical Bending Moment

(Omitted)

4.5 Loads to be Considered in Strength of Primary Supporting Structures

4.5.3 Harbour Condition

4.5.3.2 Internal Pressure

Sub-paragraph -2 has been amended as follows.

1 Loads due to cargoes, ballast and other loaded materials are to be considered as the internal pressure acting on the hull.

2 Internal pressure P_{PT-in} (kN/m^2) acting on tanks loaded with liquids and ballast holds is to be in accordance with the following formulae:

~~$P_{PT-in} = P_{ls}$~~

For ballast tanks, $P_{PT-in} = P_{ls} + \rho_L g h_{air}$

For other tanks, $P_{PT-in} = P_{ls}$

P_{ls}: Static pressure (kN/m^2), as specified in **4.4.2.4-1**

ρ_L: Density of liquid loaded (t/m^3), as specified in **Table 4.4.2-6**

h_{air}: Height of air pipe or overflow pipe above the top of the tank (m)

3 Internal pressure P_{PT-in} (kN/m^2) acting on cargo holds loaded with dry bulk cargoes in the fully loaded and partially loaded conditions is to be in accordance with the following formula:

$P_{PT-in} = P_{bs}$

P_{bs}: Static pressure (kN/m^2), as specified in **4.4.2.5-1**

4 Internal pressure P_{xs} (kN/m^2) not corresponding to **-2** and **-3** above is to be the value calculated by dividing the weight of the loaded material (kN) by the area (m^2) in the range subject to ~~the~~ said loaded material~~,~~ and is to be considered as a line load or a point load depending on the type of ~~the~~ loaded material.

4.6 Loads to be Considered in Strength Assessment by Cargo Hold Analysis

4.6.2 Maximum Load Condition

4.6.2.5 Internal Pressure Due to Liquid Loaded

1 Static pressure P_{ls} (kN/m^2) acting on tanks and ballast holds loaded with liquids is to be in accordance with **Table 4.6.2-11**.

Table 4.6.2-11 has been amended as follows.

Table 4.6.2-11 Static Pressure P_{ls} in Tanks and Ballast Holds Loaded with Liquids

Type of tank or hold	Static pressure P_{ls} (kN/m^2)	
	$z \le z_{top}$	$z > z_{top}$
Cargo tanks fully loaded with liquid cargo (excluding liquefied gas)	$\rho_L g(z_{top} - z) + P_{PV}$	0
Cargo tanks fully loaded with liquefied gas and liquefied gas fuel tanks	$\rho_L g(z_{top} - z) + P_0$	0
Ballast holds	$\rho_L g(z_{top} - z)$	0
Ballast tanks and other tanks	$\rho_L g(z_{top} - z \cancel{+ 0.5h_{air}})$	0

Notes:

ρ_L: Density of liquid loaded (t/m^3), as specified in **Table 4.6.2-12**

z_{top}: Z coordinate of the highest point (m) of tank, excluding small hatchways ~~(m)~~

~~h_{air}: Height of air pipe or overflow pipe above the top of the tank (m)~~

P_{PV}: Design vapour pressure (kN/m^2), not to be less than 25 kN/m^2

P_0: Design vapour pressure (kN/m^2). For cargo tanks, this value is not to be less than the *MARVS* specified in **1.1.4, Part N**. For liquefied gas fuel tanks, this value is not to be less than the *MARVS* specified in **2.2.1, Part GF**.

4.6.3 Harbour Condition

4.6.3.3 Internal Pressure

Sub-paragraph -2 has been amended as follows.

1 Loads due to cargoes, ballast and other cargoes are to be considered as internal pressure acting on the hull.

2 Internal pressure P_{PT-in} (kN/m^2) acting on tanks and ballast holds loaded with liquids is to be in accordance with the following formula:

~~$P_{PT-in} = P_{ls}$~~

For ballast tanks, $P_{PT-in} = P_{ls} + \rho_L g h_{air}$

For other tanks, $P_{PT-in} = P_{ls}$

P_{ls}: Static pressure (kN/m^2), as specified in **4.6.2.5-1**

ρ_L: Density of liquid loaded (t/m^3), as specified in **Table 4.6.2-12**

h_{air}: Height of air pipe or overflow pipe above the top of the tank (m)

3 Internal pressure P_{PT-in} (kN/m^2) acting on cargo holds loaded with dry bulk cargoes in the full and partial load conditions is to be in accordance with the following formula:

$P_{PT-in} = P_{bs}$

P_{bs}: Static pressure (*kN/m*^{2}), as specified in **4.6.2.6-1**

4 ~~C~~The container load F_{in_hold} (*kN*) acting on cargo holds ~~F_{in_hold} (*kN*)~~ and the container load F_{on_deck} (*kN*) acting on hatch coamings, etc.~~,~~ ~~F_{on_deck} (*kN*)~~ loaded with container cargoes are to be in accordance with the following formulae:

$F_{in\_hold} = F_{cs}$

$F_{on\_deck} = F_{cs}$

F_{cs}: Static load (*kN*) as specified in **4.6.2.7-2**

5 Internal pressure P_{xs} (*kN/m*^{2}) due to loaded materials not corresponding to **-2** to **-4** above is to be calculated by dividing the weight of the loaded material (*kN*) by the area (*m*^{2}) in the range subject to ~~the~~ said loaded material~~s~~ and is to be considered as a line load or a point load depending on the type of ~~the cargo~~loaded material.

4.7 Loads to be Considered in Fatigue

4.7.2 Cyclic Load Condition

4.7.2.5 Internal Pressure Due to Liquid Loaded

1 Static pressureP_{ls} (*kN/m*^{2}) acting on tanks and ballast holds loaded with liquids is to be in accordance with **Table 4.7.2-7**.

Table 4.7.2-7 has been amended as follows.

Table 4.7.2-7 Static Pressure P_{ls} in Tanks and Ballast Holds Loaded with Liquids

Types of tank and hold	Static pressure P_{ls} (*kN/m*^{2})	
	$z \le z_{top}$	$z > z_{top}$
Cargo tanks fully loaded with liquid cargo (excluding liquefied gas)	$\rho_L g(z_{top} - z) + P_{PV}$	0
Cargo tanks fully loaded with liquefied gas and liquefied gas fuel tanks	$\rho_L g(z_{top} - z) + P_0$	0
Ballast holds	$\rho_L g(z_{top} - z)$	0
Ballast tanks and other tanks	$\rho_L g(z_{top} - z \cancel{+ 0.5h_{air}})$	0

Notes:

ρ_L: Density of liquid loaded (*t/m*^{3}), as specified in **Table 4.6.2-12**

z_{top}: *Z* coordinate of the highest point (*m*) of the tank, excluding small hatchways ~~(*m*)~~

~~h_{air}: Height of air pipe or overflow pipe above the top of the tank (*m*)~~

P_{PV}: Design vapour pressure (*kN/m*^{2}) but not to be less than 25 *kN/m*^{2}

P_0: Design vapour pressure (*kN/m*^{2}). For cargo tanks, this value is not to be less than the *MARVS* specified in **1.1.4**, **Part N**. For liquefied gas fuel tanks, this value is not to be less than the *MARVS* specified in **2.2.1**, **Part GF**.

4.8 Loads to be Considered in Additional Structural Requirements

4.8.2 Maximum Load Condition

4.8.2.4 Sloshing Loads

Table 4.8.2-13 and Table 4.8.2-14 have been amended as follows.

4 Sloshing loads to be considered in plate panels are to be in accordance with the following **(1)** and **(2)**.

(1) Equivalent pressures P_{slh-p} (*kN/m*^{2}) obtained in accordance with **Table 4.8.2-13** are to be

considered as sloshing loads due to pitch.

(2) Equivalent pressures P_{slh-r} (kN/m^2) obtained in accordance with **Table 4.8.2-14** are to be considered as sloshing loads due to roll.

Table 4.8.2-13 Equivalent Pressure for Plate Panels and Sloshing Loads Due to Pitch

Relevant ship motion	Equivalent pressure (kN/m^2)
Pitch	$P_{slh-p} = \dfrac{F_{slh-p}}{C_{slh1} \cdot \min(1000, C_{slh2})} \cdot 10^6$

Notes:

C_{slh1}, C_{slh2}: Coefficients related to member and panel length depending on the type of stiffened system, to be taken as:

$C_{slh1} = b$, $C_{slh2} = a$ for plate panels of stiffened system A

$C_{slh1} = a$, $C_{slh2} = b$ for plate panels of stiffened system B

$C_{slh1} = b_f$ or $\cancel{b_w sin\theta}$ $\underline{b_w}$, $C_{slh2} = l$ for vertically corrugated bulkheads

Stiffened system A [1]: Transverse bulkheads, transverse wash bulkheads, front and aft walls of tanks with vertically stiffened systems; vertical girders of vertically stiffened systems attached to longitudinal bulkheads or tank side walls; tank top plates of longitudinally stiffened systems; horizontal girders stiffened in parallel to depth direction of webs which are attached to transverse bulkheads or transverse wash bulkheads or front and aft walls of tanks

Stiffened system B[2]: Transverse bulkheads, transverse wash bulkheads, front and aft walls of tanks with horizontally stiffened systems; vertical girders of horizontally stiffened systems attached to longitudinal bulkheads or tank side walls; tank top plates of transverse stiffened systems; horizontal girders in perpendicular to depth direction of webs which are attached to transverse bulkheads or transverse wash bulkheads or front and aft walls of tanks; cross-ties in transverse direction

a: Length (mm) of the longer side of the plate panel

b: Length (mm) of the shorter side of the plate panel

b_f, b_w: Width (mm) of the flange and web of corrugated bulkheads respectively, as specified in **10.9.2.1**

θ: Angle (rad) of corrugated bulkheads, as specified in **10.9.2.1**

l: Height (mm) of corrugated bulkheads, as specified in **7.2.7.3**

F_{slh-p}: Equivalent impact force (kN), to be taken as:

$\cancel{F_{slh-p} = \rho_L \cdot C_{slh1\_mod} \cdot \ell_{tk}^{1.5} \cdot C_d \cdot C_{SS} \cdot a_{5\_slh} \cdot C_{slh3} \cdot 10^{-3}}$

$\underline{F_{slh-p} = \rho_L \cdot C_{slh1} \cdot \ell_{tk}^{1.5} \cdot C_d \cdot C_{SS} \cdot a_{5\_slh} \cdot C_{slh3} \cdot 10^{-3}}$

ρ_L: Maximum design cargo density (t/m^3) in considered h_{lc}. **Table 4.4.2-6** may be applied correspondingly.

~~C_{slh1_mod}: Where C_{slh1} is $b_w sin\theta$, to be replaced to b_w. In other cases, to be taken as C_{slh1}.~~

ℓ_{tk}: Maximum tank length (m)

C_d: Coefficient depending on aspect ratio of the tank, as given by the following formula:

$$C_d = 0.65 + 0.35 \tanh\left(4 - \frac{1.5\ell_{tk}}{h_{tk}}\right)$$

h_{tk}: Maximum tank height (m)

C_{SS}: Coefficient, as given by the following formula:

$$C_{SS} = \min\left(0.3 + \frac{L_C}{325}, 1.0\right)$$

a_{5_slh}: Pitch angular acceleration (rad/s^2), as specified in **Table 4.8.2-11**. The parameters for the ballast condition are to be used.

C_{slh3}: Coefficient related to members under consideration and the distance from the centre of gravity of the ship to the tank, to be taken as:

$$C_{slh3} = C_{h1}(0.0104|x_{TG} - x_G| + 1.0)$$

C_{h1} : Parameter depending on h_{lc}, as specified in **Table 4.8.2-15**.

x_{TG} : X coordinate (m) at the volumetric centre of gravity of the tank under consideration

x_G : X coordinate (m) at the centre of gravity of the ship, to be taken as $x_G = 0.45L_C$. Where deemed appropriate by the Society, the value may be defined by the designer.

(1) *See* **Fig. 10.9.3-1**

(2) *See* **Fig. 10.9.3-2**

Table 4.8.2-14 Equivalent Pressure for Plate Panels, Sloshing Load Due to Roll

Relevant ship motion	Equivalent pressure (kN/m^2)
Roll	$P_{slh-r} = \dfrac{F_{slh-r}}{C_{slh1} \cdot \min(1000, C_{slh2})} \cdot 10^6$

Notes:

C_{slh1}, C_{slh2}: Coefficients related to member and panel length depending on the type of stiffened system, to be taken as:

$C_{slh1} = b$, $C_{slh2} = a$ for plate panels of stiffened system A

$C_{slh1} = a$, $C_{slh2} = b$ for plate panels of stiffened system B

$C_{slh1} = b_f$ or $\cancel{b_w \sin\theta}$ $\underline{b_w}$, $C_{slh2} = l$ for vertically corrugated bulkheads

Stiffened system A (1): Longitudinal bulkheads, longitudinal wash bulkheads, tank side walls with vertically stiffened systems; vertical girders of vertically stiffened systems attached to transverse bulkheads or front and aft walls of tanks; tank top plates of transverse stiffened systems; horizontal girders stiffened in parallel to depth direction of webs which are attached to longitudinal bulkheads or longitudinal wash bulkheads or front and aft walls of tanks

Stiffened system B(2): Longitudinal bulkheads, longitudinal wash bulkheads, front and aft walls of tanks with longitudinally stiffened systems; vertical girders of horizontally stiffened systems attached to transverse bulkheads or front and aft walls of tanks; tank top plates of longitudinally stiffened systems; horizontal girders stiffened in perpendicular to depth direction of webs attached to longitudinal bulkheads or longitudinal wash bulkheads or tank side walls; cross-ties in longitudinal direction

a, b, b_f, b_w, θ, l: As specified in **Table 4.8.2-13**

F_{slh-r}: Equivalent impact force (kN), to be taken as:

$\cancel{F_{slh-r} = \rho_L \cdot C_{slh1\_mod} \cdot b_{tk}^{1.5} \cdot a_4 \cdot C_{slh3} \cdot 10^{-3}}$

$\underline{F_{slh-r} = \rho_L \cdot C_{slh1} \cdot b_{tk}^{1.5} \cdot a_4 \cdot C_{slh3} \cdot 10^{-3}}$

$\rho_L$$\cancel{, C_{slh1_mod}}$: As specified in **Table 4.8.2-13**

b_{tk}: Maximum tank breadth (m)

a_4: Roll angular acceleration (rad/s^2), as specified in **4.2.3.4**. The parameters for the ballast condition are to be used.

C_{slh3}: Coefficient related to members under consideration, to be taken as:

$C_{slh3} = C_{h1}$

C_{h1} : Parameter depending on h_{lc}, as specified in **Table 4.8.2-15**

(1) *See* **Fig.10.9.3-1**

(2) *See* **Fig.10.9.3-2**

Chapter 6 LOCAL STRENGTH

6.1 General

Paragraph 6.1.3 has been amended as follows.

6.1.3 Net Scantling Approach

6.1.3.1 General

The required scantlings specified in this chapter are net scantlings, unless otherwise specified.

6.2 Design Load Scenarios and Loads of the Ship to Be Assessed

6.2.1 General

6.2.1.1

1 Unless otherwise specified, a strength assessment is to be carried out for the maximum load condition, the testing condition and flooded condition.

2 For longitudinal hull girder structural members, hull girder loads due to longitudinal bending are to be considered in addition to lateral loads on plates and stiffeners.

3 Lateral loads are, in principle, assumed to act on one side of plates and stiffeners. However, where any loads are constantly also acting on the other side, such loads may be taken into account.

4 Plates constituting boundaries of watertight compartments not intended to carry liquids and stiffeners supporting such plates, excluding shell plating, stiffeners attached to shell plating, weather deck plating and stiffeners attached to weather deck plating, are to be subjected to lateral loads under flooded conditions.

6.2.2 Assessment Design Load Scenarios and Loads for Members to Be Assessed

6.2.2.1

For the plates constituting the boundaries of compartments and the stiffeners supporting such plates listed in **Table 6.2.2-1**, the strength assessment specified in this chapter is to be carried out considering the lateral loads and hull girder loads specified in the table. For members or compartments corresponding to multiple conditions, the strength assessment is to be carried out for all applicable loads.

Table 6.2.2-1 Assessment Design Load Scenarios and Loads for Members or Compartments to Be Assessed

<table>
<tr><th rowspan="3">Compartments~~/~~ or members to be assessed</th><th rowspan="3">Design load scenario</th><th colspan="5">Load</th></tr>
<tr><th rowspan="2">Lateral load</th><th rowspan="2">Load type</th><th rowspan="2">Load component</th><th colspan="2">Refer to the following:</th></tr>
<tr><th>Lateral load (P)</th><th>Hull girder load (M_{V-HG}, M_{H-HG})</th></tr>
<tr><td>Outer shell (including stiffeners)</td><td rowspan="6">Maximum load conditions</td><td>External pressure</td><td>Seawater</td><td>Static + dynamic loads</td><td>**4.4.2.2-1**</td><td rowspan="6">**4.4.2.9**</td></tr>
<tr><td>Cargo tanks, ballast tanks, ballast holds and other tanks</td><td rowspan="3">Internal pressure</td><td>Liquid loaded</td><td>Static + dynamic loads</td><td rowspan="3">**4.4.2.2-2**</td></tr>
<tr><td>Cargo holds[(1)]</td><td>Dry bulk cargoes</td><td>Static + dynamic loads</td></tr>
<tr><td>Cargo holds[(2)]</td><td>Others</td><td>Static + dynamic loads</td></tr>
<tr><td>Weather decks (including stiffeners)</td><td rowspan="2">Others</td><td>Green sea, unspecified loads</td><td>Green sea load, static + dynamic loads</td><td>Greater of the pressures specified in **4.4.2.2-3** and **-4**</td></tr>
<tr><td>Internal decks[(2)] (including stiffeners)</td><td>Cargoes</td><td>Static + dynamic loads</td><td>**4.4.2.2-3**</td></tr>
<tr><td>Members constituting compartments subject to hydrostatic testing</td><td>Testing condition</td><td>Internal pressure</td><td>Seawater</td><td>Static loads</td><td>**4.4.3.2**</td><td>**4.4.3.3**</td></tr>
<tr><td>Compartments not carrying liquids[(3)] Transverse and longitudinal bulkheads</td><td>Flooded conditions</td><td>Internal pressure</td><td>Seawater</td><td>-</td><td>**4.4.4.1**</td><td>**4.4.4.2**</td></tr>
<tr><td colspan="7">(Notes)
(1) For ships of single-side skin construction intended for carrying cargoes other than liquids, the outer shell (including stiffeners) may be excluded from the assessment.
(2) For ships carrying cargoes other than bulk and liquid cargoes with the cargoes properly fastened or otherwise held in position so that the cargo loads can be deemed as acting only on the inner bottom plating and internal deck, the assessment need be performed only for the inner bottom plating and the internal deck.
(3) Not required to be applied to shell plating, stiffeners attached to shell plating, weather deck plating and stiffeners attached to weather deck plating.</td></tr>
</table>

6.3 Plates

6.3.2 Plates

Paragraph 6.3.2.1 has been amended as follows.

6.3.2.1 Bending Strength

Plate thickness is to be not less than the largest of the values obtained by the following formula under all applicable design load scenarios specified in **Table 6.2.2-1**. Application of gross or net scantlings in the values obtained from the following is specified in **Table 6.3.2-1**:

$$t = C_{Safety} C_{Aspect} \sqrt{\frac{4}{1.15 C_a \sigma_Y}} \sqrt{\frac{|P| b^2}{f_P}} \times 10^{-3} (mm)$$

σ_Y: Specified minimum yield stress (*N/mm*^{2})

b: Length (*mm*) of the shorter side of the plate panel

a: Length (*mm*) of the longer side of the plate panel

α: Aspect ratio to be taken as a/b.

f_P: Strength coefficient as given in **Table 6.3.2-1** ~~for cases in the maximum load condition and the testing condition or **Table 6.3.2-2** for cases in flooded conditions~~.

P: Lateral pressure (*kN/m*^{2}) corresponding to each Design load scenario specified in **Table ~~6.2.2-1~~6.3.2-1**, to be calculated at the load calculation point specified in **3.7**.

C_a: Coefficient of axial force effect as specified in **Table 6.3.2-~~3~~2** when $\alpha \geq 2$ or **Table 6.3.2-~~4~~3** when $\alpha < 2$.

C_{Aspect}: Correction coefficient for the aspect ratio of the plate panel as given in **Table 6.3.2-1** ~~for cases in the maximum load condition and the testing condition or **Table 6.3.2-2** for cases in flooded conditions~~.

C_{Safety}: Safety factor taken as 1.0.

σ_{BM}: Axial stress (*N/mm*^{2}) due to hull girder bending as specified in **6.2.3.1**.

~~Table 6.3.2-1 Definitions of C_{Aspect} and f_P for Assessment in Maximum Load Condition and Testing Condition~~

~~Member~~	~~C_{Aspect}~~	~~f_P~~
~~Longitudinal hull girder structural members~~	~~1.0~~	~~12~~
~~Other members~~	~~$1.07 - 0.28\left(\frac{b}{a}\right)^2$~~ ~~but 1.0 for $\alpha > 2$~~	~~12~~

Table 6.3.2-1 Application of Gross or Net Scantlings and Each Parameter in the Evaluation for Each Design Load Scenario

Design load scenario		Application of gross or net scantlings	Lateral load P (kN/m^2)	Member	C_{Aspect}	f_P
Maximum load condition		Net scantling	P_{ex}, P_{in}, P_{dk} and P_{GW} To be in accordance with **4.4.2.2-1** to **-4** corresponding to compartments/members to be assessed in **Table 6.2.2-1**	Longitudinal hull girder structural members	1.0	12
				Other members	$1.07-0.28\left(\frac{b}{a}\right)^2$ but 1.0 for $\alpha>2$	
Testing condition	Case 1	Gross scantling	P_{ST-in1} To be in accordance with **4.4.3.2**	Longitudinal hull girder structural members	1.0	12
				Other members	$1.07-0.28\left(\frac{b}{a}\right)^2$ but 1.0 for $\alpha>2$	
	Case 2	Net scantling	P_{ST-in2} To be in accordance with **4.4.3.2**	Longitudinal hull girder structural members	1.0	16
				Other members	$\sqrt{\frac{1}{1+\left(\frac{b}{a}\right)^2}}$	
Flooded condition		Net scantling	P_{FD-in} To be in accordance with **4.4.4.1**	Longitudinal hull girder structural members	1.0	16
				Other members	$\sqrt{\frac{1}{1+\left(\frac{b}{a}\right)^2}}$	

~~Table 6.3.2-2 Definitions of C_{Aspect} and f_P for Assessment in Flooded Conditions~~

~~Member~~	~~C_{Aspect}~~	~~f_P~~
~~Longitudinal hull girder structural members~~	~~1.0~~	~~16~~
~~Other members~~	~~$\sqrt{\frac{1}{1+\left(\frac{b}{a}\right)^2}}$~~	~~16~~

Table 6.3.2-~~3~~2 Definition of C_a (for $\alpha \geq 2$)

Member		C_a
Longitudinal hull girder structural members	Longitudinal framing system	$\sqrt{1-\left(\frac{\sigma_{BM}}{\sigma_Y}\right)^2}$
	Transverse framing system	$1.0-\frac{\lvert\sigma_{BM}\rvert}{\sigma_Y}$
Other members		1.0

Table 6.3.2-~~4~~3 Definition of C_a (for $\alpha < 2$)

Member		C_a	ζ	η
Longitudinal hull girder structural members	Longitudinal framing system	$\left[1-\left(\frac{\lvert\sigma_{BM}\rvert}{\sigma_Y}\right)^{\zeta}\right]^{\eta}$	2	$\frac{b}{a}$
	Transverse framing system		$2\frac{b}{a}$	1
Other members		1.0		

Paragraph 6.3.3 has been amended as follows.

6.3.3 ~~Longitudinal and Transverse Bulkheads~~ Corrugated Bulkheads

~~6.3.3.1 Plane Bulkheads~~

~~The thickness of plane bulkheads is to be in accordance with the requirements in 6.3.2.1.~~

6.3.3.~~2~~1 Thickness of Corrugated Bulkheads

1 The thickness of the flanges and webs of corrugated bulkheads ~~in the maximum load condition and the testing condition~~ under all applicable design load scenarios specified in **Table 6.2.2-1** is to be the largest of the values obtained by the following formula. Application of gross or net scantlings in the values obtained from following formula is specified in **Table 6.3.3-1**:

$$t = C_{Safety}\sqrt{\frac{4}{1.15\sigma_Y}}\sqrt{\frac{|P|\cancel{b_f}b^2\gamma}{\cancel{12}f_P}} \times 10^{-3}\,(mm)$$

C_{Safety}: Safety factor ~~taken as 1.0~~ as specified in **Table 6.3.3-1.**

σ_Y: Specified minimum yield stress (N/mm^2)

P: Lateral pressure (kN/m^2) corresponding to each design load scenario specified in ~~**Table 6.2.2-1**~~ **Table 6.3.3-1**, to be calculated at the load calculation point specified in **3.7**.

b: Width (mm) of the flange (face plate) and web, respectively, to be taken as b_f or b_w (mm) in **Fig. 6.3.3-1**.

γ: Coefficient ~~taken as follows:~~ as specified in **Table 6.3.3-1**.

~~$\gamma = \frac{\alpha + \beta^2}{\alpha + \beta}$~~

~~where $\alpha = \frac{t_w^{\,3}}{t_f^{\,3}}, \beta = \frac{b_w}{b_f}$~~

~~t_f and t_w: Thickness (mm) of the flange and web, respectively.~~

~~b_f and b_w: Width (mm) of the flange and web, respectively (*See* **Fig. 6.3.3-1**).~~

f_P: Strength coefficient given in **Table 6.3.3-1**.

~~**2** The thickness of the flange and web of corrugated bulkheads in flooded conditions is to be not less than the value obtained by the following formula:~~

$$\cancel{t = C_{Safety}\sqrt{\frac{4}{1.15\sigma_Y}}\sqrt{\frac{|P|b^2}{f_T}} \times 10^{-3}\,(mm)}$$

~~σ_Y: Specified minimum yield stress (N/mm^2)~~

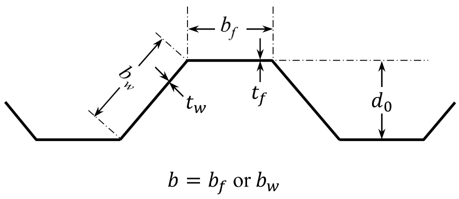
~~P: Lateral pressure (kN/m^2) in the flooded conditions specified in **Table 6.2.2-1**, to be calculated at the load calculation point specified in **3.7**.~~

~~b: Width (mm) of the flange (face plate) and web, respectively, to be taken as b_f or b_w (mm) in **Fig. 6.3.3-1**.~~

~~f_p: Strength coefficient given in **Table 6.3.3-1**.~~
~~C_{safety}: Safety factor given in **Table 6.3.3-2**.~~
~~t_f and t_w: Thickness (mm) of the flange (face plate) and web, respectively~~

~~3~~<u>2</u> Notwithstanding **-1** ~~and **-2**~~ above, horizontal corrugated bulkheads are to be as deemed appropriate by the Society.

Fig. 6.3.3-1 Measurement Method of b



~~Table 6.3.3-1 Value of f_p~~

	~~Flooded condition~~
~~Flange~~	$\cancel{8\left[1+\left(\frac{t_w}{t_f}\right)^2\right]}$
~~Web~~	~~16~~

Table 6.3.3-1 Application of Gross or Net Scantlings and Each Parameter in the Evaluation for Each Design Load Scenario

<table>
<tr><th colspan="2">Design load scenario</th><th>Application of gross or net scantlings</th><th>Lateral load P (kN/m^2)</th><th>γ</th><th>Member</th><th>C_{Safety}</th><th>f_P</th></tr>
<tr><td colspan="2">Maximum load condition</td><td>Net scantling</td><td>P_{ex}, P_{in}, P_{dk} and P_{GW}
To be in accordance with **4.4.2.2-1 to -4** corresponding to compartments/members to be assessed in **Table 6.2.2-1**</td><td>$\frac{\alpha+\beta^3}{\alpha+\beta}$</td><td>Flange and Web</td><td>1.0</td><td>12</td></tr>
<tr><td rowspan="3">Testing condition</td><td>Case1</td><td>Gross scantling</td><td>P_{ST-in1}
To be in accordance with **4.4.3.2**</td><td>$\frac{\alpha+\beta^3}{\alpha+\beta}$</td><td>Flange and Web</td><td>1.0</td><td>12</td></tr>
<tr><td rowspan="2">Case 2</td><td rowspan="2">Net scantling</td><td rowspan="2">P_{ST-in2}
To be in accordance with **4.4.3.2**</td><td rowspan="2">1.0</td><td>Flange</td><td>1.15</td><td>$8\left[1+\left(\frac{t_w}{t_f}\right)^2\right]$</td></tr>
<tr><td>Web</td><td>1.07</td><td>16</td></tr>
<tr><td colspan="2" rowspan="2">Flooded condition</td><td rowspan="2">Net scantling</td><td rowspan="2">P_{FD-in}
To be in accordance with **4.4.4.1**</td><td rowspan="2">1.0</td><td>Flange</td><td>1.15</td><td>$8\left[1+\left(\frac{t_w}{t_f}\right)^2\right]$</td></tr>
<tr><td>Web</td><td>1.07</td><td>16</td></tr>
<tr><td colspan="8">Notes:
$\alpha=\frac{t_w{}^3}{t_f{}^3}, \beta=\frac{b_w}{b_f}$
t_f and t_w: Thickness (mm) of the flange and web, respectively
b_f and b_w: Width (mm) of the flange and web, respectively (*See* **Fig. 6.3.3-1**)</td></tr>
</table>

~~Table 6.3.3-2 Value of C_{Safety}~~

~~Flange~~	~~1.15~~
~~Web~~	~~1.07~~

6.4 Stiffeners

6.4.1 General

6.4.1.1 Application

Sub-paragraph -2 has been amended as follows.

1 Stiffeners subject to lateral loads are to be in accordance with the requirements in **6.4.2**.
2 Notwithstanding **-1** above, the side frames within the cargo region are to be in accordance with **6.4.3**.

6.4.2 Stiffeners

Paragraph 6.4.2.1 has been amended as follows.

6.4.2.1 Bending Strength

For all applicable design load scenarios specified in **Table 6.2.2-1**, the section modulus of stiffeners is to be not less than the value obtained from the following formulae. Application of gross or net scantlings in the values obtained from following formula is specified in **Table 6.4.2-5**:

Table 6.4.2-1 has been amended as follows.

Table 6.4.2-1 Required Section Modulus for Stiffeners Subject to Lateral Pressure

Design load scenario	Required value
Maximum load condition Testing condition	$Z = \frac{C_{Safety} C_{VB} f_{bdg} \lvert P \rvert s \ell_{bdg}{}^2}{12 f_f C_s \sigma_Y}$ (cm^3)
Flooded conditions	$Z = \frac{C_{Safety} f_{bdg-P} \lvert P \rvert s \ell_{bdg}{}^2}{16 f C_s \sigma_Y}$ (cm^3)

ℓ_{bdg}: Effective bending span (m) as specified in **3.6.1.2**.
s: Spacing (mm) of stiffeners
f_{bdg}: Elastic bending moment distribution factor according to the type of end connection of stiffeners as specified in **Table 6.4.2-2**.
f_{bdg-P}: Plastic bending moment distribution factor according to the type of end connection of stiffeners as specified in **Table 6.4.2-3**.
C_{VB}: Coefficient taken as follows:
1.0: For stiffeners arranged horizontally
1.2: For stiffeners not arranged horizontally
P: Lateral pressure (kN/m^2) corresponding to each Design load scenario specified in **Table ~~6.2.2-1~~6.4.2-5**, to be calculated at the load calculation point specified in **3.7**.
C_s: Coefficient for axial force effect as specified in **Table 6.4.2-4**.
f_f: Coefficient taken as 1.25 for flat bars or 1.0 for other members.
f: Shape coefficient taken as 1.5 for flat bars or 1.2 for other members.
C_{Safety}: Safety factor taken as 1.0.

Table 6.4.2-5 has been amended as follows.

Table 6.4.2-5 Application of Gross or Net Scantlings and P in the Evaluation for Each Design Load Scenario

Design load scenario		Application of gross or net scantlings	Lateral load P (kN/m^2)
Maximum load condition		Net scantling	P_{ex}, P_{in}, P_{dk} and P_{GW} To be in accordance with **4.4.2.2-1** to **-4** corresponding to compartments/members to be assessed in **Table 6.2.2-1**
Testing condition	Case 1	Gross scantling	P_{ST-in1} To be in accordance with **4.4.3.2**
	Case 2	Net scantling	P_{ST-in2} To be in accordance with **4.4.3.2**
Flooded condition		Net scantling	P_{FD-in} To be in accordance with **4.4.4.1**

Paragraph 6.4.2.2 has been amended as follows.

6.4.2.2 Shear Strength of Webs

For all applicable design load scenarios specified in **Table 6.2.2-1**, the stiffener web thickness is to be not less than the value obtained from the following formula. Application of gross or net scantlings in the values obtained from following formula is specified in **Table 6.4.2-5**:

$$t_w = \frac{C_{Safety} C_{VS} f_{shr} |P| s \ell_{shr}}{2 d_{shr} \tau_{eH}} \ (mm)$$

τ_{eH}: Permissible shear stress (N/mm^2) taken as follows:

$\sigma_Y / \sqrt{3}$

d_{shr}: Effective shear depth (mm) as specified in **3.6.4.2**.

ℓ_{shr}: Effective shear span (m) as specified in **3.6.1.3**.

s: Spacing (mm) of stiffeners

C_{VS}: Coefficient taken as follows:

1.0: For stiffeners arranged horizontally

1.4: For stiffeners not arranged horizontally

f_{shr}: Shear force distribution factor according to the type of end connection of stiffeners as specified in **Table 6.4.2-~~5~~6**.

C_{Safety}: Safety factor taken as 1.2.

Table 6.4.2-~~5~~6 Definition of f_{shr}

One end	Other end		
	Fixed	Flexibly fixed	Sniped end
Fixed	1.00	1.15	1.25
Flexibly fixed	1.15	1.00	1.20
Sniped end	1.25	1.20	1.00

(Notes)

(1) A fixed end connection is a structure in which a stiffener is continuous or its ends are reinforced with proper backing.

(2) A flexibly fixed end connection is a structure fixed to an orthogonal stiffener and not reinforced on the back with an effective supporting member, as shown in **Fig. 6.4.2-1**.

Paragraph 6.4.2.3 has been amended as follows.

6.4.2.3 Reinforcement of Stiffeners with Struts

1 (Omitted)

2 Where stiffeners are supported by struts provided in between the floors in a double bottom, the section modulus and web thicknesses of bottom longitudinals and inner bottom longitudinals are to be not less than the values calculated in **6.4.2.1** and **6.4.2.2** times those shown in **Table 6.4.2-~~6~~7**. However, in a cargo loaded condition where $|P_{in}| > 2|P_{ex}|$ or $|P_{ex}| > 2|P_{in}|$, these values are to be obtained from the formula shown in **Table 6.4.2-~~7~~8** instead of **Table 6.4.2-~~6~~7**.

P_{in}: Lateral pressure (*kN/m*^{2}) acting on the inner bottom plating of a hold loaded with cargo, to be calculated as specified in any of **4.4.2.4** through **4.4.2.7** as applicable depending on the load loaded in the cargo hold. For each load condition specified in **4.4.2.1**, P_{in} is to be calculated at the inner bottom plating in a location provided with struts.

P_{ex}: External pressure (*kN/m*^{2}) acting on the bottom shell, to be calculated as specified in **4.4.2.3**. P_{ex} is to be calculated at the bottom shell in a location provided with struts for each load condition specified in **4.4.2.1**.

3 (Omitted)

Table 6.4.2-~~6~~7 Correction Factor C_1 for Struts

Ratio of the moment of inertia of stiffeners $\max(I_B, I_I)/\min(I_B, I_I)$			≥ 1.0 < 1.2	≥ 1.2 < 1.4	≥ 1.4 < 1.6	≥ 1.6 < 1.8	≥ 1.8
C_1	Bottom longitudinals	Value for section modulus (**6.4.2.1**)	0.625	0.670	0.700	0.725	0.745
		Value for web thickness (**6.4.2.2**)	0.750	0.775	0.800	0.815	0.825
	Inner bottom longitudinals	Value for section modulus (**6.4.2.1**)	0.625	0.670	0.690	0.720	0.740
		Value for web thickness (**6.4.2.2**)	0.750	0.780	0.795	0.810	0.825

Table 6.4.2-~~7~~8 Correction Factor C_2 for Struts in Ships Where $|P_{in}| > 2|P_{ex}|$ or $|P_{ex}| > 2|P_{in}|$

C_2	$\lvert P_{in}\rvert > 2\lvert P_{ex}\rvert$	$\lvert P_{ex}\rvert > 2\lvert P_{in}\rvert$
	Bottom longitudinals	Inner bottom longitudinals
Value for section modulus (**6.4.2.1**)	$\frac{3}{4}\frac{\lambda}{\lambda+1}\frac{P_{in}}{P_{ex}} - C_1 + \frac{1}{2}$	$\frac{3}{4}\frac{1}{\lambda+1}\frac{P_{ex}}{P_{in}} - C_1 + \frac{1}{2}$
Value for web thickness (**6.4.2.2**)	$\frac{1}{2}\frac{\lambda}{\lambda+1}\frac{P_{in}}{P_{ex}} - C_1 + 1$	$\frac{1}{2}\frac{1}{\lambda+1}\frac{P_{ex}}{P_{in}} - C_1 + 1$

(Notes)

C_1: Coefficient given in **Table 6.4.2-~~6~~7**.

(1) Correction Factor C_2 is not to be less than Correction Factor C_1.

Chapter 7 STRENGTH OF PRIMARY SUPPORTING STRUCTURES

Symbols has been amended as follows.

Symbols

For symbols not defined in this Chapter, refer to **1.4**.

(Omitted)

P_{DB}: ~~Reference p~~Pressure (*kN/m*^{2}) for the double bottom to be calculated at the load calculation point specified in **7.3.1.5**, as specified in ~~**4.4, Chapter 4, Part 2**~~ the requirements for loads to be considered for the strength of primary supporting structures specified in **Chapter 4, Part 2** (Requirements by ship type)

P_{DS}: ~~Reference p~~Pressure (*kN/m*^{2}) for the double side to be calculated at the load calculation point specified in **7.3.1.5**, as specified in ~~**4.4, Chapter 4, Part 2**~~ the requirements for loads to be considered for the strength of primary supporting structures specified in **Chapter 4, Part 2** (Requirements by ship type)

(Omitted)

C_{EX}: Coefficient for the ratio of the effective breadth of longitudinal girders in double hull as given in **Fig. 7.3.3-1**. The method for calculation of effective breadth is given in **3.6.3.1**. However, C_{EX} is to be taken as 0 where no longitudinal girder is provided.

C_{EY}: Coefficient for the ratio of the effective breadth of transverse girders in double ~~bottom~~ hull as given in **Fig. 7.3.3-1**. The method for calculation of the effective breadth is given in **3.6.3.1**. However, C_{EY} is to be taken as 0 where no transverse girder is provided. For double bottom, read C_{EY}. For double side, C_{EY} is to be read as C_{EZ} ~~and the transverse girder as the longitudinal girder~~.

(Omitted)

7.1 General

7.1.2 Application

Paragraph 7.1.2.1 has been amended as follows.

7.1.2.1 Application

1 The requirements in this Chapter ~~apply to ships with a length L_C of less than 200 *m*~~ are to be applied in accordance with **Table 1.2.2-1**.

~~**2** Notwithstanding -1 above, for ships subject to **Chapter 8**, the requirements in **Chapter 8** are to apply instead of those in this Chapter.~~

~~3~~2 Girders and plates to be flange in double bottom or double side constituting a double hull are to be in accordance with the requirements in **7.3**. Other girders are to be in accordance with the requirements in **7.2**. (*See* **Fig. 7.1.2-1**)

~~4~~3 Constructions of single bottom are to be according to the requirements specified in **7.2**.

~~5~~4 Notwithstanding -~~3~~2 and -~~4~~3 above, assessments may be carried out by direct strength calculations deemed appropriate by the Society, such as beam analysis.

Paragraph 7.1.3 has been amended as follows.

7.1.3 Net Scantling Approach

7.1.3.1 General

The required scantlings in this chapter are to be specified as net scantlings.

7.2 Simple Girders

7.2.2 Assessment Conditions and Loads

7.2.2.2 Assessment Conditions and Loads for Members to Be Assessed

Table 7.2.2-1 has been amended as follows.

Table 7.2.2-1 Assessment Conditions and Loads for Members or Compartments to Be Assessed

Compartments/ members to be assessed	Typical members	Assessment condition	Loads				
			Lateral load	Load type	Load components	Refer to: Load (P)	Refer to: Hull girder load (M_{V-HG}, M_{H-HG})
Girders on shell plating	Web frames, side stringers (single side skin structure)	Maximum load condition	External pressure	Seawater	Static + dynamic loads	**4.4.2.2-1**	**4.4.2.9**
Cargo oil tanks, ballast tanks, ballast holds and other tanks	Stiffening girders, corrugated bulkheads		Internal pressure	Liquid loaded	Static + dynamic loads	**4.4.2.2-2**	
Cargo holds(1)	Stiffening girders, corrugated bulkheads			Dry bulk cargoes and others	Static + dynamic loads		
Single-bottomed cargo holds	Girders, floors			Unspecified cargoes	Static + dynamic loads		
Girders on deck	Deck girders, deck transverses		Others	Green sea (weather decks only), unspecified cargoes	Green sea load, static + dynamic loads	Greater of the pressures specified in **4.4.2.2-3** and **-4**	
Internal decks(2)	Deck girders, deck transverses			Unspecified cargoes	Static + dynamic loads	**4.4.2.2-3**	
Members constituting compartments subject to hydraulic testing	Stiffening girders, corrugated bulkheads	Testing condition	Internal pressure	Seawater	Static loads	P_{ST-in1} as specified in **4.4.3.2**	**4.4.4.3**
Compartments not carrying liquids(3) Transverse and longitudinal bulkheads	Stiffening girders, corrugated bulkheads	Flooded condition	Internal pressure	Seawater	-	**4.4.4.1**	**4.4.4.2**

(Notes)

(1) For ships of a single side skin structure intended for carrying cargoes other than liquids, girders on the shell plating may be excluded from the assessment.

(2) For ships carrying cargoes other than bulk and liquid cargoes with the cargoes properly fastened or otherwise held in position so that the cargo loads can be deemed as acting only on the inner bottom plating and internal deck, the assessment need only be performed for the inner bottom plating and the internal deck.

(3) Not required for girders on shell plating and weather deck.

7.2.3 Bending Strength

Paragraph 7.2.3.1 has been amended as follows.

7.2.3.1 Section Modulus

In each assessment condition, the section modulus of simple girders is to be not less than that obtained from the following formula:

$$Z_{n50} = C_{Safety} \frac{|M|}{\sigma_{all} - \sigma_{BM}} \times 10^3 \ (cm^3)$$

C_{Safety}: Safety factor to be taken as ~~1.0~~1.1

M: Maximum moment (*kN-m*) of the assessment model as specified in **7.2.3.2**

σ_{all}: Permissible bending stress (*N/mm*^{2}) to be taken as follows:

$$\sigma_{all} = \frac{235}{K}$$

K: Material factor as specified in **3.2.1.2**

σ_{BM}: Stress (*N/mm*^{2}) due to the hull girder load at the girder to be assessed as specified in **7.2.2.3**. However, for members other than longitudinal hull girder structural members, σ_{BM} is to be taken as 0.

7.2.6 Bending Stiffness

7.2.6.1 Depth of Girders

For the members specified in **Table 7.2.6-1**, depth is not to be less than that specified in the table. However, the depth may be reduced provided that the member has equivalent moment of inertia or deflection to the required members.

Table 7.2.6-1 has been amended as follows.

Table 7.2.6-1 Depth of Girders

Members	Depth of Girders (*m*)
Web frame	$0.1\cancel{\ell}\ell_{bdg}$
Web frame supporting cantilever	$0.125\cancel{\ell}\ell_{bdg}$
Web frame supporting side stringer	$0.125\cancel{\ell}\ell_{bdg}$
Side stringer	$0.125\cancel{\ell}\ell_{bdg}$
Side stringer forward of collision bulkhead	$0.2\cancel{\ell}\ell_{bdg}$
Web frame forward of collision bulkhead	$0.2\cancel{\ell}\ell_{bdg}$
Note: ℓ_{bdg}: Effective bending span (*m*) of the girder as given in **3.6.1.4**	

Paragraph 7.2.6.2 has been amended as follows.

7.2.6.2 Moment of Inertia of Girders

For the members specified in **Table 7.2.6-2**, moment of inertia is not to be less than that obtained from following formula. However, the loads acting on the members is not distributed loads, the moment of inertia is to be deemed appropriate by the Society.

$$I = \frac{SP\cancel{\ell}\ell_{bdg}{}^4}{384E\delta} \times 10^8 \ (cm^{\cancel{3}4})$$

S : Spacing of girders (*m*)

P : Loads corresponding to each ~~assessment condition specified in **Table 7.2.6-1**,~~ member as given in **Table 7.2.6-2** . Loads are to be calculated at the middle of ℓ

~~ℓ : Full length of girders (*m*)~~

ℓ_{bdg}: Effective bending span (m) of the girder as given in **3.6.1.4**
E: Young's modulus to be taken as 206,000 (N/mm^2)
δ : Allowable values for deflection of girders as specified in **Table 7.2.6-2**

Table 7.2.6-2 Allowable values for deflection of girders

	Loads P	Allowable values δ
Girders attached to decks (except for cantilever)	Static pressure P_{dks} of cargo specified in 4.4.2.7 and green sea pressure P_{GW} specified in **4.4.2.8**, whichever is greater.	$\ell/1340 \times 10^3$
Girders supporting stiffeners attached to watertight bulkheads	Internal Pressure P_{FD-in} in flooded condition specified in **4.4.4.1**	$S/670 \times 10^3$
Girders supporting stiffeners in deep tanks	Static pressure P_{ls} specified in **4.4.2.4**	$S/2000 \times 10^3$

7.3 Double Hull Structures

7.3.2 Requirements for Scantlings

7.3.1 General

Paragraph 7.3.1.4 has been amended as follows.

7.3.1.4 Loading Conditions

The loading conditions to be considered in double hull strength assessments are to be in accordance with ~~4.4,~~ the requirements for loads to be considered for the strength of primary supporting structures specified in **Chapter 4, Part 2** (Requirements by ship type). The loading condition of which $P_{DH} = 0$ may be waived.

Paragraph 7.3.2.1 has been amended as follows.

7.3.2.1 Bending Strength

In each assessment condition, the thickness of plating of double hull is to be in accordance with the following requirements **(1)** and **(2)**. The thickness of plating according to these requirements is to be uniform at any point in the double hull under assessment.

(1) The thickness of bottom shell plating and inner bottom plating constituting a double bottom and that of side shell plating and side longitudinal bulkheads constituting a double side are to be not less than that obtained from the following formula:

$$t_{n50} = \frac{C_{Safety}}{C_{cnd}} \frac{(1-\nu^2)}{D_{DH}} \times \max\left(\frac{|M_X|}{\gamma_{\cancel{GIR}stf-x} C_{bi-x}(\sigma_{all} - \sigma_{BM})}, \frac{|M_Y|}{\gamma_{stf-y} C_{bi-y} \cancel{C_{Bt}} \sigma_{all}}\right) \quad (mm)$$

C_{Safety}: Safety factor to be taken as 1.2

~~γ_{GIR}: Coefficient of the bending stiffness effect of girder members and stiffeners to be taken as 1.12~~

~~C_{Bt}: Coefficient of strength decrease due to transverse bending to be taken as 0.5~~

γ_{stf-x}: Coefficient of the bending stiffness effect of stiffeners in the longitudinal direction, as given in **Table 7.3.2-1**

γ_{stf-y}: Coefficient of the bending stiffness effect of stiffeners in the transverse direction, as given in **Table 7.3.2-1**

C_{bi-x}: Coefficient of strength decrease due to bending in the longitudinal direction, as given in **Table 7.3.2-1**

C_{bi-y}: Coefficient of strength decrease due to bending in the transverse direction, as given in **Table 7.3.2-1**

M_X: Longitudinal bending moment (*kN-m/m*) per unit width in double hull as given in **7.3.3.1** (*See* **Fig. 7.3.2-1**).

M_Y: Transverse bending moment (*kN-m/m*) per unit length in the double ~~bottom~~ hull as given in **7.3.3.1**. When assessing double bottoms, read M_Y. When assessing double sides, M_Y is to be read as M_Z~~, *i.e.*, the vertical bending moment per unit length.~~ (*See* **Fig. 7.3.2-1**).

σ_{BM}: Stress (*N/mm*^{2}) due to hull girder bending at the member under assessment to be taken as follows:

$$\sigma_{BM} = \left[\left| \frac{M_{V-HG}}{I_{y-n50}} (z - z_B) \right| + \left| \frac{M_{H-HG}}{I_{Z-n50}} y \right| \right] \times 10^5$$

M_{V-HG}: Vertical bending moment (*kN-m*) corresponding to each assessment condition as given in **4.6.2.10** for the maximum load condition and **4.6.3.5** for the harbour condition.

M_{H-HG}: Horizontal bending moment (*kN-m*) corresponding to each assessment condition as given in **4.6.2.10** for the maximum load condition and **4.6.3.5** for the harbour condition.

I_{y-n50}: Moment of inertia (*cm*^{4}) of the transverse section at the midpoint of ℓ_{DB} about its horizontal neutral axis (net scantlings). The corrosion addition is given in **3.3.4**.

I_{z-n50}: Moment of inertia (*cm*^{4}) of the transverse section at the midpoint of ℓ_{DS} about its vertical neutral axis (net scantlings). The corrosion addition is given in **3.3.4**.

z: Position (*m*) of the double hull on the Z coordinate, which is defined as follows:
For bottom shell plating, this position is to be taken as the lowest point of the bottom shell plating of the double bottom under consideration at $x_{DB} = 0$.
For inner bottom plating, this position is to be taken as the lowest point of the inner bottom plating of the double bottom under consideration at $x_{DB} = 0$.
For side shell plating, this position is to be taken as either of the upper and lower ends of the side shell plating of the double side under consideration at $x_{DS} = 0$, whichever is greater in distance from z_n.
For longitudinal bulkhead, this position is to be taken as either of the upper and lower ends of the longitudinal bulkhead of the double side under consideration at $x_{DS} = 0$, whichever is greater in distance from z_n.

y: Position (*m*) of the double hull on the Y coordinate, which is defined as follows:
For bottom shell plating, this position is to be taken as the outermost point of the bottom shell plating of the double bottom under consideration at $x_{DB} = 0$.
For inner bottom plating, this position is to be taken as the outermost point of the inner bottom plating of the double bottom under consideration at $x_{DB} = 0$.
For side shell plating, this position is to be taken as the point most distant from the centreline of the side shell plating of the double side under consideration at $x_{DS} = 0$.
For longitudinal bulkhead, this position is to be taken as the point most distant from the centreline of the longitudinal bulkhead of the double side under consideration at $x_{DS} = 0$.

(2) Notwithstanding **(1)** above, where any of the requirements specified in **2.4.1.2-6(1)** and **2.4.1.3-1(1)** for the spacing of girders and floors in double bottom is not satisfied, the

thickness of the bottom shell plating and inner bottom plating constituting a double bottom is to be not less than that obtained from the following formula. Similarly, if any of the requirements specified in **2.4.2.1(1)** and **2.4.2.2(1)** for the spacing of side transverses and side stringers is not satisfied, the thickness of the side shell plating and longitudinal bulkheads constituting a double side is to be not less than that obtained from the following formula. However, $C_{EX} = 1.0$ where no longitudinal girders are provided, while $C_{EY} = 1.0$ where no transverse girders are provided.

$$t_{n50} = \frac{C_{Safety}}{C_{cnd}} \frac{(1-\nu^2)}{\cancel{\gamma_{GIR}} D_{DH}} \times max\left(\frac{|M_X|}{\underline{\gamma_{stf-x} C_{bi-x}} C_{EX}(\sigma_{all} - \sigma_{BM})}, \frac{|M_Y|}{\underline{\gamma_{stf-y} C_{bi-y}} C_{EY} \cancel{C_{DI}} \sigma_{all}} \right) (mm)$$

C_{Safety}: Safety factor to be taken as 1.2

$\cancel{\gamma_{GIR}}$, $\cancel{C_{DI}}$, $\underline{\gamma_{stf-x}, \gamma_{stf-y}, C_{bi-x}, C_{bi-y}}$, $M_{\cancel{x}X}$, $M_{\cancel{y}Y}$ and σ_{BM}: As specified in **(1)**

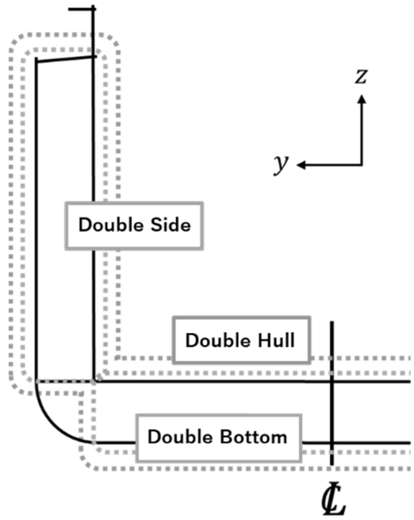
Table 7.3.2-1 has been added as follows.

Table 7.3.2-1 Bending Strength Parameters for Double Hull

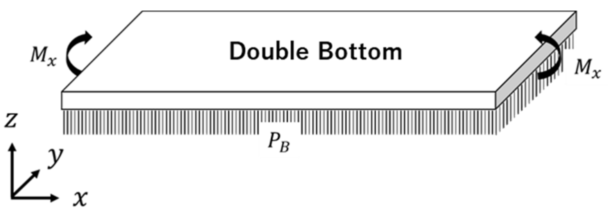
	Longitudinal framing system	Transverse framing system
C_{bi-x}	1.0	0.5
C_{bi-y}	0.5	1.0
γ_{stf-x}	1.1	1.0
γ_{stf-y}	1.0	1.1

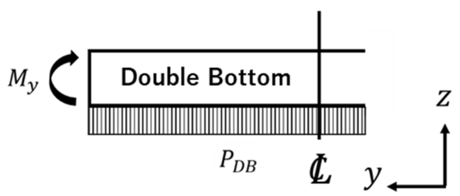
Fig. 7.3.2-1 has been added as follows.

Fig. 7.3.2-1 Bending moment of double hull

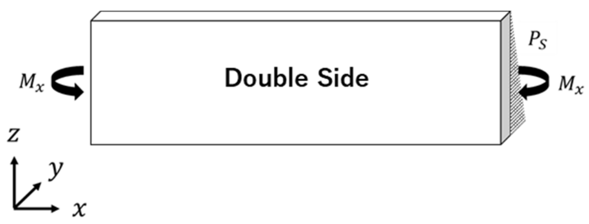


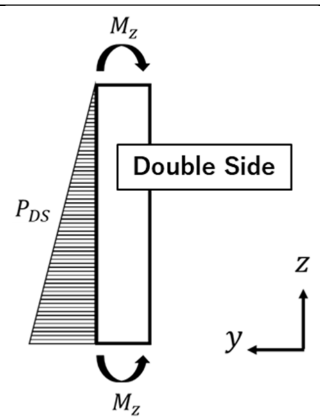
(a) Double bottom bending moment





(b) Double side bending moment





7.3.3 Moments and Shear forces

7.3.3.1 Moments

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

(2) The transverse or vertical bending moment per unit length in the double hull is to be obtained from the following formula:

$M_Y = C_{MY} P_{DH} B_{DH}^{\ 2}$ (kNm/m)

C_{MY}: Maximum transverse bending moment coefficient to be taken as follows depending on the structural arrangement: When assessing double bottom, read M_Y. When assessing double side, C_{MY} is to be read as C_{MZ}

((a) to (d) are omitted.)

Table 7.3.3-2 has been amended as follows.

Table 7.3.3-2 Moment Correction Factor β_B for Double Bottom

Type of structure	β_B
D1	$\cancel{\frac{8P_{DS}D_{DB}B_{DS}^{\ 3} + 15P_{DB}D_{DS}B_{DB}^{\ 3} + 120P_{DS}ED_{DS}D_{DB}}{120D_{DB}B_{DS} + 180D_{DS}B_{DB} + \frac{720ED_{DS}D_{DB}}{B_{DS}^{\ 2}}} \times \frac{12}{P_{DB}B_{DB}^{\ 2}}}$ $\underline{\frac{28P_{DS}D_{DB}B_{DS}^3 + 15P_{DB}D_{DS}B_{DB}^3}{240D_{DB}B_{DS} + 180D_{DS}B_{DB}} \times \frac{12}{P_{DB}B_{DB}^{\ 2}}}$
D2	$\frac{8P_{DS}D_{DB}B_{DS}^{\ 3} + 15P_{DB}D_{DS}B_{DB}^{\ 3}}{120D_{DB}B_{DS} + 180D_{DS}B_{DB}} \times \frac{12}{P_{DB}B_{DB}^{\ 2}}$
D3	$\frac{3P_{DS}D_{DB}B_{DS}^{\ 3} + 10P_{DB}D_{DS}B_{DB}^{\ 3}}{60D_{DB}B_{DS} + 120D_{DS}B_{DB}} \times \frac{12}{P_{DB}B_{DB}^{\ 2}}$
D4	$\frac{3P_{DS}D_{DB}B_{DS}^{\ 3} + 5P_{DB}D_{DS}B_{DB}^3}{60D_{DB}B_{DS} + 60D_{DS}B_{DB}} \times \frac{12}{P_{DB}B_{DB}^{\ 2}}$

Table 7.3.3-3 has been amended as follows.

Table 7.3.3-3 Moment Correction Factor β_S for Double Side

Type of structure	β_S
D1	$\cancel{\dfrac{8P_{DS}D_{DB}{B_{DS}}^3+15P_{DB}D_{DS}{B_{DB}}^3+120P_{DS}ED_{DS}D_{DB}}{120D_{DB}B_{DS}+180D_{DS}B_{DB}+\dfrac{720ED_{DS}D_{DB}}{{B_{DS}}^2}}\times\dfrac{15+\dfrac{90ED_{DS}}{{B_{DS}}^3}}{P_{DS}{B_{DS}}^2+\dfrac{15P_{DS}ED_{DS}}{B_{DS}}}}$ $\underline{\dfrac{28P_{DS}D_{DB}B_{DS}^3+15P_{DB}D_{DS}B_{DB}^3}{240D_{DB}B_{DS}+180D_{DS}B_{DB}}\times\dfrac{60}{7P_{DS}B_{DS}^2}}$
D2	$\dfrac{8P_{DS}D_{DB}{B_{DS}}^3+15P_{DB}D_{DS}{B_{DB}}^3}{120D_{DB}B_{DS}+180D_{DS}B_{DB}}\times\dfrac{15}{P_{DS}{B_{DS}}^2}$
D3	$\dfrac{3P_{DS}D_{DB}{B_{DS}}^3+10P_{DB}D_{DS}{B_{DB}}^3}{60D_{DB}B_{DS}+120D_{DS}B_{DB}}\times\dfrac{20}{P_{DS}{B_{DS}}^2}$
D4	$\dfrac{3P_{DS}D_{DB}{B_{DS}}^3+5P_{DB}D_{DS}{B_{DB}}^3}{60D_{DB}B_{DS}+60D_{DS}B_{DB}}\times\dfrac{20}{P_{DS}{B_{DS}}^2}$

Paragraph 7.3.3.2 has been amended as follows.

7.3.3.2 Shear Forces

((1) and (2) are omitted.)

(3) The shear force in side stringers is to be given by the following formula:

$$F=C_{f(x_{DH})}C_{f(z_{DH})}C_{FX}P_{DH}SB_{DS}\ (kN)$$

$C_{f(x_{DH})}$: To be taken as follows depending on the hatchway width:

(a) For the hatchway width is not more than $0.7B$, or for no hatchway is provided

$$C_{f(x_{DH})}=\max\left(0.5,2.0\frac{|x_{DH}|}{\ell_{DS}}\right)$$

(b) For the hatchway width exceeds $0.7B$

$$C_{f(x_{DH})}=\max\left(0.5,\min\left(1.0,2.5\frac{|x_{DH}|}{\ell_{DS}}+0.25\right)\right)$$

$C_{f(z_{DH})}=1.0$

C_{FX}: Maximum shear force coefficient for side stringers to be taken as follows:

$$C_{FX}=C_{FXS}+\beta_S(C_{FXF}-C_{FXS})$$

β_S: Double side moment correction factor as given in **Table 7.3.3-3**. <u>However, β_S is to be taken as 1.0 where greater than 1.0.</u>

C_{FXS} and C_{FXF}: Coefficients obtained according to the value of α_{EQ} from **Tables 7.3.3-18** to **Table 7.3.3-23**, depending on the structural model. For intermediate values of α_{EQ}, these coefficients are to be determined by interpolation.

(4) The shear force in side transverses is to be given by the following formula:

$$F=C_{f(x_{DH})}C_{f(z_{DH})}C_{FZ}P_{DH}SB_{DS}(kN)$$

$C_{f(x_{DH})}$: To be taken as follows depending on α_{EQ} for the double side:

(a) For $\alpha_{EQ}\geq 4.0$

$$C_{f(x)}=1.0$$

(b) For $\alpha_{EQ}<4.0$

$$C_{f(x)} = \min\left(1.0, \max\left(0.5, C_{AS}\left(0.5 - \frac{|x_{DH}|}{\ell_{DS}}\right) + 0.5\right)\right)$$

$$C_{AS} = \min\left(4.0, \max\left(1.667, \frac{1.0}{0.467\left(\frac{1.0}{\alpha_{EQ}} - 0.25\right)} + 0.25\right)\right)$$

$C_{f(z_{DH})}$: To be taken as follows depending on the hatchway width:

(a) ~~For the hatchway width is not more than $0.7B$ or for no hatchway is provided~~ When hatchways are provided (D1 and D2 Type)

$$C_{f(z_{DH})} = \max\left(0.3, \min\left(1.0, 1.0 - 1.667\frac{|z_{DH}|}{B_{DS}}\right)\right)$$

(b) ~~For the hatchway width exceeds $0.7B$~~ When no hatchways are provided (D3 and D4 Type)

$$C_{f(z)} = \max\left(0.5, \min\left(1.0, 1.0 - 1.667\frac{|z_{DH}|}{B_{DS}}\right)\right)$$

C_{FZ}: Maximum shear force coefficient for side transverses to be taken as follows:

$C_{FZ} = C_{FZS} + \beta_S(C_{FZF} - C_{FZS})$

β_S: Double side moment correction factor as given in **Table 7.3.3-3**

C_{FZS} and C_{FZF}: Coefficients obtained according to the value of α_{EQ} from **Tables 7.3.3-18** to **Table 7.3.3-23**, depending on the structural model. For intermediate values of α_{EQ}, these coefficients are to be determined by interpolation.

Table 7.3.3-18 has been amended as follows.

Table 7.3.3-18 Coefficients C_{FXS} and C_{FZS} at Double Side (D1) Where Boundary Condition with Bottom Structure Is "Supported"

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXS}	0.177	0.245	0.279	0.307	0.330	0.349	0.365
C_{FZS}	0.141	0.226	0.277	0.324	0.367	0.407	0.443
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXS}	0.474	0.786	1.574	2.498	3.745	8.412	
C_{FZS}	0.477	0.535	0.624	0.684	0.732	0.786	

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXS}	0.083	0.137	0.173	0.207	0.236	0.262	0.286
C_{FZS}	0.082	0.127	0.153	0.178	0.200	0.219	0.238
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXS}	0.308	0.340	0.386	0.415	0.435	0.524	
C_{FZS}	0.254	0.284	0.328	0.360	0.382	0.409	

Table 7.3.3-19 has been amended as follows.

Table 7.3.3-19 Coefficients C_{FXF} and C_{FZF} at Double Side (D1) Where Boundary Condition with Bottom Structure Is "Fixed"

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXF}	0.100	0.144	0.167	0.186	0.201	0.214	0.223
C_{FZF}	0.135	0.210	0.252	0.288	0.320	0.348	0.372
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXF}	0.231	0.345	0.548	0.687	0.781	0.927	
C_{FZF}	0.394	0.429	0.474	0.495	0.504	0.498	

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXF}	0.083	0.136	0.168	0.194	0.217	0.227	0.236
C_{FZF}	0.159	0.235	0.277	0.313	0.344	0.371	0.396
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXF}	0.242	0.247	0.242	0.245	0.249	0.235	
C_{FZF}	0.417	0.451	0.494	0.515	0.522	0.513	

Table **7.3.3-22** has been amended as follows.

Table 7.3.3-22 Coefficients C_{FXS} and C_{FZS} at Double Side (D3 or D4) Where Boundary Condition with Bottom Structure Is "Supported"

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXS}	0.122	0.169	0.200	0.225	0.249	0.274	0.296
C_{FZS}	0.064	0.107	0.133	0.155	0.175	0.192	0.205
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXS}	0.314	0.340	0.360	0.364	0.365	0.365	
C_{FZS}	0.216	0.232	0.248	0.253	0.254	0.254	

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXS}	0.107	0.158	0.188	0.215	0.239	0.260	0.278
C_{FZS}	0.070	0.113	0.138	0.161	0.181	0.197	0.211
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXS}	0.293	0.312	0.322	0.318	0.310	0.287	
C_{FZS}	0.222	0.237	0.253	0.258	0.259	0.259	

Table 7.3.3-23 has been amended as follows.

Table 7.3.3-23 Coefficients C_{FXF} and C_{FZF} at Double Side (D3 or D4) Where Boundary Condition with Bottom Structure Is "Fixed"

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXF}	0.107	0.152	0.175	0.195	0.211	0.228	0.239
C_{FZF}	0.140	0.215	0.255	0.285	0.308	0.323	0.333
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXF}	0.247	0.253	0.255	0.255	0.256	0.258	
C_{FZF}	0.350	0.350	0.350	0.350	0.350	0.350	

α_{EQ}	0.25 or less	0.4	0.5	0.6	0.7	0.8	0.9
C_{FXF}	0.100	0.144	0.167	0.186	0.202	0.215	0.223
C_{FZF}	0.135	0.209	0.250	0.282	0.305	0.321	0.332
α_{EQ}	1.0	1.2	1.6	2.0	2.5	4.0 or more	
C_{FXF}	0.228	0.232	0.226	0.220	0.213	0.195	
C_{FZF}	0.339	0.345	0.344	0.341	0.340	0.340	

7.4 Pillars, Struts, Etc.

7.4.2 Scantling Requirements

Paragraph 7.4.2.1 has been amended as follows.

7.4.2.1 Buckling Strength Requirements (Euler Buckling)

For members subject to axial compressive loads, such as pillars or struts, their sectional area is to be not less than that obtained from the following formula:

$$A_{n50} = C_S \frac{F}{\sigma_{cr}} \times 10 \ (cm^2)$$

C_S: Safety factor to be taken as 1.4. <u>However, when struts are placed between longitudinals in double bottom and double side, C_S is to be taken as 2.8.</u>

F: Compressive load (kN) specified in each requirement. However, the compressive load may be obtained by direct strength analysis.

σ_{cr}: Buckling strength of beams and pillars or such members as struts to be taken as follows:

For $\sigma_E > \frac{\sigma_Y}{2}$: $\sigma_{cr} = \sigma_Y \left(1 - \frac{\sigma_Y}{4\sigma_E}\right)$ (N/mm^2)

For $\sigma_E \leq \frac{\sigma_Y}{2}$: $\sigma_{cr} = \sigma_E$ (N/mm^2)

$$\sigma_E = C_{BC}\pi^2 E \left(\frac{k}{l}\right)^2 \ (N/mm^2)$$

k: Minimum radius (mm) of gyration of beams and pillars or members such as struts

l: Distance (mm) from the top of the inner bottom plating, deck or any other structure, to which the lower end of pillars, struts, etc., is attached, to the bottom of the beam or deck girder supported by the pillars, struts, etc.

C_{BC}: Fixed end effect coefficient as specified in the following **i)** to **iii)**:

i) For corrugated bulkheads supported at each end with a stool with a width exceeding 2 times the depth of the corrugation

$C_{BC} = 4$

ii) For corrugated bulkheads or cross ties supported at one end with a stool with a width exceeding 2 times the depth of the corrugation

$C_{BC} = 2$

iii) Other cases

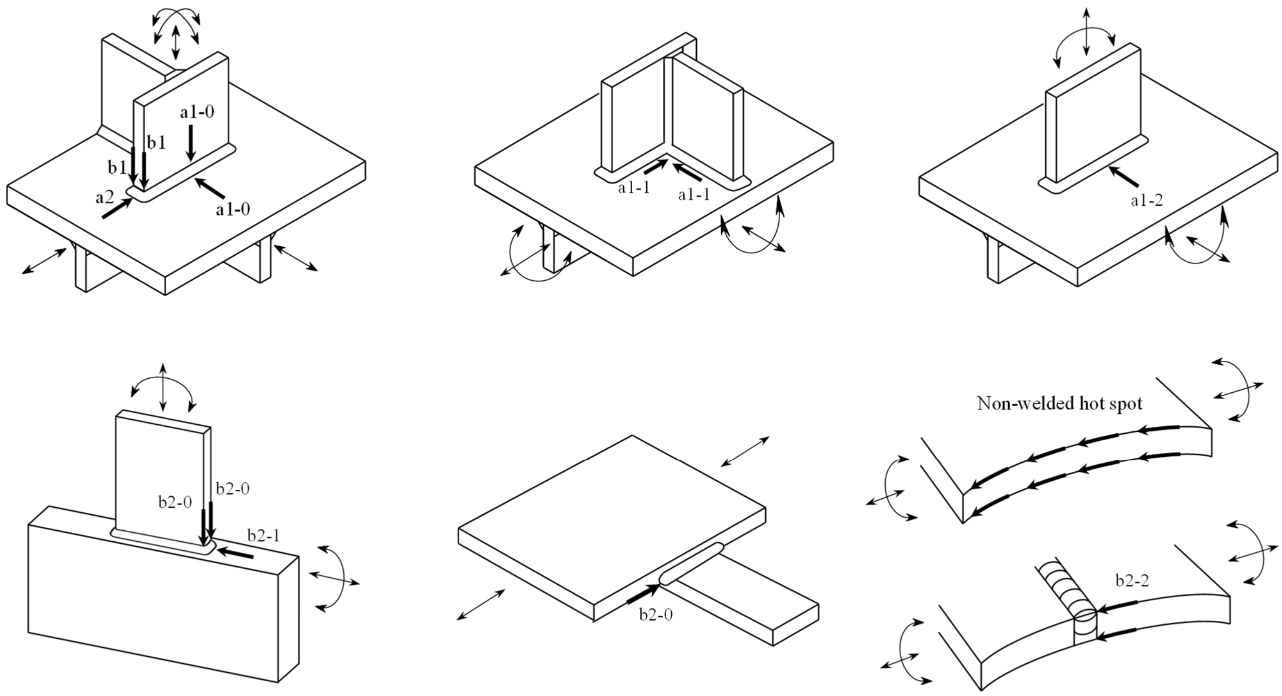
$C_{BC} = 1$

9.4 Finite Element Analysis

9.4.1.4 Types of Hot Spot

The types of hot spots are described in **Table 9.4.1-1**. These are defined according to their location on the plate and their orientation to the weld toe as shown in **Fig. 9.4.1-1**.

Fig. 9.4.1-1 Types of Hot Spots



9.4.2.7 Mesh Size

-1 has been amended as follows.

1 The size of the very fine mesh is to be in accordance with the following **(1)** to **(4)**:

(1) The very fine mesh finite element model for the evaluation of "*a*" type hot spot stress is to be based on the shell element of standard mesh size $t_{gr} \times t_{gr}$, where t_{gr} is the gross thickness (*mm*) of the member for evaluation of the considered hot spot.

(2) The very fine mesh finite element model for the evaluation of "*b*" type hot spot stress is to be based on the shell element of standard mesh size 10 *mm* × 10 *mm*.

(3) Except for the following **(a)** to **(c)**, the mesh size of hot spots consisting of plates of different thicknesses may, in principle, be the thickness of the thinnest plate among those evaluated.

(a) When the member for which fatigue strength is considered critical is assessed as "*a*" type, the mesh size is to be equal to the thickness of that member.

(b) When the mesh size for "*a*" type hot spot is smaller than half the plate thickness, very fine mesh zones corresponding to the respective mesh sizes are to be prepared.

(c) When "*a*" and "*b*" type hot spots exist together in one structural detail and the thickness of the plate with "*a*" type hot spot exceeds 20 *mm*, very fine mesh zones corresponding to the respective mesh sizes are to be prepared.

<u>(4) Notwithstanding the requirements in **(1)** to **(3)** above, a mesh size which is smaller than half</u>

the plate thickness may be used for type "*a*" hot spots where deemed appropriate by the Society.

(~~4~~5) The mesh size of very fine mesh finite element models for the evaluation of "*a*2" type spot is not to be greater than the thickness of the considered plate.

2 The very fine mesh zone is to be extending over at least 10 elements in all directions from the hot spot. The transition of the surrounding element size between the coarser mesh and the very fine mesh zone is to be done gradually. This transition mesh is to be such that a uniform mesh with regular shape gradually transitions from smaller elements to larger ones. An example of the mesh transition in way of the side frame bracket toe is shown in **Fig. 9.4.2-1**.

9.4.5.2 has been amended as follows.

9.4.5.2 Hot Spot Locations and Stress Readout Points

1 The hot spot locations and stress readout points for welded joints are to be in accordance with the following **(1)** to **(4)** depending on the type of hot spots. Examples of the types of welded joints and the joints reproduced using shell models are shown in **Fig. 9.4.5-1**.

(1) Type a1 hot spot (*See* **Fig. 9.4.5-2** to **Fig. 9.4.5-4**)

(a) The location of type a1 hot spot is the position shifted x_{shift} (*mm*) in the direction orthogonal to the weld line on the plates surface from the position of the node at the intersection of the shell elements of the plates. When assessing hot spot stress, the hot spot stress is obtained by reading out the stresses at positions shifted $0.5t_{n25}$ (*mm*) and $1.5t_{n25}$ (*mm*) in the direction orthogonal to the weld line from the hot spot location, based on the thickness of the plates for which hot spot stress is to be assessed. However, when using a mesh size smaller than half the thickness in accordance with **9.4.2.7-1(4)**, the hot spot stress is obtained by reading out the stress at the positions shifted $0.4t_{n25}$ (*mm*) and $1.0t_{n25}$ (*mm*) in the direction orthogonal to the weld line from the hot spot.

(b) x_{shift} is to be obtained from the following formula:

Cases other than $\phi = 90°$

When continuous plates are assessed~~:~~

$$x_{shift} = \frac{t_{2n25}}{2\sin\phi} + \frac{t_{1n25}}{2\tan\phi} \ (mm)$$

When discontinuous plates are assessed~~:~~

$$x_{shift} = \frac{t_{2n25}}{2\sin\phi} \ (mm)$$

Case $\phi = 90°$

$$x_{shift} = \frac{t_{2n25}}{2} \ (mm)$$

t_{1n25}: Thickness (*mm*) of plate containing the hot spot to be assessed (main plate)

t_{2n25}: Thickness (*mm*) of plate intersecting the main plate (attached plate)

ϕ: Angle (*deg*) between attached plate and main plate

(2) Type a2 hot spot (*See* **Fig. 9.4.5-5**)

The location of type a2 hot spot is the position of the node at the intersection between the shell element of a plate and the shell element edge face of a plate, gusset plate or bracket. The hot spot stress is obtained by reading out the stress at positions shifted $0.5t_{n25}$ (*mm*) and $1.5t_{n25}$ (*mm*) in the direction extending to the gusset plate or bracket from the hot spot, based on the thickness of the plate for which hot spot stress is to be assessed. However, when using a mesh size smaller than half the thickness in accordance with **9.4.2.7-1(4)**, the hot spot stress is obtained by reading out the stress at the positions shifted $0.4t_{n25}$ (*mm*) and $1.0t_{n25}$ (*mm*) in the direction extending to the gusset plate or bracket from the hot spot.

(3) Type b1 hot spot (*See* **Fig. 9.4.5-6**)

(a) The location of type b1 hot spot is the position shifted x_{shift} (mm) along the shell element edge face of the plate, gusset plate, or bracket from the position of the node at the intersection between the shell element edge face of a plate, gusset plate or bracket and the shell element of the plate. When assessing hot spot stress, the hot spot stress is obtained by reading out the stresses at position shifted 5 mm and 15 mm along the shell element edge face of the plate, gusset plate, or bracket from the hot spot.

(b) x_{shift} is taken as follows:

$$x_{shift} = \frac{t_{2n25}}{2\sin\phi} \ (mm)$$

ϕ: Angle (deg) between gusset plate edge and plate intersecting the considered plate (attached plate)

t_{2n25}: Thickness (mm) of plate intersecting the considered plate (attached plate)

(4) Type b2 hot spot (*See* **Fig. 9.4.5-7**)

(a) The location of type b2 hot spot is the position of the node at the intersection between the shell element edge face of a plate, gusset plate, or bracket and the shell element of a plate. When assessing the hot spot stress at the corner of plate edge or the plate edge face, the hot spot stress is obtained by reading out the stresses at positions shifted 5 mm and 15 mm along the corner of plate edge or the plate edge face from the hot spot. When assessing the hot spot at a weld toe at the corner of plate edge welded by butt joint, the hot spot stress is obtained by reading out the stresses of two elements adjoining the hot spot.

(b) Type b2-1 hot spot stress is to be corrected by multiplication with the following factor:

$$f_{\mathrm{HSS}} = 0.436 \cdot \left(\frac{t_{2-n25}}{t_{1-n25}} - 1\right)^2 + 1$$

t_1: Thickness (mm) of plating to be assessed

t_2: Thickness (mm) of plating not to be assessed

9.4.5.4 has been amended as follows.

9.4.5.4 Hot Spot Stress

1 The hot spot stress is to be obtained by linear extrapolation of the stress at the point on stress readout line specified in **9.4.5.2** to the hot spot location specified in **9.4.5.2**.

2 The hot spot stress is, in principle, to be obtained from the following formula:

$\sigma_{HS} = 1.5\sigma_{0.5} - 0.5\sigma_{1.5}$ (N/mm^2)

$\sigma_{0.5}$: Stress (N/mm^2) at position shifted $0.5t_{n25}$ (mm) or 5 mm from hot spot

$\sigma_{1.5}$: Stress (N/mm^2) at position shifted $1.5t_{n25}$ (mm) or 15 mm from hot spot

<u>**3** Notwithstanding the requirements specified in **-2**, the hot spot stress is to be obtained from the following formula when using a mesh size smaller than half the plate thickness in accordance with the requirements in **9.4.2.7-1(4)**.</u>

<u>$\sigma_{HS} = 1.67 \cdot (1.0\sigma_{0.4} - 0.4\sigma_{1.0})$ (N/mm^2)</u>

<u>$\sigma_{0.4}$: Stress (N/mm^2) at position shifted $0.4t_{n25}$ (mm) from hot spot</u>

<u>$\sigma_{1.0}$: Stress (N/mm^2) at position shifted $1.0t_{n25}$ (mm) from hot spot</u>

~~3~~<u>4</u> Notwithstanding the requirements specified in **-2** <u>and **-3** above</u>, when the hot spot on the tank cover at the intersection of the tank cover and the upper deck of ships carrying liquefied gases in bulk (independent spherical tanks), and the hot spot on the coaming at the intersection of the coaming of the tank dome opening and the upper deck of ships carrying liquefied gases in bulk (independent prismatic tanks) are to be evaluated, the hot spot stress for $\Delta\sigma_{ort\_j}$ is obtained from the following formula. The stress at x_{shift} position is to be obtained according to the procedure specified in -2 and -3 above:

$$\sigma_{HS} = \left[\sigma_{membrane}\left(x_{shift}\right) + 0.60 \cdot \sigma_{bending}\left(x_{shift}\right)\right] \quad (N/mm^2)$$

$\sigma_{membrane}\left(x_{shift}\right)$: Membrane stress ($N/mm^2$) at x_{shift} position

$\sigma_{bending}\left(x_{shift}\right)$: Bending stress ($N/mm^2$) at x_{shift} position obtained from the following formula:

$$\sigma_{bending}\left(x_{shift}\right) = \sigma_{surface}\left(x_{shift}\right) - \sigma_{membrane}\left(x_{shift}\right)$$

$\sigma_{surface}\left(x_{shift}\right)$: Surface stress ($N/mm^2$) at x_{shift} position

Chapter 10 ADDITIONAL STRUCTURAL REQUIREMENTS

10.4 Deck Structure

10.4.6 Helicopter Decks

Paragraph 10.4.6.2 has been amended as follows.

10.4.6.2 Longitudinals and Beams of Helicopter Decks

The section modulus of the longitudinals and beams of a helicopter deck is not to be less than that obtained by the following formula:

$$\cancel{C_{load}\frac{M}{0.75\sigma_Y}\times 10^3\ (cm^3)}$$

$$\underline{C_{safety}\frac{M}{\sigma_Y}\times 10^3\ (cm^3)}$$

σ_Y: Specified minimum yield stress (N/mm^2)

~~C_{load}: Safety coefficient for dynamic effect of ship motion to be taken as 1.2.~~

<u>C_{safety}: Safety factor taken as 1.25.</u>

M: Maximum bending moment (kN-m) acting on the longitudinals and beams. This value is to be the value of **(1)** or **(2) below,** whichever is greater. <u>However, this value is to be specified in **(1)** when $\ell_1 \geq \ell$.</u>

(1) ~~$\ell_1 \geq \ell$~~<u>When a load of helicopter acts</u> (*See* **Fig. 10.4.6-1(a)**)

$$\cancel{M = \frac{P\ell}{4}}$$

$$\underline{M = \frac{7P\ell}{40}}$$

(2) ~~$\ell_1 < \ell$~~<u>When two loads of helicopter act</u> (*See* **Fig. 10.4.6-1(b)**)

$$\cancel{M = \frac{P(2\ell - \ell_1)^2}{8\ell}}$$

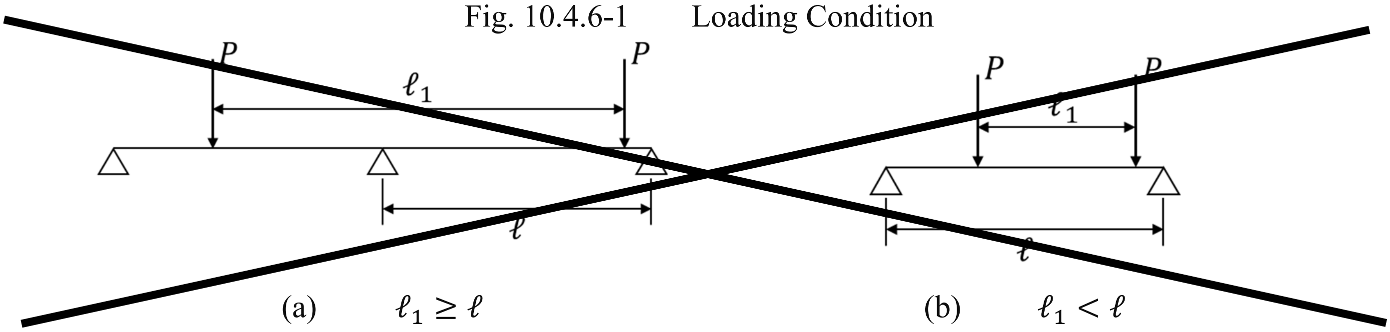
$$\underline{M = \frac{P(\ell - \ell_1)(7\ell - 3\ell_1)}{20\ell}}$$

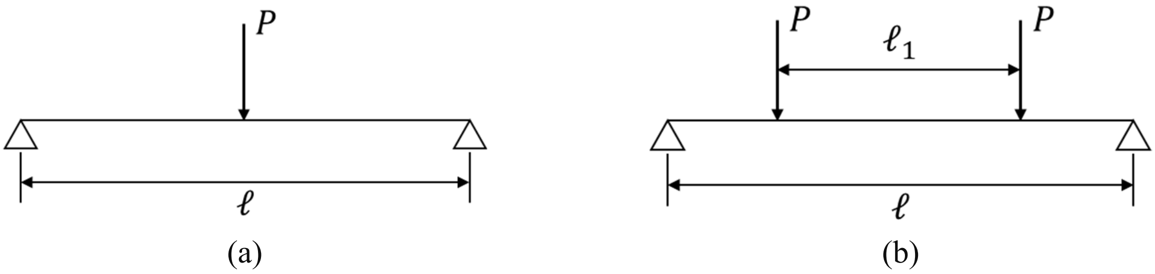
P: Load of helicopter (kN) (*See* **4.8.3.1**)

ℓ: Spacing of longitudinals and beams (m)

ℓ_1: Distance (m) between loads of helicopter P acting on longitudinals and beams

Fig. 10.4.6-1 Loading Condition





10.6 Strengthened Bottom Forward

10.6.1 General

10.6.1.1 Application

Sub-paragraph -2 has been renumbered to -3, and Sub-paragraph -2 has been added as follows.

1 The requirements of this **10.6** are to be applied to ships having a bow draught under $0.037L_{C230}$ in ballast condition. The ballast condition means the condition where the ballast is loaded only in ballast tanks such as the dedicated ballast tanks and separate ballast tank and in holds also used for ballasting. Where more than one ballast condition is planned for a ship, these requirements can be applied on the basis of the specific ballast condition provided in the loading manual as the ballast condition used in stormy weather. However, this provision does not include the exceptional ballast condition where the ballast is loaded in cargo oil tanks only in stormy weather to ensure the safety of the ship. L_{C230} is the length of the ship according to **1.4.2.2**.

2 For ships subject to this **10.6**, assessment of strengthened bottom forward is to be carried out in accordance with **10.6.2** or **10.6.3**.

~~2~~3 The required scantlings specified in this **10.6** are to be net scantlings.

10.6.2 General Ships (Ship other than those with L_C of not more than 150 m, $V/\sqrt{L_C}$ of not less than 1.4 and C_B of not more than 0.7)

Paragraph 10.6.2.1 has been amended as follows.

10.6.2.1 Application

~~Strengthening of the bottom forward of ships other than those with L_C of 150 m or less, $V/\sqrt{L_C}$ of 1.4 or larger, and C_B of 0.7 or less is to be as specified in this **10.6.2**.~~ For ships other than those subject to **10.6.3**, this **10.6.2** is to be applied.

10.6.3 Small, Slender High-Speed Ships (Ships having L_C of not more than 150 *m*, $V/\sqrt{L_C}$ of not less than 1.4, and C_B of not more than 0.7)

Paragraph 10.6.3.1 has been amended as follows.

10.6.3.1 Application

~~In ships of which L_C and C_B are not more than 150 *m* and 0.7 respectively, and $V\sqrt{L_C}$ is not less than 1.4, the thickness of the shell plating at the strengthened bottom forward is to follow the requirements of this **10.6.3.1**. However, ships that carry a certain amount of cargo regularly, such as Container Ships, may comply with the requirements in **10.6.2** instead.~~

For ships satisfying the following **(1)** to **(3)**, this **10.6.3** is to be applied. However, for ships always which are expected to carry a certain amount of cargo, such as container ships **10.6.2** may be applied instead.

(1) Ships where Length L_C is not greater than 150 *m*

(2) $V/\sqrt{L_C}$ is not less than 1.4

(3) C_B is not greater than 0.7

10.9 Tank Structures for Sloshing

10.9.2 Plates

10.9.2.1 has been amended as follows.

10.9.2.1

The thickness of plates on which sloshing loads act is to be not less than the value obtained from the following formula.

$$t = \frac{b}{2}\sqrt{\frac{P_{slh} \times 10^{-3}}{1.15 C_a \sigma_Y}} \ (mm)$$

σ_Y: Specified minimum yield stress (*N/mm*^{2})

b: Length (*mm*) of the shorter side of the plate panel. However, it is to be taken as breadth of flange b_f (*mm*) or breadth of web b_w(*mm*) in the case of corrugated bulkheads (*See* **Fig. 10.9.2-1**)

a: Length (*mm*) of the longer side of the plate panel.

α: Aspect ratio, to be taken as a/b.

P_{slh}: Equivalent pressure (*kN/m*^{2}) for the plate panels, as specified in **Table 10.9.2-1**

C_a: Coefficient of axial force effect as specified in **Table 6.3.2-~~3~~2** when $\alpha \geq 2$ or **Table 6.3.2-~~4~~3** when $\alpha < 2$. However, it is taken as 1.0 for corrugated bulkheads.

σ_{BM}: Stress (*N/mm*^{2}) due to hull girder bending, as specified in **10.9.1.4**

Chapter 11 STRUCTURES OUTSIDE CARGO REGION

11.2 Bow Construction

11.2.1 General

Paragraph 11.2.1.2 has been amended as follows.

11.2.1.2 Net Scantlings~~s~~ Approach

Unless clearly indicated to be gross scantlings, the scantlings specified in this **11.2** are to be net scantlings.

11.3 Superstructures and Deckhouses

11.3.2 Superstructures

11.3.2.3 Superstructure End Bulkheads

Sub-paragraph -2 has been amended as follows.

2 The section modulus of the stiffener on superstructure end bulkhead (gross scantlings) is not to be less than that obtained by the following formula:

$Z_{gr} = 350 s P_{GW} \ell^2 \cancel{\times 10^{-3}}\ \underline{\times 10^{-6}}$ (cm^3)

s and P_{GW}: As specified in **-1(1)** above.

ℓ: Distance (m) between the decks at the position. However, when the value is less than 2 m, ℓ is taken as 2 m.

11.5 Stern Construction

11.5.1 Stern Frames

Paragraph 11.5.1.1 has been amended as follows.

11.5.1.1 General

1 The requirements in this **11.5.1** apply only to stern frames without rudder posts.

2 Stern frames may be fabricated from steel plates or made of cast steel with a hollow section. For applicable material specifications and steel grades (*See* **3.2**). Stern frames of other material or construction will be specially considered.

3 Cast steel and fabricated stern frames are to be strengthened by adequately spaced horizontal plates with gross thicknesses not less than 80 % of the required thickness for stern frame t_1. Where the radius of curvature is large, a centreline stiffener is to be provided, and t_1 is to be according to **Table 11.5.1-1** or **Table 11.5.1-2**. Abrupt changes of section are to be avoided in castings, and all sections are to have an adequate tapering radius.

4 The scantlings specified in this **11.5.1** are to be gross scantlings.

Part 2-1 CONTAINER CARRIERS

Chapter 4 LOADS

4.2 Loads to be Considered in Longitudinal Strength

4.2.2 Maximum Load Condition

4.2.2.2 Vertical Still Water Bending Moment and Vertical Still Water Shear Force

Table 4.2.2-3 has been amended as follows.

Table 4.2.2-3 Vertical Wave Bending Moments M_{WV-h} and M_{WV-s} for Torsional Strength Assessments

The vertical wave bending moment in hogging condition	M_{WV-h} (*kN-m*)	$M_{WV-h} = 1.5 C_R C_{Vh} {L_C}^3 C C_W \left(\frac{B}{L_C}\right)^{0.8} C_{NL-h}$
The vertical wave bending moment in sagging condition	M_{WV-s} (*kN-m*)	$M_{WV-s} = 1.5 C_R C_{Vs} {L_C}^3 C C_W \left(\frac{B}{L_C}\right)^{0.8} C_{NL-s}$

Notes:

C_R, C_{NL-h}, C_{NL-s}, C: As specified in **Table 4.2.2-1.**

C_{Vh}, C_{Vs}: Distribution coefficient, as given by the following formulae, to be taken as 0 in the ranges of $x/L_C < 0$ and $x/L_C > 1$ (*See* **Fig. 4.2.2-3**)

$$C_{Vh} = 3.165 \cos\left(0.1\pi\left(\frac{x}{L_C} + 3.5\right)\right)\sin^2\left(\pi\frac{x}{L_C}\right)$$

$$C_{Vs} = -3.165 \cos\left(0.1\pi\left(\frac{x}{L_C} + 3.5\right)\right)\sin^2\left(\pi\frac{x}{L_C}\right)$$

4.2.2.6 Horizontal Bending Moment and Torsional Moment

Table 4.2.2-6 has been amended as follows.

Table 4.2.2-6 Horizontal Bending Moment and Torsional Moment when Assessing Torsional Strength by Whole Ship Analysis

Horizontal wave bending moments	M_{WH1} (*kN-m*)	$M_{WH1} = 0.32 C_R C_1 C_{H1} {L_C}^2 T_{SC} \sqrt{\dfrac{L_c - 35}{L_c}}$
	M_{WH2} (*kN-m*)	$M_{WH2} = 0.32 C_R C_1 C_{H2} {L_C}^2 T_{SC} \sqrt{\dfrac{L_c - 35}{L_c}}$
Still water torsional moments	M_{ST1} (*kN-m*)	$M_{ST1} = M_{ST\_max} \cdot C_{T1}$
	M_{ST2} (*kN-m*)	$M_{ST2} = M_{ST\_max} \cdot C_{T2}$
Wave torsional moments	M_{WT1} (*kN-m*)	$M_{WT1} = C_R C_{T1} \cdot [1.3 C_1 L_C T_{SC} C_B (0.65 T_{SC} + e) + 0.2 C_1 L_C B^2 C_W]$
	M_{WT2} (*kN-m*)	$M_{WT2} = C_R C_{T2} \cdot [1.3 C_1 L_C T_{SC} C_B (0.65 T_{SC} + e) + 0.2 C_1 L_C B^2 C_W]$

Notes:

C_R: Coefficient considering the effect of ship operation, taken as 0.85

C_{H1}, C_{H2}: Distribution coefficient, as given by the following formulae, to be taken as 0 in the ranges of $x/L_C < 0$ and $x/L_C > 1$ (*See* **Fig. 4.2.2-6**)

$$C_{H1} = -\cos\left(0.77\pi\left(\frac{x}{L_C} - 0.52\right)\right) \cdot \sin^2\left(\pi\frac{x}{L_C}\right) \cdot \left[\frac{1 - \exp(-6x/L_C)}{1 - \exp(-3)}\right]$$

$$C_{H2} = -\sin\left(0.77\pi\left(\frac{x}{L_C} - 0.52\right)\right) \cdot \sin^2\left(\pi\frac{x}{L_C}\right) \cdot \left[\frac{1 - \exp(-6x/L_C)}{1 - \exp(-3)}\right]$$

M_{ST_max}: Largest value of the permissible maximum still water torsional moment in the longitudinal direction as described in loading manual (*kN-m*).

C_{T1}, C_{T2}: Distribution coefficient, as given by the following formulae, to be taken as 0 in the ranges of $x/L_C < 0$ and $x/L_C > 1$ (*See* **Fig. 4.2.2-7**)

$$C_{T1} = -1.0\left[\sin\left(2\pi\frac{x}{L_C}\right) + 0.1\sin^2\left(\pi\frac{x}{L_C}\right)\right] \cdot \exp\left(-0.35\frac{x}{L_C}\right) \cdot \exp\left(-8\left(2\frac{x}{L_C} - 1\right)^{10}\right)$$

$$C_{T2} = -0.5\left[-\sin\left(3\pi\frac{x}{L_C}\right) + 0.65\sin^3\left(\pi\frac{x}{L_C}\right)\right] \cdot \exp\left(-0.4\frac{x}{L_C}\right) \cdot \exp\left(-8\left(2\frac{x}{L_C} - 1\right)^{10}\right)$$

e: Distance from baseline to shear centre at the midship cross section (*m*)(1)

(1) The position of the shear centre can be calculated by finding the point of action of the shearing force where a torsional moment does not occur in the cross section when the shearing force in the horizontal direction acts on the traverse section of the hull. For example, the position can be calculated by applying ~~the requirements of~~ **Annex 5.2, Part 1 "Calculation Of Shear Flow ~~CALCULATION OF SHEAR FLOW~~"**.

4.4 Loads to be Considered in Strength of Primary Supporting Structures

4.4.2 Maximum Load Condition

4.4.2.1 General

Table 4.4.2-1 has been amended as follows.

Table 4.4.2-1 Loads to be Considered in Maximum Load Condition

Structures to be assessed		Loading patterns: Draught(m)	Loading patterns: Vertical still water bending moment (kN-m)	Loading patterns: Loaded to be considered	Equivalent design wave	Difference between external and internal pressure to be considered (kN/m^2)
Double bottom	$S1$	T_{SC}	$M_{SV\ max}$	Container cargo	HM-1 / HM-2	Double bottom: P_{DB} Double side: P_{DS}
Double side	$S2$	T_{SC}	$M_{SV\ min}$	Container cargo	BP-1P / BP-1S	
	$S3$	T_{SC}	$M_{SV\ min}$	~~None~~ Container cargo		

4.4.2.2 External Pressure

Table 4.4.2-2 has been amended as follows.

Table 4.4.2-2 External and Internal Pressure to be Considered

Structures to be assessed		P_{DB} (kN/m^2) (1) (2)	P_{DS} (kN/m^2) (1) (2)
Double bottom	$S1$	$P_{exs}+P_{exw}-P_{in\_s1}$	$P_{exs}+P_{exw}$
Double side	$S2$	$P_{exs}+P_{exw}-P_{in\_s1}$	$P_{exs}+P_{exw}$
	$S3$	$P_{exs}+P_{exw}-P_{in\_s3}$	$P_{exs}+P_{exw}$

Notes:

P_{exs}, P_{exw}: Hydrostatic and Hydrodynamic pressures (kN/m^2) acting on bottom shell in the case of P_{DB}~~.~~ , and the ~~Those~~ values acting on side shell in the case of P_{DS}. Each value is to be calculated in accordance with **4.6.2.4, Part 1**.

P_{in_s1}, P_{in_s3}: The values considering the effect of container cargo (kN/m^2), as given by the following formula: however, ~~the~~said values are to be taken as 0 when the number of bays in the cargo hold is only one.

$P_{in\_S1} = 0.15\rho g T_{SC}$

$P_{in\_\cancel{s2}\_S3} = 0.3\rho g T_{SC}$

(1) Load calculation points ~~is~~are to be in accordance with **7.3.1.5, Part 1** for all loading conditions.

(2) When calculating loads, $T_{LC} = T_{SC}$.

4.6 Loads to be Considered in Fatigue

4.6.3 Loads to be Considered in Torsional Fatigue Strength Assessment by Whole Ship Analysis

4.6.3.2 Hull Girder Loads

Table 4.6.3-1 has been amended as follows.

Table 4.6.3-1 Vertical Wave Bending Moments M_{WV-h} and M_{WV-s}

The vertical wave bending moment in hogging condition M_{WV-h} (*kN-m*)	$M_{WV-h} = 1.5C_{F\_WV}C_{Vh}{L_C}^3CC_W\left(\frac{B}{L_C}\right)^{0.8}$
The vertical wave bending moment in sagging condition M_{WV-s} (*kN-m*)	$M_{WV-s} = 1.5C_{F\_WV}C_{Vs}{L_C}^3CC_W\left(\frac{B}{L_C}\right)^{0.8}$

Notes:

C_{F_WV}: Fatigue coefficient, as given by the following formula.

$C_{F\_WV} = C_{F1\_WV}C_{F2\_WV}C_{F3\_WV}$

C_{F1_WV}: Coefficient considering speed effects, to be taken as 1.2.

C_{F2_WV}: Conversion coefficient for the exceedance probability level to be considered in fatigue strength assessment, to be taken as 0.22.

C_{F3_WV}: Coefficient considering the effects of the loading condition, to be taken as 0.82.

C_{Vh}, C_{Vs}: Distribution coefficient as given by the following formulae, to be taken as 0 in the ranges of $x/L_C < 0$ and $x/L_C > 1$ (*See* **Fig. 4.6.3-1**)

$$C_{Vh} = 1.044\sin\left(\pi\frac{x}{L_C}\right)\sin^2\left(0.45\pi\frac{x}{L_C}+0.35\pi\right)\sin^2\left(0.6\pi\frac{x}{L_C}+0.21\pi\right)$$
$$C_{Vs} = -1.044\sin\left(\pi\frac{x}{L_C}\right)\sin^2\left(0.45\pi\frac{x}{L_C}+0.35\pi\right)\sin^2\left(0.6\pi\frac{x}{L_C}+0.21\pi\right)$$

C: Wave parameter, as specified in **Table 4.2.2-1**.

Table 4.6.3-3 has been amended as follows.

Table 4.6.3-3 Wave Torsional Moments M_{WT1} and M_{WT2}

Wave torsional moment M_{WT1} (*kN-m*)	$M_{WT1} = C_{F\_WT}C_{T1}\cdot[1.3C_1L_CT_{SC}C_B(0.65T_{SC}+e)+0.2C_1L_CB^2C_W]$
Wave torsional moment M_{WT2} (*kN-m*)	$M_{WT2} = C_{F\_WT}C_{T2}\cdot[1.3C_1L_CT_{SC}C_B(0.65T_{SC}+e)+0.2C_1L_CB^2C_W]$

Notes:

C_{F_WT}: Fatigue coefficient, as given by the following formula:

$C_{F_{WT}} = C_{F1\_WT}C_{F2\_WT}C_{F3\_WT}$

C_{F1_WT}: Coefficient considering speed effects, to be taken as 1.03.

C_{F2_WT}: Conversion coefficient for the exceedance probability level to be considered, to be taken as 0.23

C_{F3_WT}: Coefficient considering the effects of the loading condition, to be taken as 0.82.

C_{T1}, C_{T2}: Distribution coefficients, as given by the following formulae, to be taken as 0 in the ranges of $x/L_C < 0$ and $x/L_C > 1$:

$$C_{T1} = -1.1\left[\sin\left(2\pi\frac{x}{L_C}\right)+0.1\sin^2\left(\pi\frac{x}{L_C}\right)\right]\exp\left(-0.7\frac{x}{L_C}\right)\exp\left(-8\left(2\frac{x}{L_C}-1\right)^{10}\right)$$
$$C_{T2} = -0.5\left[-\sin\left(3\pi\frac{x}{L_C}\right)+0.8\sin^3\left(\pi\frac{x}{L_C}\right)\right]\exp\left(-0.6\frac{x}{L_C}\right)\exp\left(-8\left(2\frac{x}{L_C}-1\right)^{10}\right)$$

e: Distance from baseline to shear centre at the midship section (m), as specified in **Table 4.2.2-6**.

Chapter 5 LONGITUDINAL STRENGTH

5.5 Torsional Strength

5.5.2 Torsional Strength Assessments Based on Finite Element Analysis

5.5.2.3 Structural Models

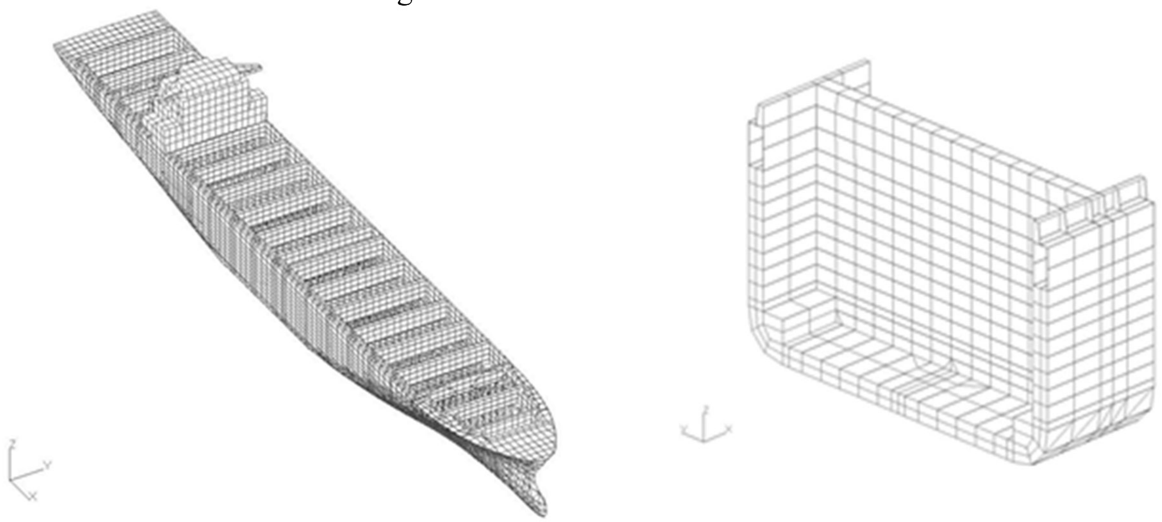
Sub-paragraph -5 has been amended as follows.

5 The meshing of elements is to be in accordance with the following **(1)** and **(2)** (*See* **Fig. 5.5.2-2**):

(1) ~~The meshing of elements is to~~ B~~b~~e performed so as to reproduce the structural responses of the whole ship accurately. In principle, ~~the~~ meshing ~~of elements~~ is to be in accordance with the following **(a)** to **(c)**:
   - (a) The size of mesh is not to be greater than floor space in general.
   - (b) The aspect ratio of shell elements is to be kept as close to 1 as possible.
   - (c) Variation of the mesh size and the use of triangular elements are to be kept to a minimum.

(2) Separate finite element models that use~~s~~ a finer mesh than usual may be used by applying the boundary conditions obtained from the structural model.

Fig. 5.5.2-2 Structural Models



(a) Overall View (b) Near the Transverse Bulkheads

Paragraph 5.2.2.4 has been amended as follows.

5.5.2.4 Load Conditions and Boundary Conditions

1 As load conditions, vertical still water bending moments, vertical wave bending moments, horizontal wave bending moments, and still water torsional moments caused by unbalanced loading of containers and wave torsional moments carrier are to be considered.

2 When applying the load, it is not to affect the axial stress caused by hull girder loads at the point of reference. ~~Torsional moments, especially, are to be applied in accordance with the following (1) to (3) as standard:~~

~~(1) Torsional moments acting on hull girders are to be applied to structural model as a series of bulkhead torsional moments resulting in a stepped curve. An approximated torsional step~~

~~moment curve is shown in **Fig. 5.5.2-3**.~~

~~(2) Torsional moments applied to bulkheads are the net change in torsional moment over the effective range of the bulkhead. The effective range of a bulkhead is the distance between the midpoints of the two adjacent bulkheads. The torsional moments at bulkhead *i* (*kN-m*) are specified as the following formulae: (*See* **Fig. 5.5.2-4**).~~

$\cancel{\delta M_{WT1i} = M_{WT1}|_{\frac{1}{2}(x_i+x_{i+1})} - M_{WT1}|_{\frac{1}{2}(x_{i-1}+x_i)}}$

$\cancel{\delta M_{WT2i} = M_{WT2}|_{\frac{1}{2}(x_i+x_{i+1})} - M_{WT2}|_{\frac{1}{2}(x_{i-1}+x_i)}}$

~~x_i: *x*-coordinate of bulkhead *i*~~

~~(3) The torsional moment at each bulkhead is to be reproduced by two equivalent shear forces on each side. An example of a method for applying shear force is shown in **Fig. 5.5.2-5**.~~

3 Torsional moments are, as a standard, to be applied in accordance with the following **(1)** to **(3)**:

(1) Torsional moments acting on hull girders are to be applied to structural models as a series of bulkhead torsional moments resulting in a stepped curve. An approximated torsional step moment curve is shown in **Fig. 5.5.2-3**.

(2) Torsional moments applied to bulkheads are the net change in torsional moment over the effective range of the bulkhead. The effective range of a bulkhead is the distance between the midpoints of the two adjacent bulkheads. The torsional moments at bulkhead *i* are specified as the following formulae (*See* **Fig. 5.5.2-4**):

$\delta M_{WT1i} = M_{WT1}|_{\frac{1}{2}(x_i+x_{i+1})} - M_{WT1}|_{\frac{1}{2}(x_{i-1}+x_i)}$

$\delta M_{WT2i} = M_{WT2}|_{\frac{1}{2}(x_i+x_{i+1})} - M_{WT2}|_{\frac{1}{2}(x_{i-1}+x_i)}$

x_i: *x*-coordinate of bulkhead *i*

(3) The torsional moment at each bulkhead is to be reproduced by two equivalent shear forces on each side. An example of a method for applying shear force is shown in **Fig. 5.5.2-5**.

4 When analysing the vertical and horizontal bending moments applied, a method applying unit moments is to be used as the standard. Stresses corresponding to the moments prescribed in **4.4.2** are to be calculated based on the stresses obtained through structural analysis with unit moments applied.

~~3~~5 Boundary conditions is to constrain the displacement of the structure at positions where the reaction force is considered to be small. Standard boundary conditions are to be given in **Table 5.5.2-2**.

Table 5.2.2-2 has been amended as follows.

Table 5.5.2-2 Boundary Conditions at Model Ends

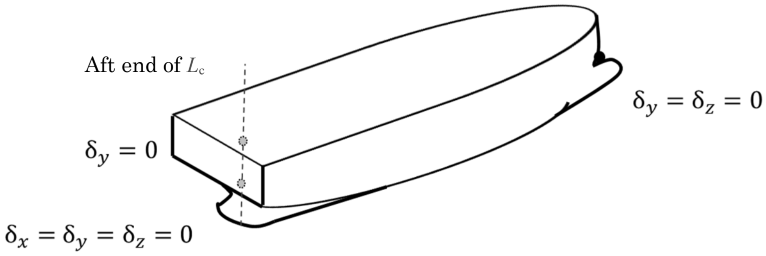
	Location	Translation			Rotation		
		X direction	Y direction	Z direction	Around the x~~X~~-axis	Around the y~~Y~~-axis	Around the z~~Z~~-axis
Boundary conditions of torsional moment (*See* **Fig. 5.5.2-~~2~~6 (a)**)	Aft end of L_c	Fix	Fix	Fix	-	-	-
	Fore end of L_c	-	Fix	Fix	-	-	-
Boundary conditions of vertical bending moment (*See* **Fig. 5.5.2-~~3~~7**)	Aft end of L_c	Fix	Fix	Fix	-	-	-
	Fore end of L_c	-	Fix	Fix	-	-	-
Boundary conditions of horizontal bending moment (*See* **Fig. 5.5.2-~~4~~8**)	Aft end of L_c	Fix	Fix	~~-~~Fix	-	-	-
	Fore end of L_c	~~-~~Fix	~~Fix~~	~~-~~Fix	-	-	-
	Transverse bulkheads of L_c	~~Fix~~	~~Fix~~	Fix	-	-	-

Notes:
[-] means no constraint applied (free).
The position of a constraint is to be the position in which the reaction force is thought to be small.
This table may not be applied for some load applying methods and stress calculation methods

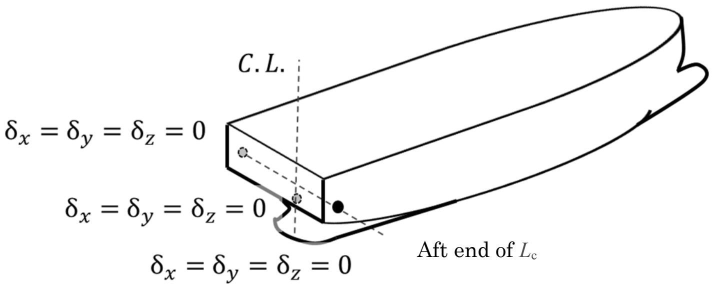
Figs. 5.2.2-2 to 5.2.2-5 have been amended as follows.

Fig. 5.5.2-~~2~~6 Boundary Conditions of Torsional Moment

(a) Example 1



(b) Example 2



~~Fig. 5.5.2-4 Boundary Conditions of Vertical Bending Moment~~

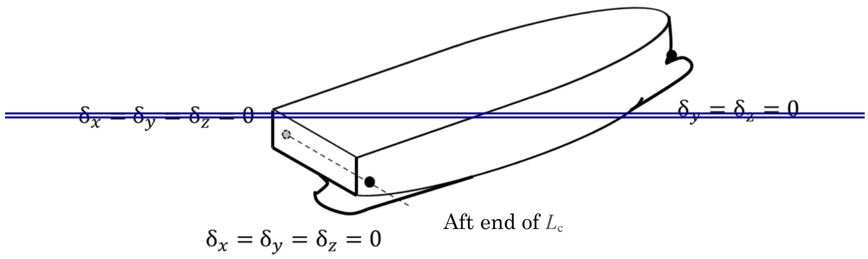
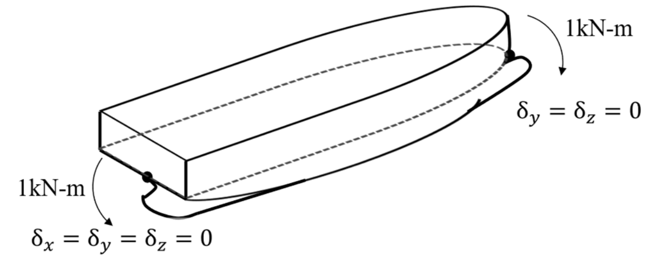


Fig. 5.5.2-7 Boundary Conditions and Loads Application of Vertical Bending Moment



~~Fig. 5.5.2-5 Boundary Conditions of Horizontal Bending Moment~~

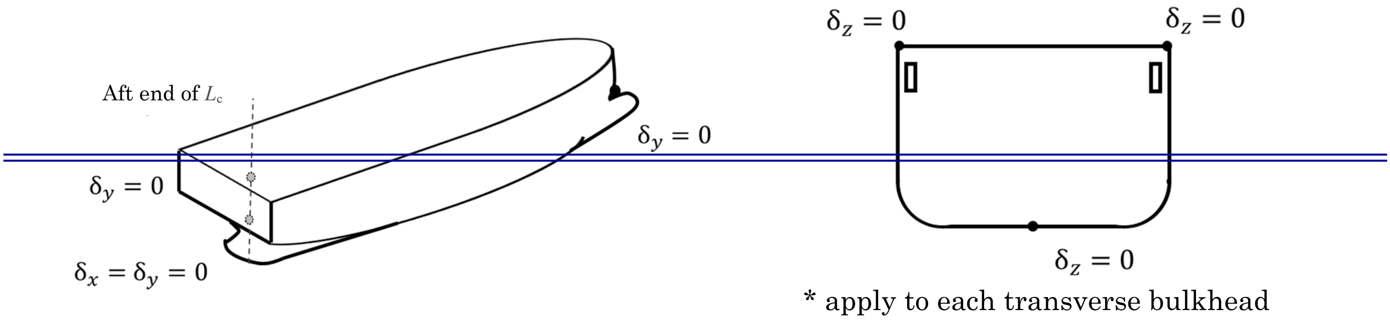
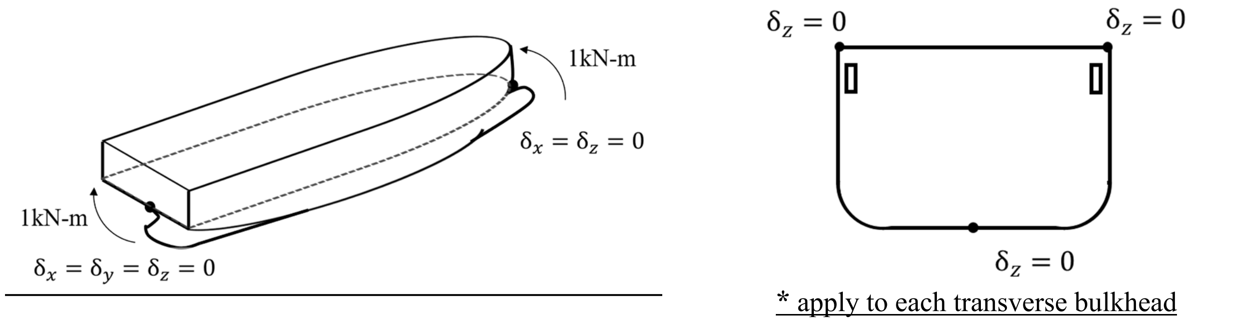


Fig. 5.5.2-8 Boundary Conditions and Loads Application of Horizontal Bending Moment



Paragraph 5.5.2.9 has been amended as follows.

5.5.2.9 Buckling Strength Assessment

1 The requirements in **8.6.2.1, Part 1** are applied correspondingly for buckling assessments. However, the buckling permissible utilisation factor is to be taken as 0.9 for bottom shell plating, bilge strakes and longitudinal stiffeners attached to these members.

2 Notwithstanding the requirement in **-1** above, bilge strakes longitudinally stiffened and longitudinal stiffeners attached to the bilge strakes may be verified in accordance with the following ~~requirements~~ **(1)** or **(2)** according to net thickness of bilge strakes and bilge radius:

(1) In case where the bilge strake net thickness is not less than 14.5 *mm* and the bilge radius is not greater than 8 *m*, the following ~~requirements~~ **(a)** and **(b)** are to be applied.

(a) The evaluation stress determined in accordance with **5.5.2.7** is not greater than 0.9 *times* the specified minimum yield stress of the steel used or 3~~3~~2̲0 *N/mm*^{2}, whichever is smaller.

(b) The following formula is satisfied:

$$\sqrt{11 \cdot \left(\frac{t}{1000R}\right)^2 + \left(\frac{\pi t}{1000S}\right)^4 + \left(\frac{\pi t}{1000S}\right)^2} \geq 0.014$$

t: Bilge strake net plate thickness (*mm*)

S: Spacing (*m*) of stiffeners. To be taken as the girth length.

R: Bilge radius (*m*)

(2) If the bilge strake net thickness is less than 14.5 *mm* and the bilge radius is greater than 8 *m*, the evaluated stress determined in accordance with **5.5.2.7** is not to be greater than 0.9 *times* the buckling strength obtained by using non-linear analysis~~, etc~~ and other methods.

Chapter 7 STRENGTH OF PRIMARY SUPPORTING STRUCTURES

7.1 General

7.1.1 Application

Paragraph 7.1.1.1 has been amended as follows.

7.1.1.1

1 The requirements of this Chapter apply to ships of less than 150 m in length L_C.

2 Notwithstanding **-1** above, strength assessments for deck girders with respect to deck loads and green sea loads are to be carried out in accordance with this Chapter.

~~**2**~~**3** For the double bottom and double-side skin structure, the requirements of the double hull structure specified in **7.3, Part 1** are to be applied. For other girder members that can be regarded as simple girders, the requirement of the simple girder specified in **7.2, Part 1** are to be applied.

7.2 Double Hull Structure

7.2.1 General

Paragraph 7.2.1.1 has been amended as follows.

7.2.1.1 Handling of Partial Bulkheads in the Hold

In applying **7.3, Part 1**, the length between the watertight bulkheads is to be assessed as the length of the cargo hold regardless of whether there are partial bulkheads in the middle of the hold. When assessing in consideration of the influence of the partial bulkheads in the middle of the hold, the strength is to be assessed by the cargo hold analysis specified in **Chapter 8**. Girders near partial bulkheads are to ensure sufficient strength to account for shear force effects.

Chapter 8 STRENGTH ASSESSMENT BY CARGO HOLD ANALYSIS

8.6 Strength Assessment

8.6.1 Yield Strength Assessment and Buckling Strength Assessment

Paragraph 8.6.1.3 has been added as follows.

8.6.1.3 Strength Assessments of Transverse Bulkheads in Flooded Condition

Where strength assessments are performed in the flooded condition, girders attached to transverse bulkheads are to satisfy the criteria for yield strength assessment and buckling strength assessment. Platings of bulkheads, however, only need to satisfy the criteria for yield strength assessment.

Chapter 9 FATIGUE

9.3 Torsional Fatigue Strength Assessment

9.3.4 Boundary Conditions and Load Conditions

9.3.4.1 Boundary Conditions

1 Boundary conditions are to be set to appropriately reproduce the structural responses of the whole ship model in consideration of the extent of model and loads to be considered, etc.

2 Boundary conditions which do not generate torsional deformation are to be given when calculating stress due to horizontal bending moments.

3 The boundary conditions for torsional moment is to constrain the translational and rotational displacements of the positions where the reaction force in the port and starboard model is thought to be small.

4 The standard boundary conditions are in accordance with the following **(1)** to **(3)**:

(1) The boundary conditions for the standard torsional moment are as shown in **Fig. 9.3.4-1**.

(2) The boundary conditions for the standard vertical bending moment are as shown in **Fig. 9.3.4-2**.

(3) The boundary conditions for the standard horizontal bending moment are as shown in **Fig. 9.3.4-3**.

Fig. 9.3.4-2 has been amended as follows.

Fig. 9.3.4-2 Boundary Conditions of Vertical Bending Moments and Load Conditions

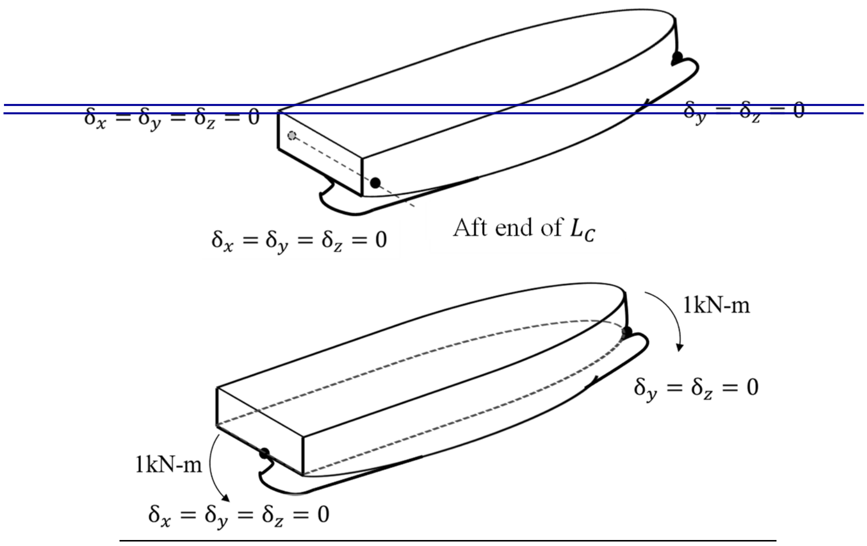
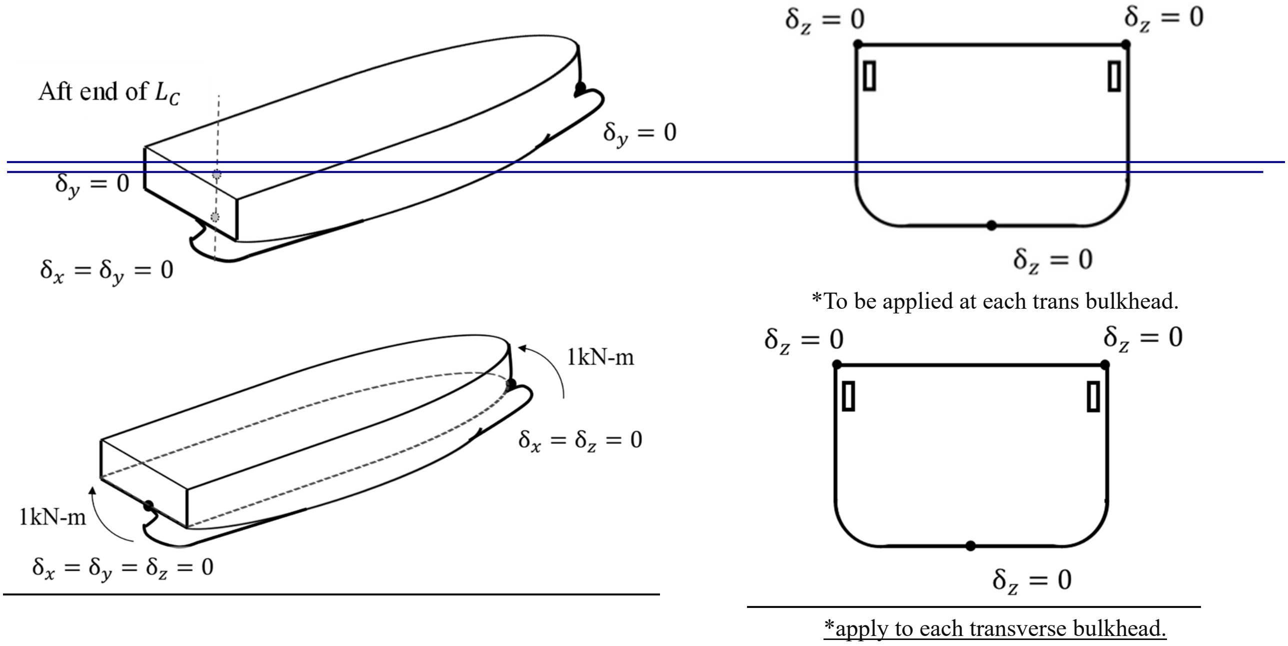


Fig. 9.3.4-3 has been amended as follows.

Fig. 9.3.4-3 Boundary Conditions of Horizontal Bending Moments and Load Conditions



9.3.4.2 Load Conditions

Sub-paragraph -4 has been added as follows.

1 The loads to be used in the torsional fatigue strength assessments are to be in accordance with **4.6.3**.

2 Stresses due to vertical bending moment, horizontal bending moment and torsional moment are calculated based on structural analysis using the whole ship model.

3 Torsional moments are to be applied to structural models in accordance with the following **(1)** to **(3)**:

(1) Torsional moments acting on hull girders are to be applied to structural model as a series of bulkhead torsional moments resulting in a stepped curve. An approximated torsional step moment curve is shown in **Fig. 9.3.4-4**.

(2) Torsional moments applied to bulkheads are the net change in torsional moment over the effective range of the bulkhead. The effective range of a bulkhead is the distance between the midpoints of the two adjacent bulkheads. The torsional moments at bulkhead i(*kN-m*) are specified as the following formulae: (*See* **Fig. 9.3.4-5**)

$$\delta M_{WT1i} = M_{WT1}|_{\frac{1}{2}(X_i+X_{i+1})} - M_{WT1}|_{\frac{1}{2}(X_{i-1}+X_i)}$$

$$\delta M_{WT2i} = M_{WT2}|_{\frac{1}{2}(X_i+X_{i+1})} - M_{WT2}|_{\frac{1}{2}(X_{i-1}+X_i)}$$

X_i: X-coordinate of bulkhead i

(3) The torsional moment at each bulkhead is to be reproduced by two equivalent shear forces on each side. An example of a method for applying shear force is shown in **Fig. 9.3.4-6**.

4 When analysing the vertical and horizontal bending moments applied, a method applying unit moments is to be used as the standard. Stresses corresponding to the moments prescribed in **4.6.3.2** are to be calculated based on the stresses obtained through structural analysis with unit moments applied. (*See* **Fig.9.3.4-2** and **Fig.9.3.4-3**)

Part 2-2 BOX-SHAPED BULK CARRIERS

Chapter 7 PRIMARY SUPPORTING STRUCTURE STRENGTH

7.1 General

7.1.1 Application

Paragraph 7.1.1.1 has been amended as follows.

7.1.1.1

1 The requirements of this Chapter apply to ships of less than 150 m in ship length L_C.

2 Notwithstanding **-1** above, strength assessments for deck girders with respect to deck loads and green sea loads are to be carried out in accordance with this Chapter.

~~2~~3 For the double bottom and double-side skin construction, the requirements of the double hull structure specified in **7.3, Part 1** are to be applied. For other girder members that can be regarded as simple girders, the requirement of the simple girder specified in **7.2, Part 1** are to be applied.

Chapter 8 STRENGTH ASSESSMENT BY CARGO HOLD ANALYSIS

8.5 Strength Assessment

8.5.1 Yield Strength Assessment and Buckling Strength Assessment

Paragraph 8.5.1.3 has been added as follows.

8.5.1.3 Strength Assessments of Plane-type Transverse Bulkheads

1 Where strength assessments are performed in the maximum load condition, **8.6.2.1-2, Part 1** may be applied instead of the assessment under compressive loads in shorter side direction specified in **8.6.2.1-1, Part 1**, for plate panels of plane-type transverse bulkheads of vertically stiffened system (*See* **Table 8.5.1-1**).

2 In the application of **-1** above, the yield strength assessments specified in **8.6.1, Part 1** need not be carried out for the said plane-type transverse bulkheads.

3 In the application of **-1** above, where the yield strength assessments and buckling strength assessments specified in **An2.7, Annex 8.6A, Part 1 "Strength Assessment Considering Effect of Surrounding Structures**" are carried out, such yield strength and buckling strength assessments need not be required for the following **(1)** to **(3)**.

(1) Plate panels within the rigidity reduction range

(2) Buckling panels which include elements sharing nodes included in the elements of **(1)** above

(3) Elements which include **(1)** and **(2)** above

Table 8.5.1-1 has been amended as follows.

Table 8.5.1-1 Relationship between the application of Part 1 and Part 2

<table>
<tr><th rowspan="2">~~Member to be assessed~~</th><th colspan="2">~~Maximum load condition~~</th></tr>
<tr><th>~~Equivalent design wave *HM* and *FM*~~</th><th>~~Equivalent design wave *BR* and *BP*~~</th></tr>
<tr><td>~~Side shell~~
~~(**Annex 8.6A, Part 1** is applied for equivalent design wave *BR* and *BP*)~~</td><td rowspan="2">~~・Yield strength assessment:~~
~~As specified in **8.6.1, Part 1**~~
~~・Buckling strength assessment:~~
~~As specified in **8.6.2.1-1, Part 1**~~</td><td>~~・**An2.2 to An2.6 of Annex 8.6A, Part 1** are applied.~~
~~・Permissible utilization factor (buckling): 0.8~~
~~・Yield strength assessment: *NA*~~</td></tr>
<tr><td>~~Members other than side shell~~
~~(**Annex 8.6A, Part 1** is applied for equivalent design wave *BR* and *BP*)~~</td><td>~~・**An2.7 of Annex 8.6A, Part 1** is applied.~~
~~・Yield strength assessment:~~
~~As specified in **8.6.1, Part 1**.~~
~~・Buckling strength assessment:~~
~~As specified in **8.6.2.1-1, Part 1**.~~</td></tr>
<tr><td>~~Cross deck~~</td><td>~~・Yield strength assessment:~~
~~As specified in **8.6.1, Part 1**.~~
~~・Buckling strength assessment:~~
~~As specified in **8.5.1.2**.~~</td><td>~~・Yield strength assessment:~~
~~As specified in **8.6.1, Part 1**.~~
~~・Buckling strength assessment:~~
~~As specified in **8.6.2.1-1, Part 1**.~~</td></tr>
</table>

<table>
<tr><th rowspan="2">Paragraph 2</th><th rowspan="2">Member to be assessed</th><th colspan="2">Maximum load condition</th></tr>
<tr><th>Equivalent design waves *HM* and *FM*</th><th>Equivalent design waves *BR* and *BP*</th></tr>
<tr><td rowspan="2">**8.5.1.1**</td><td>Side shells within rigidity reduction ranges</td><td rowspan="2">・Yield strength assessment:
As specified in **8.6.1, Part 1**
・Buckling strength assessment:
As specified in **8.6.2.1-1, Part 1**</td><td>・**An2.2 to An2.6, Annex 8.6A, Part 1** apply
・Permissible utilisation factor (buckling): 0.8
・Yield strength assessment: *NA*</td></tr>
<tr><td>Other members[1]</td><td>・**An2.7, Annex 8.6A, Part 1** applies
・Yield strength assessment:
As specified in **8.6.1, Part 1**.
・Buckling strength assessment:
As specified in **8.6.2.1-1, Part 1**</td></tr>
<tr><td>**8.5.1.2**</td><td>Cross decks</td><td>・Yield strength assessment:
As specified in **8.6.1, Part 1**
・Buckling strength assessment:
As specified in **8.5.1.2**</td><td>・Yield strength assessment:
As specified in **8.6.1, Part 1**
・Buckling strength assessment:
As specified in **8.6.2.1-1, Part 1**</td></tr>
<tr><td rowspan="2">**8.5.1.3**</td><td>Plane-type transverse bulkheads within rigidity reduction ranges</td><td colspan="2">・**An2.2 to An2.6, Annex 8.6A, Part 1** apply
・Permissible utilisation factor (buckling): 0.8
・Yield strength assessment: *NA*</td></tr>
<tr><td>Other members[1]</td><td colspan="2">・**An2.7, Annex 8.6A, Part 1** applies
・Yield strength assessment: As specified in **8.6.1, Part 1**
・Buckling strength assessment: As specified in **8.6.2.1-1, Part 1**</td></tr>
<tr><td colspan="4">(1) Where **8.5.1.1** and **8.5.1.3** are applied simultaneously for the equivalent design waves *BR* and *BP*, members within rigidity reduction ranges are excluded.</td></tr>
</table>

Annex 1.1 ADDITIONAL REQUIREMENTS FOR BULK CARRIERS IN CHAPTER XII OF THE SOLAS CONVENTION

An3 Transverse Watertight Bulkheads in Cargo Holds

An3.2 Load Conditions

An3.2.1

Table An6 has been amended as follows.

Table An6 Pressure P_{bs} and Force F_{bs} Acting on ~~the~~ Corrugated Bulkheads Due to~~by~~ Bulk Cargo

The pressure P_{bs} (kN/m^2) at each point of the bulkhead	$P_{bs} = \rho_c g K_{c-f}(z_C - z)$
The force F_{bs} (kN) acting on the corrugated bulkhead	$F_{bs} = \rho_c g S_1 \frac{(z_C - h_{DB} - h_{LS})^2}{2} K_{c-f}$
Notes: ρ_c: Bulk cargo density (t/m^3) K_{c-f}: Coefficient, as given by the following formula: $\cancel{K_{c-f} = \tan^2\left(45 - \frac{\psi}{2}\right)}$ $K_{c-f} = \tan^2\left(45° - \frac{\psi}{2}\right)$ ψ:As specified in **Table An2**. z_C: Distance (m) from the baseline to the horizontal plane corresponding to the top of the cargo when levelled out ~~(m)~~ (*See* **Fig. An1**) h_{DB}: Height (m) of the double bottom S_1: Spacing (m) of corrugation h_{LS}: Height (m) of the lower stool from the inner bottom plating	

An4 Allowable Hold Loading on Double Bottom

An4.3 Strength Criteria

Paragraph An4.3.1 has been amended as follows.

An4.3.1

1 Shear capacity of double bottoms C_h and C_e are to comply with the following formulae:

$\cancel{C_h = Z \cdot A_{DB,h} \ (kN)}$ $C_h = P_{FD-db} \cdot A_{DB,h}(kN)$

$\cancel{C_e = Z \cdot A_{DB,e} \ (kN)}$ $C_e = P_{FD-db} \cdot A_{DB,e}(kN)$

The variables in the above formulae are to be in accordance with the following **-2** to **-4**.

2 (Omitted)

3 The load P_{FD-db} ~~(N/mm²)~~ (kN/m^2) acting on the double bottom ~~for~~in the flooded hold condition is to be obtained from **Table An11**. In ~~this~~such cases, the flooding head z_F (m) under consideration is to be the vertical distance from the baseline in the absence of trim or heel, according to **Table An12**.

Table An11 has been amended as follows.

Table An11 Load P_{FD-db} Acting on Double Bottoms ~~In~~When Flooding Occurs

Flooding case	Load P_{FD-db} ~~(N/mm^2)~~ (kN/m^2)
$z_F > z_C$	$P_{FD-db} = \rho g[(z_C - h_{DB})(perm - 1) - E + (z_F - h_{DB})] + \rho_c g(z_C - h_{DB})$
$z_F \le z_C$	$P_{FD-db} = \rho_c g(z_C - h_{DB}) - \rho g[E - (z_F - h_{DB})perm]$

Notes:

z_F: As specified in ~~**4.2.1.5-1.**~~**Table An12**

z_C, ~~z,~~ h_{DB}: As specified in **Table** ~~**4.2.1-3.**~~**An6**

ρ_c: ~~As specified in **Table 4.2.1-1.**~~Bulk cargo density (t/m^3). The density for steel is to be used for steel mill products(1).

$perm$: As specified in ~~**Table 4.2.1-3**~~**An1.2.1(7).** 0 for steel mill products.

V_C: Cargo volume (m^3) ~~in~~for each cargo hold as given by the following formula:

$$V_C = \frac{FW}{\rho_c}$$

F: Coefficient to be taken as 1.1. However, it is to be taken as 1.05 for steel mill products.

W: Cargo mass (t) loaded in each hold

E: Ship immersion (m) for flooded hold condition as given by the following formula~~;~~:

$E = z_F - 0.1D$

(1) The load in the cargo hold is determined by the sum of the weight of the steel products and the weight of the flooded load, which is obtained by determining the volume of steel products in the cargo hold using the actual density of the steel mill products being loaded, and it is to be assum~~ing~~ed that seawater enters the void spaces remaining in the cargo hold at a flooding rate of 0.95~~,~~ in cases where the flooding rate for the volume of steel products being considered is assumed to be 0.

Part 2-5 GENERAL CARGO SHIPS AND REFRIGERATED CARGO SHIPS

Chapter 4 LOADS

4.3 Loads to be Considered in Strength of Primary Supporting Structures

4.3.2 Maximum Load Condition

Table 4.3.2-2 has been amended as follows.

Table 4.3.2-2 External and Internal Pressure to be Considered

Structures to be assessed		P_{DB}(kN/m^2) (1) (2)	P_{DS}(kN/m^2) (1) (2)
Double bottom	$S1$	$P_{exs} + P_{exw}$	$P_{exs} + P_{exw}$
Double side	$S2$	$P_{exs} + P_{exw} - P_{in\_s2}$	$P_{exs} + P_{exw}$
	$S3$	$P_{exs} + P_{exw} - P_{in\_s3}$	$P_{exs} + P_{exw}$

Notes:

P_{exs}, P_{exw} : Hydrostatic and Hydrodynamic pressure (kN/m^2) act on bottom shell in case of P_{DB}. Those values act on side shell in case of P_{DS}. Each value is calculated in accordance with **4.6.2.4, Part 1**.

P_{in_s2}, P_{in_s3} : loads considering the effect of cargo (kN/m^2), as given by the formulae:

$$P_{in\_s2} = 0.5\rho g T_{SC}$$

$$P_{in\_s3} = \rho g T_{SC}$$

(1) Load calculation points ~~is~~are to be in accordance with **7.3.1.5, Part 1** for all loading conditions.

(2) When calculating loads, $T_{LC} = 0.7T_{SC}$ for $S1$ and $T_{LC} = T_{SC}$ for $S2$ and $S3$.

4.4 Loads to be Considered in Additional Structural Requirements

4.4.2 Maximum Load Condition

4.4.2.1 Steel Coils

1 (Omitted)

2 The total load F_{SC} (kN) of the steel coil acting on the hull is to be calculated by the following formula. However, it is to not be less than 0.

$$F_{SC} = F_{SCs} + F_{SCd}$$

F_{SCs}: Static load (kN), as specified in **Table 4.4.2-1**.

F_{SCd}: Dynamic load (kN), as specified in **Table 4.4.2-2**.

Table 4.4.2-1 Static Load of Steel Coil F_{SCs}

Members	n_2 and n_3	F_{SCs} (*kN*)
Inner bottom plating	$n_2 \leq 10$ and $n_3 \leq 5$	$C_{SC1} W_{SC} \frac{n_1 n_2}{n_3} g$
	$n_2 > 10$ or $n_3 > 5$	$C_{SC1} W_{SC} n_1 \frac{\ell}{\ell_{st}} g$
Hopper tank sloping	$n_2 \leq 10$ and $n_3 \leq 5$	$C_{SC2} W_{SC} \frac{n_2}{n_3} g \cdot \cos\alpha$
	$n_2 > 10$ or $n_3 > 5$	$C_{SC2} W_{SC} \frac{\ell}{\ell_{st}} g \cdot \cos\alpha$
Longitudinal bulkheads and side frames	*NA*	0

Notes:

n_1: Number of loading stages of steel coil

n_2: The load point per panel (the number of dunnages for a single panel), as specified in **4.4.2.2-3**.

n_3: Number of dunnage threads supporting one row of steel coils

W_{SC}: Mass of one steel coil (*t*)

C_{SC1}: Coefficient as follows:

$C_{SC1} = 1.4$ for ~~multi-tiered stacking secured by a single coil~~ single-tiered loading secured with one or more key coils

$C_{SC1} = 1.0$ for ~~single~~multi-tiered ~~stacking~~loading or single-tired loading without key coils

C_{SC2}: Coefficient, as follows:

$C_{SC2} = 3.2$ for single-tiered stacking or multi-tiered stacking in which the key coil is arranged in the second or third position from the bilge tank sloping or inner hull

$C_{SC2} = 2.0$ for all other cases

ℓ: Distance between floors (*m*) (*see* **Fig. 4.4.2-2**)

ℓ_{st}: Steel coil length (*m*) (*see* **Fig. 4.4.2-2**)

α: The angle between the inner bottom plating and the hopper tank sloping (*rad*)

Table 4.4.2-2 Dynamic Load F_{SCd}

Members	Load in waves F_{SCd} (kN)	
Inner bottoms	$\cancel{\frac{F_{SC\_s}}{g} C_{WDz} a_{Ze-SC}}$ $\frac{F_{SCs}}{g} C_{WDz} a_{Ze-SC}$	
Hopper tank sloping	$\cancel{\frac{F_{SC\_s}}{\cos\alpha} \cos(\lvert\theta-\alpha\rvert)}$ $\frac{F_{SCs}}{\cos\alpha} \cos(\lvert\theta-\alpha\rvert)$	
Longitudinal bulkheads	$n_2 \leq 10$ and $n_3 \leq 5$	$C_{SC3} W_{SC} \frac{n_1 n_2}{n_3} g \sin\theta$
	$n_2 > 10$ or $n_3 > 5$	$C_{SC3} W_{SC} n_1 \frac{\ell}{\ell_{st}} g \sin\theta$
Side frames	$C_{SC3} W_{SC} \frac{n_1}{n_4} g \sin\theta$	

Notes:

C_{WDz}: Coefficient of each load condition, specified in **Table 4.4.2-8, Part 1**

a_{Ze-SC} : Envelope acceleration in vertical direction (m/s^2) at the centre of gravity of steel coil in the cargo hold to be considered, as calculated in accordance with **4.2.4.1, Part1**(1)

α, n_1, n_2, n_3, W_{SC} : As specified in **Table 4.4.2-1**

θ: Roll angle (*rad*), as specified in **4.2.2, Part 1**(2).

C_{SC3}: Coefficient, as follows:

$C_{SC3} = 4.0$ for single-tiered stacking or multi-tiered stacking in which the key coil is arranged in the second or third position from the ship side

$C_{SC3} = 2.5$ for all other cases

n_4: The number of side frames that support a single steel coil.

(1) The centre of gravity of steel coil to be considered is in accordance with **Table 4.4.2-3**.

(2) The parameters (GM, z_G, etc.) required to calculate the ship motions and acceleration is in accordance with the values in the full load condition. The values in **Table 4.2.2-1** may be used if the parameters is not available.

Table 4.4.2-3 The Centre of Gravity of Steel Coil
(Omitted)

3 In applying **-2** above, the number of load points per panel by dunnage n_2 and the distance between the load points of dunnage at both ends of each panel ℓ_{lp} are to be in accordance with the following **(1)** to **(2)**.

(1) For steel coil arrangements that do not consider floor position, as specified in **Fig. 4.4.2-2** and **Table 4.4.2-4**.

(2) For steel coil arrangements that do consider floor position, as specified in the following **(a)** to **(b)**. (*See* **Fig. 4.4.2-3**)

   (a) The number of load points per panel by dunnage n_2 is to be $n_2 = n_3$.

   (b) The distance between the load points of the dunnage at both ends of each panel ℓ_{lp} is to be the distance between the dunnage at both ends supporting a row of steel coils.

Fig. 4.4.2-2 Loading of Steel Coils on the Inner Bottom without Taking into Consideration the Floor Position

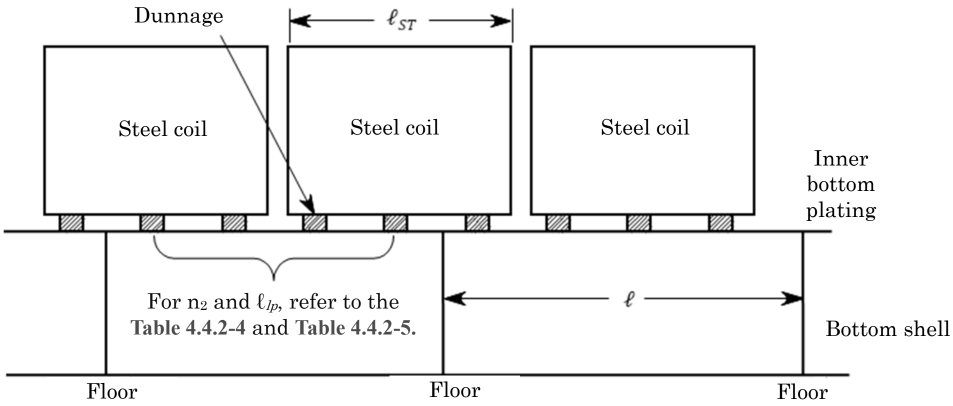


Fig. 4.4.2-3 Loading of Steel Coils on the Inner Bottom Taking into Consideration the Floor Position
(Omitted)

Table 4.4.2-4 Number of Load Points Per Panel According to Dunnage n_2
(Omitted)

Table 4.4.2-5 Distance Between Load Points of Dunnage on Both Ends of Each Panel ℓ_{lp} (m)

n_2	n_3			
	2	3	4	5
1	Actual width of dunnage			
2	$0.5\ell_{st}$	$0.33\ell_{st}$	$0.25\ell_{st}$	$0.2\ell_{st}$
3	$1.2\ell_{st}$	$0.67\ell_{st}$	$0.50\ell_{st}$	$0.4\ell_{st}$
4	$1.7\ell_{st}$	$1.20\ell_{st}$	$0.75\ell_{st}$	$\cancel{0.4\ell_{st}}$ $\underline{0.6\ell_{st}}$
5	$2.4\ell_{st}$	$1.53\ell_{st}$	$1.20\ell_{st}$	$0.8\ell_{st}$
6	$2.9\ell_{st}$	$1.87\ell_{st}$	$1.45\ell_{st}$	$1.2\ell_{st}$
7	$3.6\ell_{st}$	$2.40\ell_{st}$	$1.70\ell_{st}$	$1.4\ell_{st}$
8	$4.1\ell_{st}$	$2.73\ell_{st}$	$1.95\ell_{st}$	$1.6\ell_{st}$
9	$4.8\ell_{st}$	$3.07\ell_{st}$	$2.40\ell_{st}$	$1.8\ell_{st}$
10	$5.3\ell_{st}$	$3.60\ell_{st}$	$2.65\ell_{st}$	$2.0\ell_{st}$

4 (Omitted)

Chapter 10 ADDITIONAL STRUCTURAL REQUIREMENTS

10.1 Ships Carrying Steel Coils

10.1.2 Inner Bottom Plating and Longitudinals

Paragraph 10.1.2.1 has been amended as follows.

10.1.2.1 Inner Bottom Plating

The thickness of the inner bottom plating is not to be less than that obtained from the following formulae.

$$t = K_1 \sqrt{\frac{F_{SC}}{C_a \sigma_Y}} \times 10^3 (mm)$$

Where:

σ_Y: Specified minimum yield stress (N/mm^2)

F_{SC}: Load (kN) acting on the inner bottom according to **4.4.2.1-2**.

K_1: Coefficient.

$$K_1 = \sqrt{\frac{1.7 \frac{s}{1000} \ell K_2 - 0.73 \left(\frac{s}{1000}\right)^2 {K_2}^2 - \left(\ell - \ell_{lp}\right)^2}{2\ell_{lp}\left(2\frac{s}{1000} + 2\ell K_2\right)}}$$

K_2: Coefficient

$$K_2 = -\frac{s}{1000\ell} + \sqrt{\left(\frac{s}{1000\ell}\right)^2 + 1.37\left(\frac{1000\ell}{s}\right)^2 \left(1 - \frac{\ell_{lp}}{\ell}\right)^2 + 2.33}$$

C_a: Axial force effect coefficient according to **6.3.2.1, Part 1**.

s: Distance between stiffeners (mm)

ℓ: Distance between floors (m)

ℓ_{lp}: The distance between the load points of the dunnage at both ends of each panel (m) according to **4.4.2.1-3**

Paragraph 10.1.2.2 has been amended as follows.

10.1.2.2 Inner Bottom Longitudinals

The section moduli and the web thicknesses of inner bottom longitudinals are not to be less than that obtained from the following formulae.

$$Z = K_3 \frac{F_{SC}\ell_{bdg}}{8C_s\sigma_Y} \times 10^3 (cm^3),\ t_w = \frac{0.5F_{SC}}{d_{shr}\tau_Y} \times 10^3 (mm)$$

Where:

σ_Y: Specified minimum yield stress (N/mm^2)

τ_Y: Allowable shear stress (N/mm^2)

$\sigma_Y/\sqrt{3}$

F_{SC}: Load (kN) acting on a longitudinal frame with inner bottom according to **4.4.2.1-2**, ℓ is to be substituted by ℓ_{bdg}.

K_3: Coefficient according to **Table 10.1.2-1** $K_3 = 2\cancel{\ell_{bdg}}/3$ for $n_2 > 10$

n_2: Load point per panel (the number of dunnages on one panel) according to **4.4.2.1-3**

C_s: Coefficient related to the influence of axial force according to **Table 6.4.2.1, Part 1**

ℓ_{bdg}: Effective bending span (*m*) of stiffener according to **3.6.1.2, Part 1**
d_{shr}: Effective shear depth (*mm*) of stiffener according to **3.6.4.2, Part 1**
ℓ_{lp}: Distance (*m*) between the load points of the dunnage at both ends for each panel according to **4.4.2.1-3**

Table 10.1.2-1 Coefficient K_3

n_2	1	2	3	4	5
K_3	ℓ_{bdg}	$\ell_{bdg}-\frac{\ell_{lp}^2}{\ell_{bdg}}$	$\ell_{bdg}-\frac{2\ell_{lp}^2}{3\ell_{bdg}}$	$\ell_{bdg}-\frac{5\ell_{lp}^2}{9\ell_{bdg}}$	$\ell_{bdg}-\frac{\ell_{lp}^2}{2\ell_{bdg}}$
n_2	6	7	8	9	10
K_3	$\ell_{bdg}-\frac{7\ell_{lp}^2}{15\ell_{bdg}}$	$\ell_{bdg}-\frac{4\ell_{lp}^2}{9\ell_{bdg}}$	$\ell_{bdg}-\frac{3\ell_{lp}^2}{7\ell_{bdg}}$	$\ell_{bdg}-\frac{5\ell_{lp}^2}{12\ell_{bdg}}$	$\ell_{bdg}-\frac{11\ell_{lp}^2}{27\ell_{bdg}}$

$\underline{n_2}$	$\underline{1}$	$\underline{2}$	$\underline{3}$	$\underline{4}$	$\underline{5}$
$\underline{K_3}$	$\underline{1.0}$	$\underline{1.0-\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$	$\underline{1.0-\frac{2}{3}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$	$\underline{1.0-\frac{5}{9}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$	$\underline{1.0-\frac{1}{2}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$
$\underline{n_2}$	$\underline{6}$	$\underline{7}$	$\underline{8}$	$\underline{9}$	$\underline{10}$
$\underline{K_3}$	$\underline{1.0-\frac{7}{15}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$	$\underline{1.0-\frac{4}{9}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$	$\underline{1.0-\frac{3}{7}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$	$\underline{1.0-\frac{5}{12}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$	$\underline{1.0-\frac{11}{27}\left(\frac{\ell_{lp}}{\ell_{bdg}}\right)^2}$

Paragraph 10.1.2.3 has been amended as follows.

10.1.2.3 Inner Bottom Longitudinals with Struts

1 (Omitted)

2 The section modulus is not to be less than that obtained from the following formula. However, it is necessary to consider the conditions that correspond to either the following **(1)** or **(2)**. It is presumed that the load condition is a steel coil loaded directly above the longitudinal and that a concentrated load is acting at the position of the dunnage.

$$Z=\frac{M}{C_S\sigma_Y}\times 10^3\,(cm^3)$$

(1) Equidistant load points (*See* **Fig. 10.1.2-2**)

$$M_B=\frac{W}{2\cancel{\ell}\underline{\ell_{fs}}^2}\left[\sum_{k=1}^{n}\{a_1+(k-1)\ell_1\}\cancel{\ell}\underline{\ell_{fs}}^2\cancel{+}\underline{-}\sum_{k=1}^{n}\{a_1+(k-1)\ell_1\}^3\right]$$

$$M_{Cm}=\frac{W\{a_1+(m-1)\ell_1\}}{2\cancel{\ell}\underline{\ell_{fs}}^{\cancel{2}\underline{3}}}\left[\sum_{k=1}^{n}\{a_1+(k-1)\ell_1\}^3-3\cancel{\ell}\underline{\ell_{fs}}^2\sum_{k=1}^{n}\left\{a_1+(k-1)\ell_1-\frac{2}{3}\cancel{\ell}\underline{\ell_{fs}}\right\}\right]-\sum_{k=1}^{m}W(m-k)\ell_1$$

(2) Non-equidistant load points (*See* **Fig. 10.1.2-3**)

$$M_B=\sum_{k=1}^{n}\frac{Wa_k\left(\cancel{\ell}\underline{\ell_{fs}}^2\cancel{+}\underline{-}a_k^2\right)}{2\cancel{\ell}\underline{\ell_{fs}}^2}$$

$$M_{Cm}=\sum_{k=1}^{n}\frac{W\left(\cancel{\ell}\underline{\ell_{fs}}-a_k\right)^2\left(2\cancel{\ell}\underline{\ell_{fs}}+a_k\right)}{2\cancel{\ell}\underline{\ell_{fs}}^3}a_m-\sum_{k=1}^{m}W(a_m-a_k)$$

Where:

M: Bending moment (*kN-m*) and is to be the larger of M_B and M_C

n: Maximum total number of load points between girders and struts

M_B: Bending moment at fixed end (*kN-m*)

M_{Cm}: Bending moment at the m-th load point from the strut support point (*kN-m*)

M_C: Bending moment (*kN-m*) at the load point is to be the largest of the following values M_{C1}, M_{C2}, M_{C3}, and M_{Cn}

a_m: Distance from strut support point to the m-th load point (*m*)

a_1: The distance (*m*) from the strut support point to the first load point, and the value when the dunnage is arranged so that the values from M_{C1} to M_{Cm} and M_B are maximum values

ℓ_1: Distance between load points (*m*)

$\underline{\ell_{fs}}$: Distance between girders and struts (*m*)

W: The load of the steel coil that each dunnage is responsible for (*kN*)

$$W = \frac{F_{SC}}{\cancel{n_3}\underline{n_2}}$$

$F_{\cancel{cs}\underline{SC}}$: Total load by steel coil acting on the plate panel (*kN*) (*See* **4.4.2.1-2**), ℓ is to be substituted by ℓ_{bdg}.

~~n_3: Number of dunnage threads supporting one row of steel coils (*see* **4.4.2.1-2**)~~

n_2: The load point per panel (the number of dunnages for a single panel), as specified in **4.4.2.1-3.**

3 The web thickness is not to be less than that obtained from the following formulae. However, it is necessary to consider under the conditions that correspond to either the following **(1)** or **(2)**. It is presumed that the load condition is a steel coil loaded directly above the longitudinal and that a concentrated load is acting at the dunnage position.

$$t_w = \frac{F}{d_{shr}\tau_Y} \times 10^3 \ (mm)$$

(1) Equidistant load points (*See* **Fig. 10.1.2-2**)

$$R_A = \frac{W}{2\cancel{\ell}\underline{\ell_{fs}}^3}\left[\sum_{k=1}^{n}\{a_1 + (k-1)\ell_1\}^3 - 3\cancel{\ell}\underline{\ell_{fs}}^2 \sum_{k=1}^{n}\left\{a_1 + (k-1)\ell_1 - \frac{2}{3}\cancel{\ell}\underline{\ell_{fs}}\right\}\right]$$

$$R_B = \frac{W}{2\cancel{\ell}\underline{\ell_{fs}}^3}\left[3\cancel{\ell}\underline{\ell_{fs}}^2 \sum_{k=1}^{n}\{a_1 + (k-1)\ell_1\} - \sum_{k=1}^{n}\{a_1 + (k-1)\ell_1\}^3\right]$$

(2) Load point position user determined (*See* **Fig. 10.1.2-3**)

$$R_A = \sum_{k=1}^{n}\frac{W\left(\cancel{\ell}\underline{\ell_{fs}} - a_k\right)^2\left(2\cancel{\ell}\underline{\ell_{fs}} + a_k\right)}{2\cancel{\ell}\underline{\ell_{fs}}^3}$$

$$R_B = \sum_{k=1}^{n}\frac{W a_k\left(3\cancel{\ell}\underline{\ell_{fs}}^2 + a_k^2\right)}{2\cancel{\ell}\underline{\ell_{fs}}^3}$$

Where:

F: Shear force (*kN*) and is to be the larger of R_A and R_B

R_A: Reaction force with simple support (*kN*)

R_B: Reaction force at fixed end (*kN*)

a_1: Distance (*m*) from the strut support point to the first load point, and the value when the dunnage is arranged so that the respective values of R_A and R_B are maximum values

Fig. 10.1.2-1 Inner Bottom Longitudinal with Struts

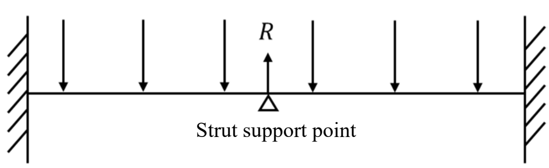


Fig. 10.1.2-2 Load Conditions Between Girders and Struts (Equidistant Load Points)

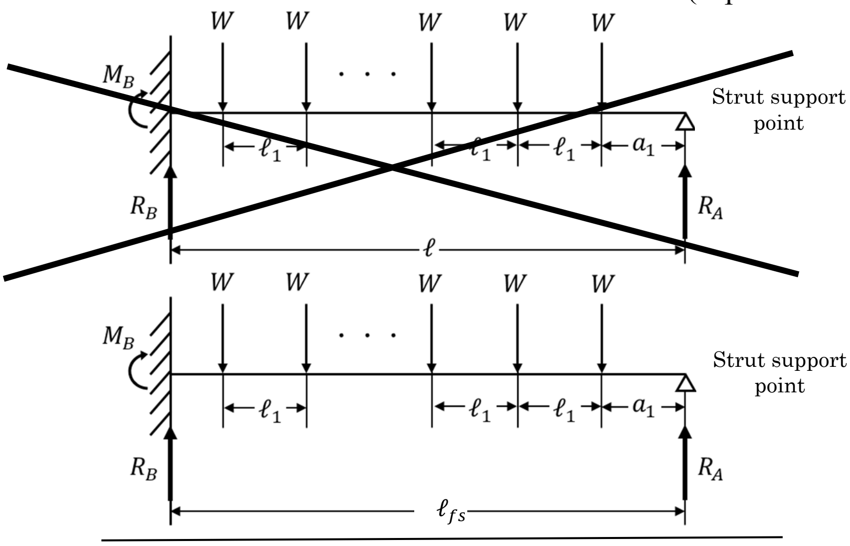
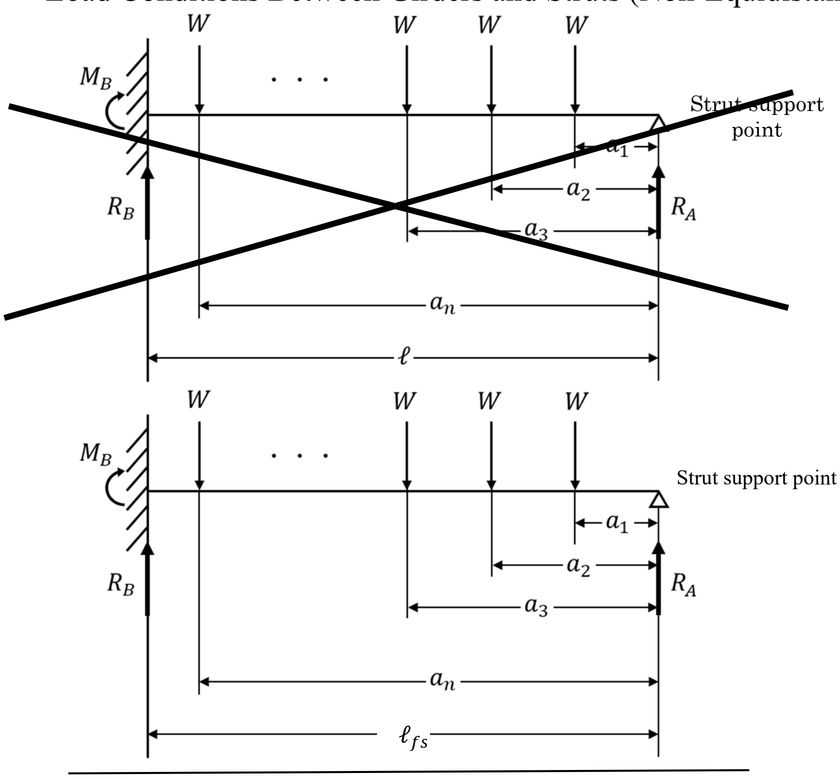


Fig. 10.1.2-3 Load Conditions Between Girders and Struts (Non-Equidistant Load Points)



10.1.3 Hopper Slant Plates and Longitudinal Frames with Hopper Slant Plates (Ships with Bilge Hoppers)

Paragraph 10.1.3.2 has been amended as follows.

10.1.3.2 Longitudinal Frames with Hopper Slant Plates

The section moduli and web thicknesses of longitudinal frames with hopper slant plates are to be greater than or equal to the following values.

$$Z = K_3 \frac{F_{SC}\ell_{bdg}}{8C_s\sigma_Y} \times 10^3 (cm^3),\ t_w = \frac{0.5F_{SC}}{d_{shr}\tau_Y} \times 10^3 (mm)$$

Where:

σ_Y: Specified minimum yield stress (N/mm^2)

τ_Y: Allowable shear stress (N/mm^2)

$\sigma_Y/\sqrt{3}$

F_{SC}: Load (kN) acting on the longitudinal frame with hopper slant plate according to **4.4.2.1-2**, ℓ is to be substituted by ℓ_{bdg}.

K_3: Coefficient according to **10.1.2.2**

C_s: Coefficient related to the influence of axial force according to **6.4.2.1, Part 1**

d_{shr}: Effective shear depth (mm) of stiffener according to **3.6.4.2, Part 1**

10.1.4 Longitudinal Bulkheads and Longitudinal Frames with Longitudinal Bulkheads (Ships without Bilge Hopper and Ships with Double Side Shells)

Paragraph 10.1.4.2 has been amended as follows.

10.1.4.2 Longitudinal Frames with Longitudinal Bulkheads

The section moduli and web thicknesses of longitudinal frames with longitudinal bulkheads are to be greater than or equal to the following values.

$$Z = K_3 \frac{F_{SC}\ell_{bdg}}{8C_s\sigma_Y} \times 10^3 (cm^3),\ t_w = \frac{0.5F_{SC}}{d_{shr}\tau_Y} \times 10^3 (mm)$$

Where:

σ_Y: Specified minimum yield stress (N/mm^2)

τ_Y: Allowable shear stress (N/mm^2)

$\sigma_Y/\sqrt{3}$

F_{SC}: Load (kN) acting on the longitudinal frame with longitudinal bulkhead according to **4.4.2.1-2**, ℓ is to be substituted by ℓ_{bdg}.

K_3: Coefficient according to **10.1.2.2**

C_s: Coefficient related to the influence of axial force according to **6.4.2.1, Part 1**

d_{shr}: Effective shear depth (mm) of stiffener, according to **3.6.4.2, Part 1**

10.1.5 Side Frames (Ships Without Bilge Hoppers and Single-Side Ships)

Paragraph 10.1.5.1 has been amended as follows.

10.1.5.1 Side Frames

The section moduli and web thicknesses of side frames are to be greater than or equal to the following values.

$$Z = 1.2 \frac{F_{SC}\ell_{1bdg}}{8\sigma_Y} \times 10^3 (cm^3),\quad t_w = 2.0 \frac{0.5F_{SC}}{d_{shr}\tau_Y} \times 10^3 (mm)$$

σ_Y: Specified minimum yield stress (*N/mm*^{2})

τ_Y: Allowable shear stress (*N/mm*^{2})

$\sigma_Y/\sqrt{3}$

F_{SC}: Load (*kN*) acting on the ~~longitudinal frame with longitudinal bulkhead~~ side frame according to **4.4.2.1-2**

ℓ_{1bdg}: Effective bending span (*m*) of the side frame. Where a bracket is provided, the end of the effective bending span is to be taken to the position where the depth of the side frame and the bracket is equal to $2h_w$ (*See* **Fig. 6.4.3-2, Part 1**).

d_{shr}: Effective shear depth (*mm*) of stiffener according to **3.6.4.2, Part 1**

Part 2-6 VEHICLES CARRIERS AND ROLL-ON/ROLL-OFF SHIPS

Chapter 4 LOADS

4.3 Loads to be Considered in Strength of Primary Supporting Structures

4.3.2 Maximum Load Condition

Table 4.3.2-2 has been amended as follows.

Table 4.3.2-2 External and Internal Pressure to be Considered

Structures to be assessed		P_{DB}(kN/m^2)[(1)(2)]	P_{DS}(kN/m^2)[(1)(2)]
Double bottom	$S1$	$P_{exs} + P_{exw}$	$P_{exs} + P_{exw}$
Double side	$S2$	$P_{exs} + P_{exw} - P_{in\_s2}$	$P_{exs} + P_{exw}$
	$S3$	$P_{exs} + P_{exw} - P_{in\_s3}$	$P_{exs} + P_{exw}$

Notes:

P_{exs}, P_{exw} : Hydrostatic and Hydrodynamic pressure (kN/m^2) act on bottom shell in case of P_{DB}. Those values act on side shell in case of P_{DS}. Each value is calculated in accordance with **4.6.2.4, Part 1**.

P_{in_s2}, P_{in_s3} : The values considering the effect due to cargo (kN/m^2), as given by the following formulae:

$$P_{in\_s2} = 0.5\rho g T_{SC}$$
$$P_{in\_s3} = \rho g T_{SC}$$

(1) Load calculation points ~~is~~are to be in accordance with **7.3.1.5, Part 1** for all loading conditions.

(2) When calculating loads, $T_{LC} = 0.7T_{SC}$ for $S1$ and $T_{LC} = T_{SC}$ for $S2$ and $S3$.

Chapter 8 STRENGTH ASSESSMENT BY CARGO HOLD ANALYSIS

8.5 Racking Strength Assessment

8.5.3 Yield Strength Assessment

Paragraph 8.5.3.2 has been amended as follows.

8.5.3.2 Strength Criteria

1 Members to be assessed within the evaluation are to satisfy the following formula:

$\lambda_y \leq \lambda_{yperm}$

λ_y: Yield utilisation factor, as given by the following formulae:

For shell elements, $\lambda_y = \frac{\sigma_{eq}}{188/K}$

For rod elements, $\lambda_y = \frac{|\sigma_a|}{188/K}$

λ_{yperm}: Permissible utilisation factor, be taken as 1.0

2 Notwithstanding **-1** above, yield strength assessments of intersections of pillars and deck transverses are considered to be satisfied for the structural types specified in **8.5.1.2-1(2)** or similar structural types when the following formula is satisfied:

$t_{is-gr}\sigma_{Y-is} \geq 1.7 \cdot t_{dt-gr}\sigma_{Y-dt}$

t_{is-gr}: Thickness (*mm*) (gross scantling) of intersections of pillars and deck transverses.

σ_{Y_is}: Specified minimum yield stress (*N/mm*^{2}) of intersections of pillars and deck transverses.

t_{dt-gr}: Smallest thickness (*mm*) (gross scantling) of the web of the deck transverses at the same height of the intersection.

σ_{Y_dt}: Smallest specified minimum yield stress (*N/mm*^{2}) of the web of the deck transverses at the same height of the intersection.

~~2~~3 Where members do not satisfy the criteria specified in **-1** and **-2** above, a detailed fatigue strength assessment are to be performed for the members and so as to ensure a sufficient fatigue lifetime.

Chapter 9 FATIGUE

Section 9.5 has been added as follows.

9.5 Screening Assessment

9.5.1 General

9.5.1.1 General

1 This **9.5** specifies a method for assessing the fatigue strength of structural details including those specified in **9.2** using coarse mesh models instead of the very fine mesh models specified in **9.4, Part 1**.

2 When the fatigue damage calculated based upon the method specified in this **9.5** does not satisfy the criteria, fatigue strength assessment using a very fine mesh model is to be carried out.

3 The hot spot to be assessed, stress concentration factor derivation method, etc. is to be submitted beforehand to the Society for approval, when the fatigue strength is assessed according to the method specified in this **9.5**.

9.5.1.2 Application

The method specified in this **9.5** is applied to general structural details to be assessed, as specified in **Table 9.2.1-1** and **Table 9.2.1-2**.

9.5.1.3 Confirmation of Calculation Method and Accuracy of Analysis

1 The analysis method and analysis program are to have the following functions.

(1) The effects of bending, shear, axial, and torsional deformation are to be effectively taken into consideration.

(2) The behaviour of the 3-D structural model is to be represented effectively under reasonable boundary conditions.

(3) The method and program are to be confirmed to have sufficient analytical accuracy.

2 The analysis method is to be approved in advance by the Society. The submission of details regarding the analysis method and verification of accuracy may be required when deemed necessary by the Society.

9.5.2 Finite Element Modelling

9.5.2.1 General

Coarse mesh models used in screening assessments are to be in accordance with **8.2**.

9.5.2.2 Corrosion Models

Coarse mesh models used for screening assessments are to be made using t_{n25} (mm). The corrosion addition to be considered is to be in accordance with the requirement in **3.3.4, Part 1**.

9.5.3 Loading Conditions and Fractions of Time to be Considered

9.5.3.1 General

Loading conditions and fractions of time are to be in accordance with **9.3.1**.

9.5.4 Boundary Conditions and Load Conditions

9.5.4.1 General

Boundary conditions and load conditions to be considered are to be in accordance with **9.4**.

9.5.5 Hot Spot Stress

9.5.5.1 General

1 Hot spot stress may be obtained by using the stress acting on element midpoints of shell elements irrespective of the hot spot type used in the screening assessment.

2 The hot spot stress range and mean stress are to be obtained from the following formulae when conditions "$i1$" and "$i2$" for the same equivalent design wave for the same loading condition (j) are considered. The orthogonal direction to the weld line is represented by the x-direction and the parallel direction is represented by the y-direction.

$$\Delta\sigma_{HS\_ort,i(j)} = K_{SCF} \cdot \Delta\sigma_{adj\_x,i(j)}$$

$$\Delta\sigma_{HS\_par,i(j)} = K_{SCF} \cdot \Delta\sigma_{adj\_y,i(j)}$$

K_{SCF}: Stress concentration factor as given in **-3** below.

$\Delta\sigma_{adj\_x,i(j)}$: Stress range ($N/mm^2$) in the x-direction in the x-y coordinate system of the equivalent design wave "i" for loading condition (j) according to the following formula:

$$\Delta\sigma_{adj\_x,i(j)} = \left|\sigma_{adj\_x,i1(j)} - \sigma_{adj\_x,i2(j)}\right|$$

$\sigma_{adj\_x,i1(j)}$: Surface stress (N/mm^2) in the x-direction in the x-y coordinate system of the equivalent design wave "$i1$" for loading condition "j" on element midpoint of element in way of hot spot

$\sigma_{adj\_x,i2(j)}$: Surface stress (N/mm^2) in the x-direction in the x-y coordinate system of the equivalent design wave "$i2$" for loading condition "j" on element midpoint of element in way of hot spot

$\Delta\sigma_{adj\_y,i(j)}$: Stress range ($N/mm^2$) in the y-direction in the x-y coordinate system of the equivalent design wave "i" for loading condition "j" according to the following formula:

$$\Delta\sigma_{adj\_y,i(j)} = \left|\sigma_{adj\_y,i1(j)} - \sigma_{adj\_y,i2(j)}\right|$$

$\sigma_{adj\_y,i1(j)}$: Surface stress (N/mm^2) in the y-direction in the x-y coordinate system of the equivalent design wave "$i1$" for loading condition "j" on element midpoint of element in way of hot spot

$\sigma_{adj\_y,i2(j)}$: Surface stress (N/mm^2) in the y-direction in the x-y coordinate system of the equivalent design wave "$i2$" for loading condition "j" on element midpoint of element in way of hot spot

$$\sigma_{mean\_ort,i(j)} = K_{SCF} \cdot \frac{\sigma_{adj\_x,i1(j)} + \sigma_{adj\_x,i2(j)}}{2}$$

$$\sigma_{mean\_par,i(j)} = K_{SCF} \cdot \frac{\sigma_{adj\_y,i1(j)} + \sigma_{adj\_y,i2(j)}}{2}$$

3 K_{SCF} for a representative hot spot of a representative transverse section is to be obtained by the following. The application method of an obtained K_{SCF} to other transverse sections is to be approved in advance by the Society.

(1) Hot spot stress range for a representative hot spot of a representative transverse section is to be obtained by fatigue strength assessment using a very fine mesh model.

(2) Nominal stress range is to be obtained in the same location as assessed in **(1)** above by finite element analysis using a coarse mesh model

(3) K_{SCF} is to be obtained as the ratio of stress range obtained by **(1)** and **(2)** above.

9.5.6 Fatigue Strength Assessment

9.5.6.1 General

1 This **9.5.6** specifies requirements for the fatigue strength assessment method using the hot spot stresses obtained in **9.5.5**.

2 The fatigue strength assessment in this **9.5** is based on Miner's linear cumulative damage rule.

3 Total cumulative fatigue damage is to be calculated for all loading conditions by using each fatigue damage in the in-air environment where the coating is effective and in the corrosive environment where the coating is not effective, considering the ratio of period of each environment.

9.5.6.2 Reference Stress for Fatigue Strength Assessment

Hot spot stress range used in screening assessments is to be in accordance with the following:

$$\Delta\sigma_{FS,(j)} = \max_i\left(\Delta\sigma_{FS,i(j)}\right)$$

where

$$\Delta\sigma_{FS,i(j)} = \max\left(\Delta\sigma_{FS\_ort,i(j)}, \Delta\sigma_{FS\_par,i(j)}\right)$$

$\Delta\sigma_{FS\_ort,i(j)}$: Hot spot stress range (*N/mm*^{2}) for screening assessment according to the hot spot stress in the direction orthogonal to the weld line, as obtained from the following formula:

$$\Delta\sigma_{FS\_ort,i(j)} = f_{mean\_ort,i(j)} \cdot \Delta\sigma_{HS\_ort,i(j)}$$

$\Delta\sigma_{FS\_par,i(j)}$: Hot spot stress range (*N/mm*^{2}) for screening assessment according to the hot spot stress in the direction parallel to the weld line, as obtained from the following formula:

$$\Delta\sigma_{FS\_par,i(j)} = 0.72 \cdot f_{mean\_par,i(j)} \cdot \Delta\sigma_{HS\_par,i(j)}$$

$f_{mean\_ort,i(j)}$, $f_{mean\_par,i(j)}$: Correction factor for mean stress effect, as obtained by the following formulas for each combination of $\Delta\sigma_{HS\_ort,i(j)}$, $\sigma_{mean\_ort,i(j)}$ and $\Delta\sigma_{HS\_par,i(j)}$, $\sigma_{mean\_par,i(j)}$ respectively.

$$\begin{cases} f_{mean,i(j)} = \min\left[1.0, 0.8 + 0.2\dfrac{\sigma_{mCor,i(j)}}{2\Delta\sigma_{HS,i(j)}}\right] & : \sigma_{mCor,i(j)} \geq 0 \\ f_{mean,i(j)} = \max\left[0.6, 0.8 + 0.2\dfrac{\sigma_{mCor,i(j)}}{2\Delta\sigma_{HS,i(j)}}\right] & : \sigma_{mCor,i(j)} < 0 \end{cases}$$

Where, $\sigma_{mCor,i(j)}$ is to be obtained as follows:

$$\begin{cases} \sigma_{mCor,i(j)} = \sigma_{mean,i(j)} & : \sigma_{max} \leq \sigma_{YEq} \\ \sigma_{mCor,i(j)} = \sigma_{YEq} - \sigma_{max} + \sigma_{mean,i(j)} & : \sigma_{max} > \sigma_{YEq} \end{cases}$$

$$\sigma_{max} = \max_{i(j)}\left(\Delta\sigma_{HS,i(j)} + \sigma_{mean,i(j)}\right)$$

$$\sigma_{YEq} = \max(315, \sigma_Y)$$

$\Delta\sigma_{HS\_ort,i(j)}$, $\Delta\sigma_{HS\_par,i(j)}$: As given in **9.5.5.1-2**.

$\sigma_{mean\_ort,i(j)}$, $\sigma_{mean\_par,i(j)}$: As given in **9.5.5.1-2**.

9.5.6.3 Fatigue Damage Calculation and Fatigue Strength Assessment Criterion

1 The cumulative fatigue damage D is to be obtained from the following formula:

$$D = \sum_j \alpha_{(j)} \cdot D_{(j)}$$

$\alpha_{(j)}$: Fraction of time of loading condition (j) in the fatigue design life, as given in **Table 9.3.1-1**.

$D_{(j)}$: Cumulative fatigue damage for the fatigue design life for loading condition (j)

calculated by the following formula:

$$D_{(j)} = \frac{T_{DF} - T_C}{T_{DF}} D_{air,(j)} \cdot + \frac{T_C}{T_{DF}} D_{cor,(j)}$$

$D_{air,(j)}$, $D_{cor,(j)}$: Cumulative fatigue damage in the in-air environment and corrosive environment for the fatigue design life for loading condition (j).

$$D_{air,(j)} = \frac{N_{DF}}{K_{2,air}} \frac{\Delta\sigma_{FS,(j)}^m}{(\ln N_R)^{m/\xi}} \cdot \mu_{(j)} \cdot \Gamma\left(1 + \frac{m}{\xi}\right)$$

$$D_{cor,(j)} = \frac{N_{DF}}{K_{2,cor}} \frac{\Delta\sigma_{FS,(j)}^m}{(\ln N_R)^{m/\xi}} \cdot \Gamma\left(1 + \frac{m}{\xi}\right)$$

N_{DF}: Total number of cycles in the fatigue design life T_{DF} .

$$N_{DF} = \frac{60 \times 60 \times 24 \times 365.25}{4\log L_c} \cdot f_D \cdot T_{DF}$$

f_D: Ship's operation rate, taken as 0.85

$\Delta\sigma_{FS,(j)}$: Fatigue stress range (N/mm^2) at the reference probability level of exceedance of 10^{-2}

m: Inverse of the slope of the *S-N* curve, taken as $m = 3$

N_R: Number of cycles corresponding to the reference probability of exceedance of 10^{-2}, taken as $N_R = 100$

ξ: Weibull shape parameter, taken as $\xi = 1$

$\Gamma(x)$: Complete Gamma function

$K_{2,air}$: Constant of the design *S-N* curve for in-air environment, taken as 1.52×10^{12}

$K_{2,cor}$: Constant of the design *S-N* curve for corrosive environment, taken as 7.60×10^{11}

$\Delta\sigma_q$: Stress range (N/mm^2) corresponding to the intersection of the two segments of design *S-N* curve at $N = 10^7$ cycles, taken as $\Delta\sigma_q = 53.4$

$\mu_{(j)}$: Coefficient taking into account the change of inverse slope of the *S-N* curve, *m*,

· For in-air environment

$$\mu_{(j)} = 1 - \frac{\left\{\gamma\left(1 + \frac{m}{\xi}, \nu_{(j)}\right) - \nu_{(j)}^{-\Delta m/\xi} \cdot \gamma\left(1 + \left(\frac{m + \Delta m}{\xi}\right), \nu_{(j)}\right)\right\}}{\Gamma\left(1 + \frac{m}{\xi}\right)}$$

$$\nu_{(j)} = \left(\frac{\Delta\sigma_q}{\Delta\sigma_{FS,(j)}}\right)^{\xi} \ln N_R$$

· For corrosive environment

$$\mu_{(j)} = 1$$

$\gamma(\mathrm{a}, x)$: Incomplete Gamma function

Δm: Change in inverse slope of *S-N* curve at $N = 10^7$ cycles, taken as $\Delta m = 2$.

2 Fatigue strength assessment criterion is to be in accordance with **9.5.5, Part 1**.

3 Correction factor for post-weld treatment by grinding is not to be considered.

Part 2-7 TANKERS

Chapter 2 GENERAL ARRANGEMENT DESIGN

2.1 Structural Arrangements

Paragraph 2.1.2 has been deleted.

~~2.1.2 Primary Supporting Members~~

~~2.1.2.1 Arrangements of Primary Supporting Members~~

~~1 For tankers with double hull structures having no longitudinal bulkheads on the centreline or tankers with double hull structures having longitudinal bulkheads only on the centreline, the arrangement of primary members in the double bottom and double side hull of the cargo tank area are to be determined in the following (1) to (5).~~

~~(1) The height of the double bottom in cargo oil spaces is not to be less than~~ $\cancel{B/20}$ ~~(*m*).~~

~~(2) The width of the double side hull is not to be less than~~ $\cancel{D/9}$ ~~(*m*).~~

~~(3) In double bottoms in cargo oil spaces, girders are to be provided at a spacing not exceeding~~ $\cancel{0.9\sqrt{\ell_T}}$ ~~(*m*) and floors are to be provided at a spacing not exceeding~~ $\cancel{0.55\sqrt{B}}$ ~~(*m*) or~~ $\cancel{0.75\sqrt{D}}$ ~~(*m*), whichever is smaller.~~

~~(4) In the double side hull, stringers are to be provided at a spacing not exceeding~~ $\cancel{1.1\sqrt{\ell_T}}$ ~~(*m*).~~

~~(5) Transverses in the double side hull, cargo oil tanks and deep tanks are to be provided in line with the floors in the double bottom.~~

~~2 If the spacing of girders and floors in the double bottom and stringers and transverses in the double side hull according to -1 above are smaller than the values shown in (1) and (2) in tankers without partial~~

~~loading conditions (such as half-loading or alternate loading), the spacing may be increased to the values given in (1) and (2).~~

~~(1) Girders in the double bottom and stringers in the double side hull: 4.1 (*m*)~~

~~(2) Floors in the double bottom and transverses in the double side hull: 2.8 (*m*)~~

Chapter 7 PRIMARY SUPPORTING MEMBER STRUCTURAL STRENGTH

7.1 General

7.1.1 Application

Paragraph 7.1.1.1 has been amended as follows.

7.1.1.1

1 The requirements in this Chapter apply to ships of less than 150 m in length L_C.

2 Notwithstanding **-1** above, strength assessments for deck girders with respect to deck loads and green sea loads are to be carried out in accordance with this Chapter.

~~2~~3 For the double bottom and double-side skin structure, the requirements of the double hull structure specified in **7.3, Part 1** are to be applied. For other girder members that can be regarded as simple girders, the requirement of the simple girder specified in **7.2, Part 1** are to be applied.

Chapter 8 STRENGTH ASSESSMENT BY CARGO HOLD ANALYSIS

8.3 Structural Models

8.3.1 General

Paragraph 8.3.1.2 has been amended as follows.

8.3.1.2 In Way of Lower End of Vertically Corrugated Bulkhead

1 In applying **8.3.3.1-2, Part 1**, plating and primary supporting members around the lower end of vertically corrugated bulkhead are to be modelled by shell elements with the mesh-sized of 100 $mm \times 100\ mm$ or less.

2 In applying **-1** above, members for reinforcement directly under vertically corrugated bulkheads across the inner bottom plating are to be appropriately modelled. Shell elements are to be used for modelling if necessary.

8.5 Strength Assessments

8.5.1 Yield Strength Assessments

8.5.1.1 Reference Stress

Sub-paragraph -1 has been amended as follows.

1 In applying **8.6.1.1, Part 1**, the averaged stresses of multiple elements within the range deemed appropriate by the Society may be taken as the reference stress for locations where the mesh size specified in **8.3.1.2** is applied. A range that web depth of the vertically corrugated bulkhead is divided into three parts (that is, approximately 300 $mm \times 300\ mm$) is to be taken as the standard range.

Part 2-9 SHIPS CARRYING LIQUEFIED GASES IN BULK (INDEPENDENT PRISMATIC TANKS TYPE A/B)

Chapter 4 Loads

4.2 Loads to be Considered in Local Strength

4.2.2 Maximum Load Condition

4.2.2.1 Lateral Loads

Sub-paragraph -1 has been amended as follows.

1 In applying **4.4.2, Part 1**, the parameters required to calculate the dynamic pressure due to cargo are to be the values in the loading condition where cargo is loaded in the cargo hold to be considered <u>and the draught is at a minimum</u> (e.g. one-tank-loaded condition). The radius of gyration (*m*) around *X-axis* is to be taken as 0.38*B* but the value calculated based upon the weight distribution according to the loading condition to be considered may be used.

4.2.3 has been amended as follows.

4.2.3 Loads to be Considered in Tank Type A

4.2.3.1 Loads to be Considered in Tank Boundary plates

The load P_{in} (*kN/m*^{2}) to be considered for tank boundary plates is to be in accordance with the following formula. However, P_2 is used only where P_h is given specified in **4.13.2-3, Part N**.

$P_{in} = \max(P_1, P_2, P_3)$

$P_1 = P_{ls} + P_{ld}$

$\cancel{P_2 = P_{ls\_2}}$ $\underline{P_2 = P_{ls\_2}/0.95}$

$P_3 = P_{heel}$

P_{ls}: Static pressure and design vapor pressure (*kN/m*^{2}), as specified in **4.4.2.4, Part 1**~~,~~

P_{ld}: Dynamic pressure (*kN/m*^{2}), in accordance with **4.4.2.4, Part 1**.

P_{ls_2}: Static pressure and design vapor pressure in harbour condition (*kN/m*^{2}). As for P_{ls} specified in **4.4.2.4, Part 1**, the value obtained by replacing the design vapor pressure with P_h specified in **4.13.2-3, Part N**.

P_{heel}: Maximum static pressure in 30-degree static heel condition (*kN/m*^{2})

4.2.3.2 Loads Considering Increase of Pressure due to a Fire

The Load P_f (*kN/m*^{2}) considering increase of pressure due to a fire is to be in accordance with the following formula. However, P_{f2} is used only where P_h is given specified in **4.13.2-3, Part N**.

$P_f = \max(P_{f1}, P_{f2})$

$P_{f1} = P_{ls\_f1} + P_{ld}$

$\cancel{P_{f2} = P_{ls\_f2}}$ $\underline{P_{f2} = P_{ls\_f2}/0.95}$

P_{ls_f1}: Static pressure and design vapor pressure (*kN/m*^{2}), the value is obtained by multiplying the design vapor pressure P_0 by 1.2 in P_{ls} specified in **4.4.2.4, Part 1**.

P_{ld}: Dynamic pressure (*kN/m*^{2}) in accordance with the requirements of **4.4.2.4, Part 1**.

P_{ls_f2}: Static pressure and design vapor pressure in harbour condition (kN/m^2). As for P_{ls} specified in **4.4.2.4, Part 1**, the value obtained by replacing the design vapor pressure with 1.2 times the value of P_h specified in **4.13.2-3, Part N**.

4.2.3.3 Loads to be Considered in Centreline Bulkheads

The load P_{CL} (kN/m^2) to be consider for the centreline bulkhead is to be in accordance with the following formula:

$P_{CL} = \max(P_{CL1}, P_{CL2}, P_{CL3})$

$P_{CL1} = P_{ld}$

$P_{CL2} = P_{heel}$

$P_{CL3} = P_{ope}$

P_{ld}: Dynamic pressure (kN/m^2) in accordance with the requirements of **4.4.2.4, Part 1**.

P_{heel}: Static pressure (kN/m^2) from maximum difference between liquid levels of both sides of cargo tank in 30-degree static heel condition.

P_{ope}: Internal pressure (kN/m^2) of cargo tank according to operational restrictions, to be taken as follows. Where operations are limited, operational limitations are to be specified in the loading manual.

Where asymmetric loading of both side of cargo tanks is not allowed in harbour condition,

$P_{ope} = 0.4P_{CL1}$

Where asymmetric loading of both side of cargo tanks is allowed in harbour condition,

$\cancel{P_{ope} = P_{ls}}$ $\underline{P_{ope} = P_{ls}/0.95}$

Where asymmetric loading of both side of cargo tanks is allowed in maximum load condition,

$P_{ope} = P_{ls} + P_{ld}$

Chapter 6 LOCAL STRENGTH

6.1 Independent Prismatic Tanks

6.1.1 General

6.1.1.1 Application

The scantlings of the plates and stiffeners which subject to liquid cargo are to be in accordance with **6.1**.

6.1.2 Design Load Scenarios and Applied Loads for Assessment Target Members

6.1.2.1

The Design Load Scenarios and Applied Loads for Assessment Target Members/Compartments are to be in accordance with **Table 6.1.2-1**.

Table 6.1.2-1 has been amended as follows.

Table 6.1.2-1 Design Load Scenarios and Applied Loads for Assessment Target Members/Compartments

Members/compartments to be assessed	Design Load Scenarios	Applied load				
		Lateral load	Load type	Load component	Reference	
					Lateral load (P)	Hull girder load $(M_{V-HG},\ M_{H-HG})$
Tank casing	Maximum load condition (normal)	Internal pressure	Liquid cargo	Static/dynamic loads	**4.2.3.1**	-
Tank casing	Harbour condition (normal)	Internal pressure	Liquid cargo	Static load	**4.2.3.1**	
Tank casing	30-degree static listed condition	Internal pressure	Liquid cargo	Static load	**4.2.3.1**	
Tank casing	Maximum load condition (Pressure rising due to a fire)	Internal pressure	Liquid cargo	Static/dynamic loads	**4.2.3.2**	
Tank casing	Harbour condition (Pressure rising due to a fire)	Internal pressure	Liquid cargo	Static load	**4.2.3.2**	
~~e~~Centre line bulkhead(1)	Maximum load condition (normal)	Internal pressure	Liquid cargo	Static/dynamic loads	**4.2.3.3**	
Centre line bulkhead(1)	30 degree static listed condition	Internal pressure	Liquid cargo	Static load	**4.2.3.3**	
Centre line bulkhead(1)	Condition under operational restrictions	Internal pressure	Liquid cargo	Static load	**4.2.3.3**	

Note:
(1) Where openings which cannot be closed (excluding vapour spaces at the centreline bulkhead) are installed, the requirements need not be applied.

6.1.3 has been amended as follows.

6.1.3 Plates and Stiffeners

6.1.3.1

1 The plates and stiffeners of the independent prismatic tanks are to satisfy the requirements of **6.3** and **6.4, Part 1** respectively for design load scenarios and applied loads specified in **Table 6.1.1-1**. In applying **6.3** and **6.4, Part 1**, the following requirements **(1)** to **(3)** are to be complied with.

(1) ~~f~~For design load scenarios considering pressure rising due to a fire in those in **Table 6.1.2-1**, the plate and stiffeners are to be evaluated by using formulae for flooded conditions. And, for other design load scenarios, the evaluations are to be carried out by using formulae for maximum load conditions.

(2) ~~However, t~~The coefficients C_a and C_s related to the influence of the axial force ~~may~~ are to be taken as 1.0 respectively.

(3) In applying **6.4, Part 1**, C_{Safety} is to be 1.1, and $\sigma_Y/1.33$ or $\sigma_B/2.66$, whichever is less, is to be used instead of σ_Y, where σ_B is the specified minimum tensile strength at room temperature, as specified in **8.5.1.1-2**.

2 In addition to **-1** above, where high density cargoes are partially loaded into cargo tanks, strength assessments are to be carried out taking into account the cargo density and cargo loading height.

3 In structures where the membrane or axial force due to internal pressure cannot be neglected, the requirements in **-1** above is to be applied with necessary modification.

Chapter 8 STRENGTH ASSESSMENT BY CARGO HOLD ANALYSIS

8.5 Strength Assessment

8.5.2 Buckling Strength Assessment

Paragraph 8.5.2.2 has been amended as follows.

8.5.2.2 Side Shell Plating with Transverse Stiffness

1 In applying **Annex 8.6, Part 1 "BUCKLING STRENGTH ASSESSMENT BASED ON CARGO HOLD ANALYSIS"**, for the side shell with stiffened in transverse direction which is surrounded by the bilge hopper tanks and top side tanks, the stress act on the members in the shorter side direction of the panels may be averaged regardless of the definition of the reference stress σ_y, which is in the shorter side direction of the panels specified in **A3.2.2, Annex 8.6**.

2 In the application of **-1** above, where the requirements for hull girder ultimate strength specified in **5.4, Part 1** are satisfied, for the strength assessments performed in the equivalent design waves *HM*-1, *FM*-1, *AV*-1*P* and *AV*-1*S* of the maximum load condition, the stress under the shorter side direction of the panels acting on the said members is to be considered up to the value obtained by the following formula:

$$\sigma_{y\_limit} = \frac{\pi^2 E}{12(1-\nu^2)}\left(\frac{t_p}{b}\right)^2$$

E: Young's modulus (N/mm^2), taken as 2.06×10^5.

ν: Poisson's ratio, taken as 0.3.

t_p: Thickness (mm) of the plate panel.

b: Length (mm) of the shorter side of the plate panel.

Part 2-10 SHIPS CARRYING LIQUEFIED GASES IN BULK (INDEPENDENT TANKS OF TYPE C)

Chapter 4 LOADS

4.3 Loads to be Considered in Strength of Primary Supporting Structures

4.3.2 Maximum Load Condition

Table 4.3.2-2 has been amended as follows.

Table 4.3.2-2 External and Internal Pressure to Be Considered

		P_{DB}(kN/m^2)(1),(2)	P_{DS}(kN/m^2)(1),(2)
Double bottom	$S1$	$P_{exs} + P_{exw}$	$P_{exs} + P_{exw}$
	$S2$	$P_{exs} + P_{exw}$	$P_{exs} + P_{exw}$

Notes:

P_{exs}, P_{exw}: Hydrostatic and Hydrodynamic pressure (kN/m^2) act on bottom shell in case of P_{DB}. Those values act on side shell in case of P_{DS}. Each value is calculated in accordance with **4.6.2.4, Part 1**.

(1) Load calculation points for calculating each component of loads such as P_{exs} ~~is~~are to be in accordance with **7.3.1.5, Part 1** for all loading conditions.

(2) When calculating loads, $T_{LC} = T_{SC}$.

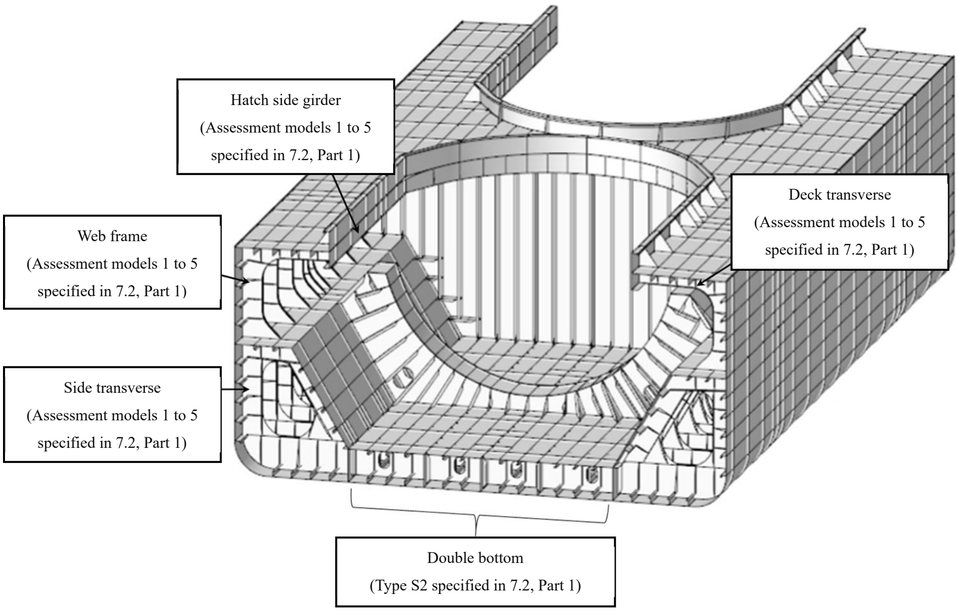
Chapter 7 PRIMARY SUPPORTING STRUCTURE STRENGTH

7.1 General

7.1.1 Application

Fig. 7.1.1-1 has been amended as follows.

Fig. 7.1.1-1 Application Example of Liquified Gas Bulk Carriers with Independent Tanks Type C



Note:

Where bottom structure is single bottom, ~~the requirement of the simple girder specified in~~ **7.2,** ~~**Part 1 are**~~ <u>is</u> to be applied.

Section 7.2 has been added as follows.

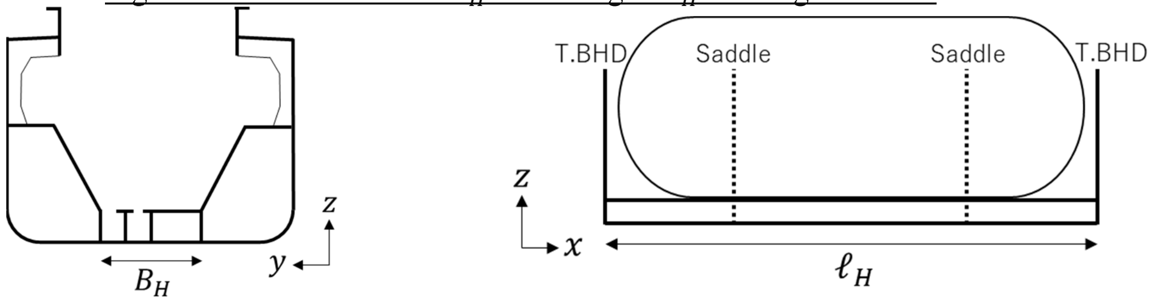
7.2 General

7.2.1 Application

7.2.1.1

Where the ship is single bottom and the aspect ratio ℓ_H/B_H is 2.0 or more, to be in accordance with **7.2.2**. ℓ_H and B_H are defined in **Fig. 7.2.1-1**. Where the aspect ratio is small, it is to be as deemed appropriate by the Society.

Fig. 7.2.1-1 Breadth B_H and Length ℓ_H of Single Bottom



7.2.2 Evaluation Members to be Assessed

7.2.2.1 Floors

Strength assessments are to be carried out in accordance with the requirements for simple girders specified in **7.2 of Part 1**. The full length ℓ of the floor is to be B_H shown in **Fig. 7.2.1-1**.

7.2.2.2 Girders

Girder scantlings are to be of the same degree as floor scantlings.

Part 2-11 SHIPS CARRYING LIQUEFIED GASES IN BULK (MEMBRANE TANKS)

Chapter 4 Loads

4.2 Loads to be Considered in Local Strength

4.2.2 Maximum Load Condition

4.2.2.1 Lateral Loads

Sub-paragraph -1 has been amended as follows.

1 In applying **4.4.2.4, Part 1**, the parameters (GM, z_G etc.) required to calculate the dynamic pressure due to cargo are to be the values in the loading condition that cargo is loaded only in the cargo hold to be considered <u>and the draught is at a minimum</u> (<u>e.g.</u> one-tank-loaded condition). <u>The radius of gyration (m) around *x-axis* is to be taken as 0.38B, but a value calculated based upon the weight distribution according to the loading condition to be considered may be used.</u>

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

Part N SHIPS CARRYING LIQUEFIED GASES IN BULK

N4 CARGO CONTAINMENT

N4.21 Type *A* Independent Tanks

N4.21.3 has been amended as follows.

N4.21.3 Ultimate Design Condition

~~**1** The definitions of the symbols specified in **N4.21.3** are given in **Table N4.21.3-1**.~~

~~Table N4.21.3-1 Definitions~~

~~Symbol~~		~~Definitions~~
~~L~~	~~m~~	~~Length of ship specified in **2.1.2, Part A of the Rules**~~
~~S~~	~~m~~	~~Spacing of stiffeners~~
~~l~~	~~m~~	~~Spacing of girders~~
~~ρ_c~~	~~kg/m^3~~	~~Maximum cargo density in design temperature among all cargoes fully loaded in cargo tanks~~
~~ρ_s~~	~~kg/m^3~~	~~Sea water density~~
~~R_e~~	~~N/mm^2~~	~~As specified in **4.18.1(3), Part N of the Rules**~~
~~R_m~~	~~N/mm^2~~	~~As specified in **4.18.1(3), Part N of the Rules**~~
~~P_0~~	~~MPa~~	~~Design vapour pressure~~
~~P_h~~	~~MPa~~	~~As specified in **4.13.2-3, Part N of the Rules**~~
~~P_{0f}~~	~~MPa~~	~~P_0 multiplied by 1.2.~~
~~P_{hf}~~	~~MPa~~	~~P_h multiplied by 1.2.~~
~~P_S~~	~~MPa~~	~~Static pressure of cargo liquid obtained from the following formula~~ ~~$P_S = \rho_c z_f g \times 10^{-6}$~~
~~P_D~~	~~MPa~~	~~Dynamic pressure of cargo liquid obtained from the following formula~~ ~~$P_D = \rho_c \sqrt{(x_f a_x)^2 + (y_f a_y)^2 + (z_f a_z)^2} \cdot g \times 10^{-6}$~~
~~P_{Dh}~~	~~MPa~~	~~Dynamic pressure of cargo liquid in harbor condition obtained from the following formula:~~ ~~$P_{Dh} = 0.4 P_D$~~
~~a_x, a_y, a_z~~	~~m/s^2~~	~~As specified in **4.28.2, Part N of the Rules**~~
~~x_f, y_f, z_f~~	~~m~~	~~As specified in **N4.28.1-1(1)**~~
~~C~~		~~Coefficient according to the type of end connections is given as follows:~~ ~~– Both ends of stiffeners are connected by bracket, lug connection or supported by girders: 1.0~~ ~~– One end of stiffeners is connected by bracket, lug connection or supported by girders and the other end of stiffeners is unattached: 1.5~~ ~~– Both ends of stiffeners are unattached: 1.5~~
~~σ_{allow}~~	~~N/mm^2~~	~~The lower of $R_m/2.66$ or $R_e/1.33$~~
~~g~~	~~m/s^2~~	~~Acceleration due to gravity to be taken as 9.81~~
~~α~~		~~Opening ratio of swash bulkhead in cargo tanks~~
~~l_c~~	~~m~~	~~Length of cargo tank~~

~~2~~1 The "classical analysis procedures" referred to in the requirements in **4.21.3-1, Part N of the Rules** means to meet the ~~following (1) to (7)~~ requirements in **Chapter 6, Part 2-9, Part C of the Rules**. ~~Where openings which cannot be close, excluding vapour spaces at centreline bulkhead, are installed, requirements (3) and (4) need not be applied.~~

~~(1) The thicknesses of tank boundary plates are not to be less than the greater of the values obtained from the following (a) and (b):~~

~~(a)~~ $\cancel{3.46 S \sqrt{\frac{235}{R_e}} h \ (mm)}$

~~h: pressure head as given in the following formula;~~

$$\cancel{h = \frac{P}{\rho_s g} \times 10^6 \ (m)}$$

~~P is to be the greatest value of the following P_1, P_2 or P_3. However, P_2 is used only where P_h is set.~~

~~P_1: Internal pressure of tank in sea going condition, obtained from the following formula:~~

$$P_1 = P_0 + P_S + P_D \ (MPa)$$

~~P_2: Internal pressure of tank in harbour condition, obtained from the following formula:~~

$$P_2 = P_h + P_S + P_{Dh} \ (MPa)$$

~~P_3: Maximum static pressure under a 30-degree static heel condition~~

~~(b)~~ $3.2S\sqrt{\frac{235}{R_e}h_f} \ (mm)$

~~h_f: Pressure head taking into account a fire scenario, obtained from the following formula:~~

$$h_f = \frac{P_f}{\rho_S g} \times 10^6 \ (m)$$

~~P_f is to be greater value of the following P_{f1} and P_{f2}. However, P_{f2} is used only where P_h is set.~~

~~P_{f1}: Internal pressure of tank in sea going condition, obtained from the following formula:~~

$$P_{f1} = P_{0f} + P_S + P_D \ (MPa)$$

~~P_{f2}:Internal pressure of tank in harbour condition, obtained from the following formula:~~

$$P_{f2} = P_{hf} + P_S + P_{Dh} \ (MPa)$$

~~(2) The section moduli of the stiffeners on tank boundary plates are not to be less than those obtained from the following formula:~~

$$\frac{CSPl^2}{12\sigma_{allow}} \times 10^6 \ (cm^3)$$

$$2.33 \cdot \frac{235}{R_e} \cdot CSh_f l^2 \ (cm^3)$$

~~P and h_f: As specified in (1)~~

~~(3) The thickness of the centreline bulkhead is not to be less than the greater value of the following (a) and (b):~~

~~(a)~~ $3.46S\sqrt{\frac{235}{R_e}h_{CL}} \ (mm)$

~~h_{CL}: Pressure head, obtained from the following formula:~~

$$h_{CL} = \frac{P_{CL}}{\rho_S g} \times 10^6 \ (m)$$

~~P_{CL} is to be the greatest value of the following P_{CL1}, P_{CL2} and P_{CL3}.~~

~~P_{CL1}: Tank pressure in sea-going condition obtained from the following formula:~~

$$P_{CL1} = \rho_c y_t a_y g \times 10^{-6} \ (MPa)$$

~~P_{CL2}: Static pressure(MPa) from maximum difference between liquid levels of both side of cargo tank under 30-degree static heel condition~~

~~P_{CL3}: Internal pressure of cargo tank according to operational limitation as specified in the following. Where operations are limited, operational~~

~~limitations are to be specified in the loading manual.~~

- ~~where asymmetric loading of both side of cargo tanks is not allowed in the harbour condition:~~ ~~$P_{CL3} = 0.4P_{CL1}$ (MPa)~~
- ~~where asymmetric loading of both side of cargo tanks is allowed in the harbour condition:~~ ~~$P_{CL3} = P_S + P_{Dh}$ (MPa)~~
- ~~where asymmetric loading of both side of cargo tanks is allowed in the sea going condition:~~ ~~$P_{CL3} = P_S + P_D$ (MPa)~~

~~(b)~~ ~~$3.2S\sqrt{\frac{235}{R_e}h_{CL\_A}}$ (mm)~~

~~h_{CL_A}: Pressure head taking into account the static pressure of liquid cargo, obtained from the following formula:~~

~~$h_{CL\_A} = \frac{P_S}{\rho_S g} \times 10^6$ (m)~~

~~(4) The section moduli of stiffeners of centreline bulkhead are not to be less than those obtained from the following formula:~~

~~$\frac{CP_{CL}Sl^2}{12\sigma_{allow}} \times 10^6$ (cm^3)~~

~~$2.33 \cdot \frac{235}{R_e} \cdot CSh_{CL\_A}l^2$ (cm^3)~~

~~P_{CL} and h_{CL_A}: As specified in **(3)**~~

~~(5) The thicknesses of transverse swash bulkheads are not to be less than those obtained from the following formula:~~

~~$3.46S\sqrt{\frac{235}{R_e}h_{SW}}$ (mm)~~

~~h_{SW}: Pressure head taking into consideration sloshing obtained from the following formula:~~

~~$h_{SW} = \frac{\rho_c h_{st}}{\rho_s}$ (m)~~

~~h_{st}: As given by the following formula, not to be taken less than 5.6 m~~

~~$h_{st} = \left(0.176 - \frac{0.025}{100}L\right)(1-\alpha)l_t$ (m)~~

~~(6) The section moduli of the stiffeners on transverse swash bulkheads are not to be less than those obtained from the following formula:~~

~~$\frac{CP_{SW}Sl^2}{12\sigma_{allow}} \times 10^6$ (cm^3)~~

~~P_{SW}: Sloshing pressure as given by the following formula:~~

~~$P_{SW} = \rho_c h_{st} g \times 10^{-6}$ (MPa)~~

~~h_{st}: As specified in **(5)**~~

~~(7) The scantling of girders are to be in accordance with the requirements in **Chapter 29, Part C of the Rules** except where the scantlings of members are determined by direct calculations.~~

~~**3** Where high density cargoes are partially loaded into cargo tanks, strength assessments are to be carried out taking into account the cargo density and loading height of the cargo in addition to -2.~~

~~4~~2 For the purpose of the requirements in **4.21.3-1, Part N of the Rules**, the allowable stress for the equivalent stress σ_c when detailed stress calculations are made on primary members is to be as given in **Table N4.21.3-~~2~~1**.

~~**5** The corrosion allowance used in **-2** is to be in accordance with the requirements in **4.3.5, Part N of the Rules**. In structures where the membrane or axial force due to internal pressure can not be neglected, the calculation equation specified in **-2** may be used after suitable modification.~~
~~**6** Scantling of stiffeners specified in **-2** may be decided based on the requirements specified in **1.1.13-7, Part C of the Rules.**~~

Table N4.21.3-~~2~~1 Allowable Stresses for the Primary Equivalent Stress

Ferrite steels	Austenitic steels	Aluminium alloys
$0.79R_e$	$0.84R_e$	$0.79R_e$
$0.53R_m$	$0.42R_m$	$0.42R_m$

Note:
For each member, the smaller of the above values is to be used with R_e and R_m as specified in **4.18.1(3), Part N of the Rules**.