RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part C Hull Construction and Equipment

Rules for the Survey and Construction of Steel Ships
Part C 2017 AMENDMENT NO.1
Guidance for the Survey and Construction of Steel Ships
Part C 2017 AMENDMENT NO.1

Rule No.29 / Notice No.27 1st June 2017
Resolved by Technical Committee on 30th January 2017
Approved by Board of Directors on 20th February 2017

ClassNK
NIPPON KAIJI KYOKAI

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part C Hull Construction and Equipment

2017 AMENDMENT NO.1

Rule No.29 1st June 2017

Resolved by Technical Committee on 30th January 2017

Approved by Board of Directors on 20th February 2017

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

Rule No.29 1st June 2017
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

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

Part C HULL CONSTRUCTION AND EQUIPMENT

Chapter 15 LONGITUDINAL STRENGTH

15.2 Bending Strength

Paragraph 15.2.1 has been amended as follows.

15.2.1 Bending Strength at the Midship Part*

1 The section moduli of the transverse sections of the hull at the midship part under consideration are not to be less than the values of Z_σ obtained from the following two formulae for all conceivable loading and ballasting conditions.

$$Z_\sigma = 5.72\left|M_s + M_w(+)\right| \quad (cm^3)$$

$$Z_\sigma = 5.72\left|M_s + M_w(-)\right| \quad (cm^3)$$

M_s: Longitudinal bending moment in still water (*kN-m*) at the transverse section under consideration along the length of the hull, which is calculated by the method deemed appropriate by the Society

The positive value of M_s, however, is to be defined as a positive value which is obtained assuming that downward loads are taken as positive values and are integrated in the forward direction from the aft end of the ship. (*See* **Fig. C15.1**)

M_w (+) and M_w (-): Wave induced longitudinal bending moments (*kN-m*) at the transverse section under consideration along the length of the hull, which are obtained from the following formulae:

$$M_w(+) = +0.19 C_1 C_2 L_1^2 B C_b' \quad (kN\text{-}m)$$

$$M_w(-) = -0.11 C_1 C_2 L_1^2 B (C_b' + 0.7) \quad (kN\text{-}m)$$

C_1: As given by the following formulae:

$$10.75 - \left(\frac{300 - L_1}{100}\right)^{1.5} \quad \text{for } L_1 \leq 300m$$

$$10.75 \quad \text{for } 300m < L_1 \leq 350m$$

$$10.75 - \left(\frac{L_1 - 350}{150}\right)^{1.5} \quad \text{for } 350m < L_1$$

L_1: Length (*m*) of ship specified in **2.1.2, Part A** or 0.97 *times* the length of ship on the designed maximum load line, whichever is smaller. The fore end of L_1 is the perpendicular to the designed maximum load draught at the forward side of the stem, and the aft end of L_1 is the perpendicular to the designed maximum load draught at a distance L_1 aft of the fore end of L_1.

C_b' : Volume of displacement corresponding to the designed maximum load line divided by L_1Bd

However, the value is to be taken as 0.6, where it is less than 0.6.

C_2 : Coefficient specified along the length at positions where the transverse section of the hull is under consideration, as given in **Fig. C15.2**

2 Notwithstanding the requirements of **-1** above, the section modulus of the transverse section of the hull ~~at the middle point of *L*~~ amidships is not to be less than the value of W_{min} obtained from the following formula:

$$W_{min} = C_1 L_1^2 B(C_b' + 0.7) \quad (cm^3)$$

C_1, L_1 and C_b' are to be as specified in **-1** above

3 Moment of inertia of the transverse section of the hull ~~at the middle point of *L*~~ amidships is not to be less than the value obtained from the following formula. Note, however, that the calculation method for the moment of inertia of the actual transverse section is to be correspondingly in accordance with the requirements in **15.2.3**.

$$3W_{min}L_1 \quad (cm^4)$$

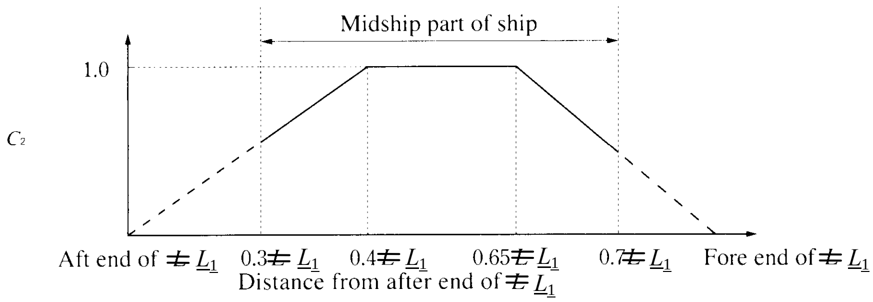
W_{min} : Section modulus of the transverse section of hull ~~at the middle point of *L*~~ amidships as specified in **-2** above

L_1 : As specified in **-1** above

4 The scantlings of longitudinal members in way of the midship part are not to be less than the scantlings of longitudinal members at the ~~middle point of *L*~~ midship which are determined by the requirement in **-2** and **-3** above, excluding changes in the scantlings due to variations in the sectional form of the transverse section of the hull.

Fig.C15.2 has been amended as follows.

Fig. C15.2 Value of Coefficient C_2



15.3 Shearing Strength

15.3.1 Thickness of Shell Plating of Ships without Longitudinal Bulkheads*

Fig.C15.4 and Fig.C15.5 have been amended as follows.

Fig. C15.4 Values of Coefficient C_3

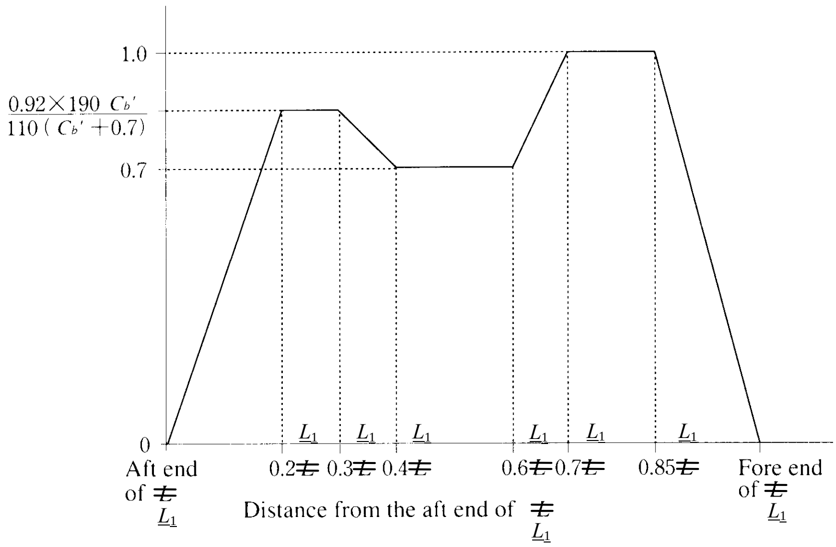
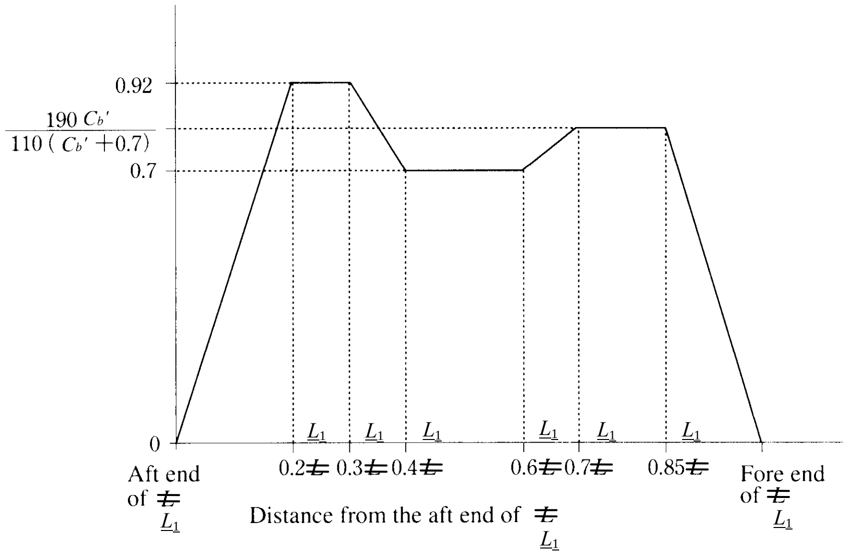


Fig. C15.5 Values of Coefficient C_4



15.4 Buckling Strength

Paragraph 15.4.1 has been amended as follows.

15.4.1 General*

1 ~~The buckling strength for main members related to longitudinal strength is to be in accordance with t~~The requirements in this section apply to platings and longitudinals subject to hull girder bending and shear stresses and contributing to longitudinal strength.

2 In addition to the requirements specified in **-1** above, throughout the length of the ship, the buckling strength for members in regions where changes in the framing system or significant changes in the hull cross-section occur is to be in accordance with the requirement in this section.

3 Notwithstanding the requirements in **-1** and **-2** above, ~~T~~the buckling strength can be examined by ~~other appropriate analytical~~ other measures as deemed appropriate by the Society than that specified in this section~~ subject to the approval by the Society~~.

4 When calculating the buckling stresses in **15.4.3** and **15.4.4**, the standard thickness deductions given in **Table C15.2** apply to t_b, t_w, t_f, and t_p according to the location.

5 Where deemed necessary by the Society, the buckling strength of members other than that specified in **-1** and **-2** above are to be examined.

Paragraph 15.4.6 has been amended as follows.

15.4.6 Scantling Criteria

The buckling strength for ~~main members related to longitudinal strength~~ platings (including web platings of longitudinal girders and stringers) and longitudinals is to comply with the following:

(1) $\sigma_C \geq \beta\sigma_a$ for compressive, bending and torsional buckling

β : Coefficient given by the following:

1.0: for plating and for web plating of stiffeners

1.1: for stiffeners

(2) $\tau_C \geq \tau_a$ for shearing buckling of plate panels

Chapter 32 CONTAINER CARRIERS

32.1 General

32.1.2 Definitions

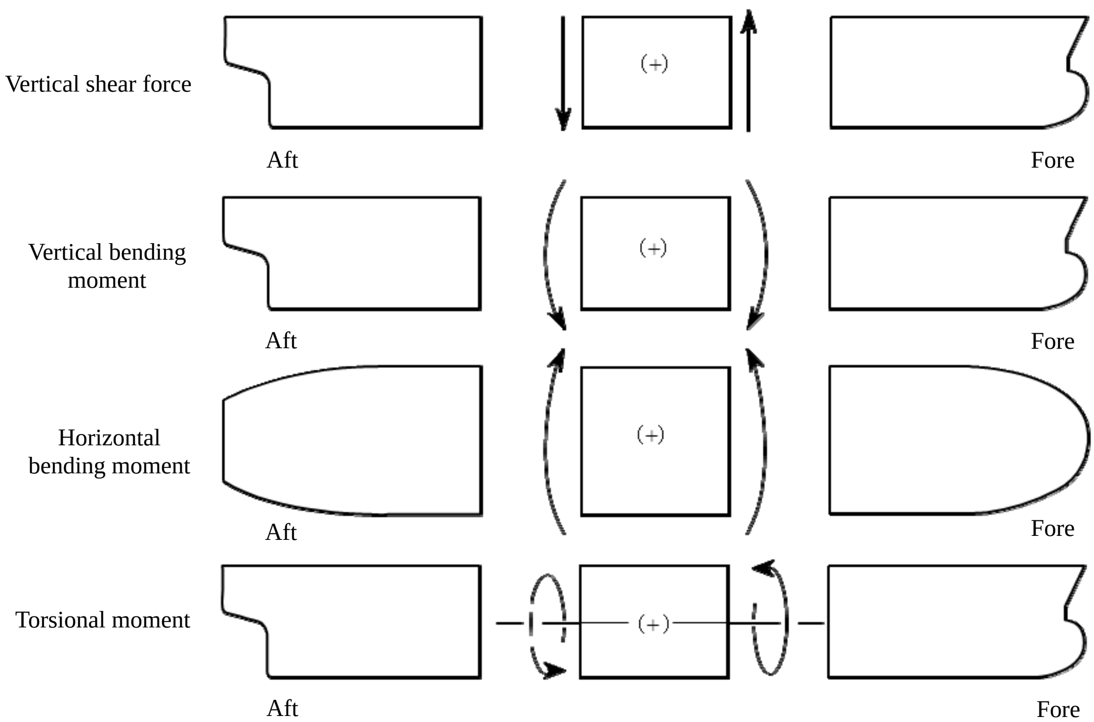
Sub-paragraph -4 has been amended as follows.

4 The definitions of positive and negative vertical shear forces, vertical bending moments, ~~and~~ horizontal bending moments and torsional moments at any ship transverse section are as shown in **Table C32.4** and **Fig. C32.4**.

Table C32.4 Sign Conventions for Vertical Shear Force, Vertical Bending Moment, ~~and~~ Horizontal Bending Moment and Torsional Moment

	Definition of positive force and moments
Vertical shear force (*kN*)	Positive in the case of downward resulting forces acting aft of the transverse section and upward resulting forces acting forward of the transverse section under consideration.
Vertical bending moment (*kN*)	Positive when inducing tensile stresses in strength deck (hogging bending moment) and negative when inducing tensile stresses in the bottom (sagging bending moment).
Horizontal bending moment (*kN-m*)	Positive when inducing tensile stresses in the starboard side and negative when inducing tensile stresses in the port side.
Torsional moment (*kN-m*)	Positive in the case of resulting moment acting aft of the transverse section following positive rotation around the *X*-axis and resulting moment acting forward of the transverse section following negative rotation around the *X*-axis.

Fig. C32.4 Definition of Positive Vertical Shear Force, Vertical Bending Moment, ~~and~~ Horizontal Bending Moment and Torsional Moment



32.1.3 Net Scantling Approach*

Sub-paragraph -1 has been amended as follows.

1 In **32.2** and **32.9**, the strength is to be assessed using the net scantling approach on all scantlings if not otherwise specified. In **32.3**, the stress is calculated using the gross scantling approach where the gross scantling means the built scantling, and the strength is assessed using stress corrected for the net scantling approach separately specified. In **32.~~3~~4** to **32.8**, the strength is assessed using the gross scantling approach~~ where the gross scantling means the built scantling~~.

2 The net thickness of plating, t_{net} (mm), for the plates, webs, and flanges is obtained by the following formula.

$$t_{net} = t_{as\_built} - t_{vol\_add} - \alpha t_c$$

t_{as_built} : Built thickness (mm)

t_{vol_add} : Voluntary addition (mm)

α: Corrosion addition factor whose values are defined in **Table C32.5**

t_c: Total corrosion addition (mm) whose value is defined in **-4**

Table C32.5 has been amended as follows.

Table C32.5 Values of Corrosion Addition Factor

Requirement		α
Stiffness assessment and yield strength assessment (**32.2.5** and **32.2.6**)		0.5
Buckling strength (**32.2.7**)	Sectional properties (stress determination)	0.5
	Buckling capacity	1.0
Hull girder ultimate strength (**32.2.8**)		0.5
Torsional strength (**32.3**)	Buckling capacity	1.0
Strength assessment by direct strength calculation (**32.9.8** and **32.9.9**)	Stress determination	0.5
	Buckling capacity	1.0

Section 32.3 has been amended as follows.

32.3 Torsional Strength

32.3.1 ~~General~~Application*

~~Where the width of the hatchway at the midship exceeds 0.7B, special considerations are to be made to additional stresses and deformation of hatchway openings due to torsion. However, where the ship has two or more rows of hatchways, the distance between the outermost lines of hatchway openings is to be taken as the width of the hatchway.~~

1 Hatch side coamings (including top plates), strength decks, sheer strakes, topmost strakes of inner hulls/bulkheads, bottom shell plating, bilge strakes and longitudinal stiffeners attached to these members within the range from the aft end of aftmost cargo hold to the fore end of foremost cargo hold are to satisfy the criteria of torsional strength assessment specified in this section for any of the following cases:

(1) Ships not less than 200 m in length L_1;

(2) Ships exceeding 32.26 m in breadth B; or

(3) In cases where deemed necessary by the Society.

2 For ships to which **-1(1)** to **(3)** above are not applicable, torsional strength assessments deemed appropriate by the Society are to be carried out in cases where the widths of hatchways amidships exceed 0.7B. However, the distances between the outermost lines of hatchway openings are to be taken as the widths of hatchways in cases where the ship has two or more rows of hatchways.

3 Notwithstanding the requirements in this section, torsional strength assessments may be carried out in accordance with direct load analyses and direct strength calculations when deemed appropriate by the Society.

32.3.2 Verification of Calculation Method and Accuracy

1 In cases where torsional strength assessments are carried out by direct strength calculations, necessary documents and data related to the calculation method are to be submitted beforehand to the Society for approval.

2 Analysis programs are to have sufficient accuracy. If deemed necessary, the Society may require the submission of details regarding the analysis method, verification of accuracy, etc.

32.3.3 Evaluation Procedure

The evaluation procedure for torsional strength is given in the following **(1)** to **(4)** (See **Fig. C32.10**):

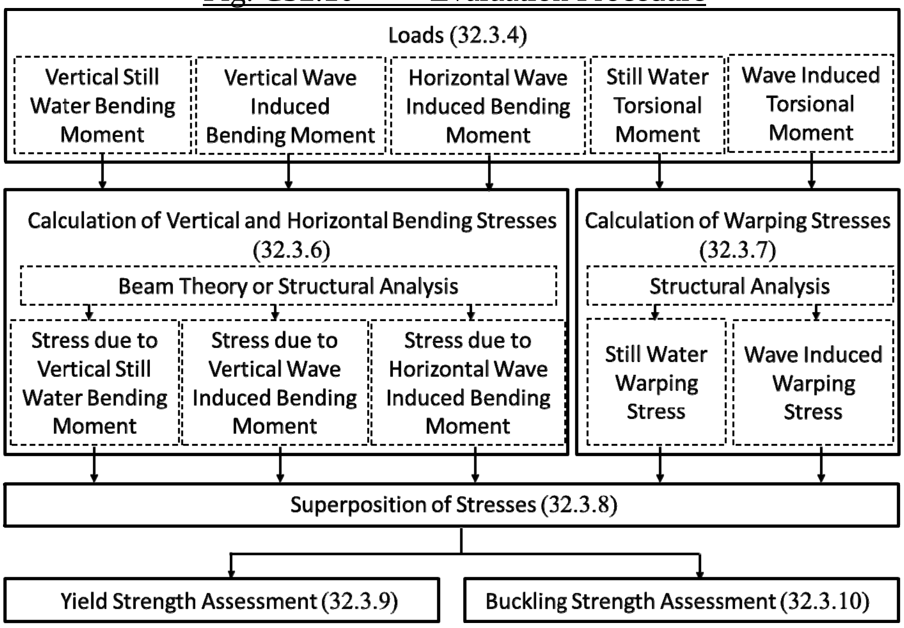
(1) Vertical still water bending moments, vertical wave induced bending moments, horizontal wave induced bending moments, still water torsional moments and wave induced torsional moments are to be considered as applied loads;

(2) Stresses due to vertical still water bending moments, vertical wave induced bending moments and horizontal wave induced bending moments are to be calculated using beam theory or structural analysis of a full ship FE model;

(3) Warping stresses due to still water torsional moments and wave induced torsional moments are to be calculated using structural analysis of a full ship FE model; and

(4) Yielding strength assessments and buckling strength assessments are to be carried out based upon evaluated stresses determined by combining the stress components.

Fig. C32.10 Evaluation Procedure



Note: Numbers in parentheses indicate section number

32.3.4 Loads*

1 The horizontal wave induced bending moments, M_{H1} and M_{H2}, are to be obtained from the following formulae:

$$M_{H1} = M_H \cdot C_{H1}$$

$$M_{H2} = M_H \cdot C_{H2}$$

M_H: As given by the following formula:

$$M_H = 0.32 C_1 C_2 L_1^{\,2} d \sqrt{\frac{L_1 - 35}{L_1}} \quad (kN\text{-}m)$$

C_1: Coefficient, to be taken as follows:

$$C_1 = 10.75 - \left(\frac{300 - L_1}{100}\right)^{1.5} \quad \text{for } L_1 \leq 300\ m$$

$$C_1 = 10.75 \quad \text{for } 300\ m < L_1 \leq 350\ m$$

$$C_1 = 10.75 - \left(\frac{L_1 - 350}{150}\right)^{1.5} \quad \text{for } 350\ m < L_1$$

C_2: Coefficient, to be taken as 0.9

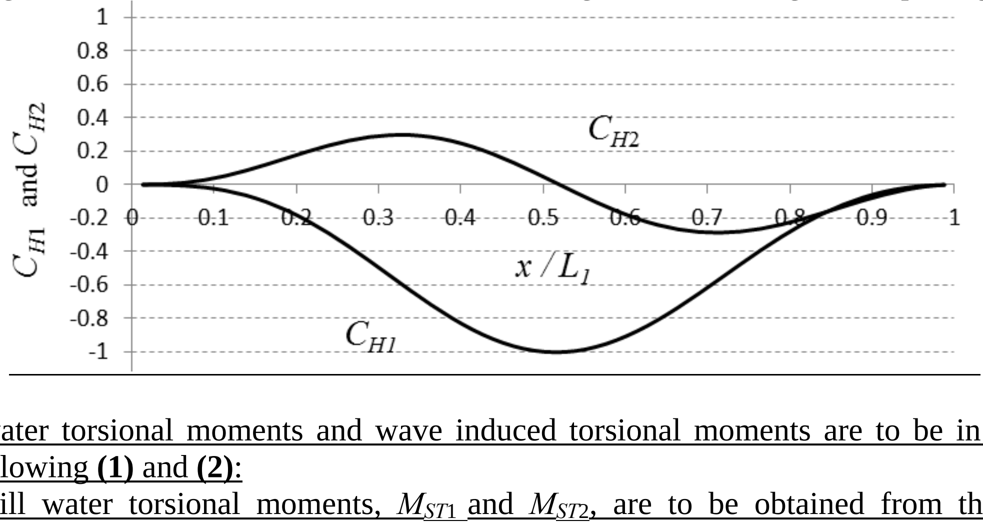
C_{H1}, C_{H2}: As given by the following formulae (See **Fig. C32.11**):

$$C_{H1} = -\cos\left(0.77\pi\left(\frac{x}{L_1} - 0.52\right)\right)\sin^2\left(\pi\frac{x}{L_1}\right)\cdot\left(\frac{1 - \exp(-6x/L_1)}{1 - \exp(-3)}\right)$$

$$C_{H2} = -\sin\left(0.77\pi\left(\frac{x}{L_1} - 0.52\right)\right)\sin^2\left(\pi\frac{x}{L_1}\right)\cdot\left(\frac{1 - \exp(-6x/L_1)}{1 - \exp(-3)}\right)$$

x: Distance from AE (m)

Fig. C32.11 Distribution of Horizontal Bending Moments along the Ship Length



2 Still water torsional moments and wave induced torsional moments are to be in accordance with the following **(1)** and **(2)**:

(1) The still water torsional moments, M_{ST1} and M_{ST2}, are to be obtained from the following formulae:

$$M_{ST1} = M_{ST\_MAX} \cdot C_{T1}$$

$$M_{ST2} = M_{ST\_MAX} \cdot C_{T2}$$

M_{ST_MAX}: The maximum of values distributed along the longitudinal direction for the permissible maximum still water torsional moment defined in the loading manual

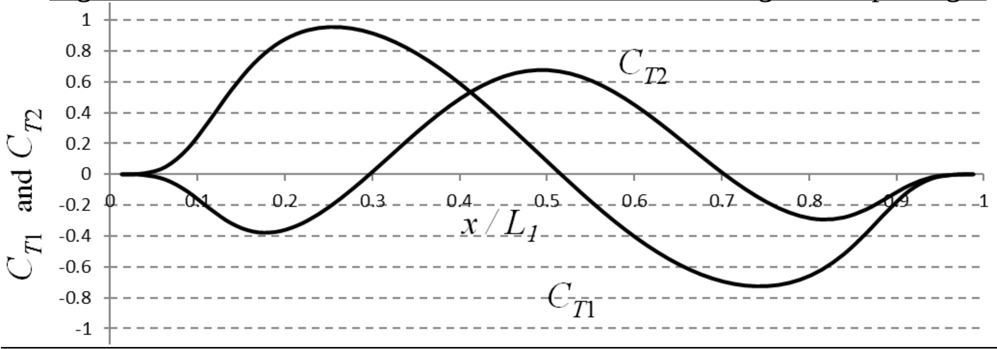
C_{T1},C_{T2}: As given by the following formulae (See **Fig. C32.12**):

$$C_{T1} = 1.0\left[\sin\left(2\pi\frac{x}{L_1}\right) + 0.1\sin^2\left(\pi\frac{x}{L_1}\right)\right]\exp\left(-0.35\frac{x}{L_1}\right)\exp\left(-8\left(\frac{x/L_1 - 0.5}{0.5}\right)^{10}\right)$$

$$C_{T2} = 0.5\left[-\sin\left(3\pi\frac{x}{L_1}\right) + 0.65\sin^3\left(\pi\frac{x}{L_1}\right)\right]\exp\left(-0.4\frac{x}{L_1}\right)\exp\left(-8\left(\frac{x/L_1 - 0.5}{0.5}\right)^{10}\right)$$

x: Distance from AE (m)

Fig. C32.12 Distribution of Torsional Moments along the Ship Length



(2) The wave induced torsional moments, M_{WT1} and M_{WT2}, are to be obtained from the following formulae:

$$M_{WT1} = M_{WT} \cdot C_{T1}$$

$$M_{WT2} = M_{WT} \cdot C_{T2}$$

M_{WT}: As given by the following formula:

$$M_{WT} = 1.3C_1C_2L_1dC_b'(0.65d + e) + 0.2C_1C_2L_1B^2C_W$$

C_1, C_2: As specified in **-1** above

C_b': Volume of displacement corresponding to the designed maximum load line divided by L_1Bd

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

C_W: Waterplane coefficient at the designed maximum load draught, to be taken as follows:

$$C_W = \frac{A_W}{L_1B}$$

A_W: Waterplane area at the designed maximum load draught (m^2)

C_{T1}, C_{T2}: As specified in **(1)** above

32.3.5 Modelling for Structural Analysis*

1 Structural models are to be for the entire ship, both the port and starboard sides.

2 Structural models are to take into account all longitudinal members, primary supporting members and longitudinal stiffeners.

3 The thickness of models and dimensions of stiffeners are to be based upon the gross scantling approach.

4 Finite element types are to be in accordance with the following **(1)** and **(2)**:

(1) Shell elements are to be used to represent plates; and

(2) Stiffeners are to be modelled so that the model has the same sectional properties as those of the considered transverse section. Several small stiffeners may be combined into one equivalent element according to the meshing size of element.

5 The meshing of element is to be performed so as to accurately reproduce the structural responses to be assessed.

6 Structural model validity is to be verified. Stresses obtained when vertical bending moments and horizontal bending moments are applied are to be confirmed to be equivalent to the stresses calculated using beam theory.

7 Boundary conditions are to be set accordingly to correctly reflect any warping stresses caused by the torsional moment.

32.3.6 Calculation of Stresses due to Vertical Bending Moment and Horizontal Bending Moment*

1 Stresses due to vertical bending moments and horizontal moments are to be in accordance with the following **(1)** and **(2)**. The sign convention for tension stress is to be positive, while the sign convention for compressive stress is to be negative.

(1) The stress due to vertical still water bending moment, σ_S, and the stress due to vertical wave induced bending moment, σ_W, are to be obtained from the following formulae:

$$\sigma_S = \frac{M_S}{1000I} \cdot (z - z_n) \quad (N/mm^2)$$

$$\sigma_W = \frac{M_W}{1000I} \cdot (z - z_n) \quad (N/mm^2)$$

M_S: Permissible maximum vertical still water bending moment and permissible minimum vertical still water bending moment (*kN-m*) specified in **32.2.3-4** at the cross section under consideration

M_W: Vertical wave induced bending moment (*kN-m*) specified in **32.2.3-6** at the cross section under consideration. The combination of M_S and M_W is to be in accordance with the load cases for hogging and sagging specified in **32.2.3-8**.

I: Moment of inertia around horizontal neutral axis (m^4) for the cross section under consideration based upon gross scantling approach

z: Z coordinate at the location under consideration (Vertical distance from base line) (*m*)

z_n: The distance from base line to horizontal neutral axis (*m*) for the cross section based upon gross scantling approach

(2) The stresses due to horizontal wave induced bending moments, σ_{H1} and σ_{H2}, are to be obtained from the following formulae:

$$\sigma_{H1} = -\frac{M_{H1}}{1000 I_H} \cdot y \quad (N/mm^2)$$

$$\sigma_{H2} = -\frac{M_{H2}}{1000 I_H} \cdot y \quad (N/mm^2)$$

M_{H1}: First component of horizontal bending moment (*kN-m*) at the cross section under consideration specified in **32.3.4-1**

M_{H2}: Second component of horizontal bending moment (*kN-m*) at the cross section under consideration specified in **32.3.4-1**

I_H: Moment of inertia around centre line (m^4) for the cross section under consideration based upon gross scantling approach

y: Y coordinate at the location under consideration (Horizontal distance from centre line) (m)

2 Notwithstanding the requirements of **-1** above, the stresses due to vertical bending moments and horizontal bending moments may be calculated using structural analysis of a full ship FE model. In cases where structural analysis is carried out, the effect of bending stresses locally generated in hatch corners need not be considered.

32.3.7 Calculation of Warping Stress due to Torsional Moment*

1 Warping stresses are to be calculated in accordance with the following **(1)** and **(2)** by applying torsional moments to structural models satisfying the requirements of **32.3.5**. The sign convention for tension stress is to be positive, while the sign convention for compressive stress is to be negative.

(1) The still water warping stresses, σ_{ST1} and σ_{ST2}, are to be calculated by applying the structural model the still water torsional moments, M_{ST1} and M_{ST2}, specified in **32.3.4-2(1)**.

(2) The wave induced warping stresses, σ_{WT1} and σ_{WT2}, are to be calculated by applying the structural model the wave induced torsional moments, M_{WT1} and M_{WT2}, specified in **32.3.4-2(2)**.

32.3.8 Superposition of Stresses

Evaluated stress, σ_T, is to be determined by combining each stress component in accordance with the following formula:

$$\sigma_T = C_3 \cdot \left(\sqrt{\sigma_W^2 + (\sigma_{H1} + \sigma_{WT1})^2 + (\sigma_{H2} + \sigma_{WT2})^2} + |\sigma_S| + \sqrt{\sigma_{ST1}^2 + \sigma_{ST2}^2} \right)$$

C_3: Coefficient to correct stress for net scantling approach, to be taken as 1.05

σ_S, σ_W: Stresses due to the vertical still water bending moments and vertical wave induced bending moments (N/mm^2) specified in **32.3.6-1(1)**

σ_{H1}, σ_{H2}: Stresses due to the horizontal wave induced bending moments (N/mm^2) specified in **32.3.6-1(2)**

σ_{WT1}, σ_{WT2}: The wave induced warping stresses (N/mm^2) specified in **32.3.7(2)**

σ_{ST1}, σ_{ST2}: The still water warping stresses (N/mm^2) specified in **32.3.7(1)**

32.3.9 Yield Strength Assessment*

1 Each element for members to be assessed is to be verified according to the criteria given in the following formulae:

For hatch side coamings (including top plates), strength decks, sheer strakes and topmost strakes of inner hulls/bulkheads:

$\sigma_T \leq 200/K$ (N/mm^2)

For bottom shell plating and bilge strakes:

$\sigma_T \leq 210/K$ (N/mm^2)

σ_T: As specified in **32.3.8**

K: Coefficient corresponding to the kind of steel
e.g., 1.0 for mild steel, the values specified in **1.1.7-2(1)** for high tensile steel

2 The requirements in **-1** above need not be applied to the locations where localized stress increase is due to hatch deformation, etc. (*e.g.*, foremost cargo holds and the fore/aft ends of engine rooms and accommodation areas) provided that fatigue strength assessments are carried out.

However, the evaluated stress obtained in accordance with **32.3.8** is to be less than the specified minimum yield stress of relevant steel assigned at such locations.

32.3.10 Buckling Strength Assessment*

1 The buckling strength of panels and stiffeners for members to be assessed is to be verified as being adequate.

2 A structural member is considered to have acceptable buckling strength if it satisfies the following criteria:

For hatch side coamings (including top plates), strength decks, sheer strakes, topmost strakes of inner hulls/bulkheads and longitudinal stiffeners attached to these members:

$\eta_{act} \leq 1.0$

For bottom shell plating, bilge strakes and longitudinal stiffeners attached to these members:

$\eta_{act} \leq 0.9$

η_{act} : Buckling utilisation factor based upon the applied stress obtained from structural analysis, which is separately specified by the Society.

32.9 Direct Strength Calculations for Primary Structural Members

Paragraph 32.9.3 has been amended as follows.

32.9.3 Procedure for Evaluation

The procedure for evaluation of primary structural members is given in the following **(1)** to **(4)** (See **Fig. C32.~~10~~13**):

Fig. C32.~~10~~13 Procedure for Evaluation
(The figure is omitted.)

Paragraph 32.9.5 has been amended as follows.

32.9.5 Wave Load Conditions

1 The wave load conditions considered in this section are given in **Table C32.17**. The definitions of weather side down and weather side up are according to **Fig. C32.~~11~~14**.

(-2 and -3 are omitted.)

Fig. C32.~~11~~14 Definitions of Weather Side Down and Weather Side Up
(The figure is omitted.)

Paragraph 32.9.6 has been amended as follows.

32.9.6 Loads

(-1 is omitted.)

2 Sea pressures are to be considered as external pressures acting on the hull structures. The sea pressures are the sum of hydrostatic pressures and hydrodynamic pressures, and are not to be taken as less than 0. Hydrostatic pressure and hydrodynamic pressures are to be in accordance with the following **(1)** and **(2)**.

(1) The pressure corresponding to the draught in still water is to be considered the hydrostatic pressure for each loading condition. The hydrostatic pressure is to be as given in **Table C32.21**.

(2) Hydrodynamic pressure is to be in accordance with the following requirements **(a)** to **(c)**:

(a) The hydrodynamic pressures P corresponding to the wave load conditions *L-180* and *L-0* are to be as given in **Table C32.22**, **Fig. C32.~~12~~15** and **Fig. C32.~~13~~16**;

(b) The hydrodynamic pressure *P* corresponding to the wave load condition *R* is to be as given in **Table C32.23** and **Fig. C32.~~14~~17**; and

(c) The hydrodynamic pressure *P* corresponding to the wave load condition *P* is to be as given in **Table C32.24** and **Fig. C32.~~15~~18**.

Fig. C32.~~12~~15 Distribution of Hydrodynamic Pressure at Midship Section
(Wave Load Condition *L-180-1*)
(The figure is omitted.)

Fig. C32.~~13~~16 Distribution of Hydrodynamic Pressure at Midship Section
(The Wave Load Condition *L-0-1*)
(The figure is omitted.)

Fig. C32.~~14~~17 Distribution of Hydrodynamic Pressure at Midship Section
(Wave Load Condition *R-P1*)
(The figure is omitted.)

Fig. C32.~~15~~18 Distribution of Hydrodynamic Pressure at Midship Section
(Wave Load Condition *P-P1*)
(The figure is omitted.)

(-3 to -5 are omitted.)

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 December 2017.

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

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part C **Hull Construction and Equipment**

GUIDANCE

2017 AMENDMENT NO.1

Notice No.27 1st June 2017

Resolved by Technical Committee on 30th January 2017

Notice No.27 1st June 2017
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

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

Part C HULL CONSTRUCTION AND EQUIPMENT

C15 LONGITUDINAL STRENGTH

C15.1 General

C15.1.1 Special Cases in Application

Sub-paragraph (4) has been amended as follows.

The ships stated in **15.1.1-2, Part C** of the Rules are to be treated as follows.
((1) to (3) are omitted.)

(4) Ships with large flares and high ship speed

According to the values of K_v and K_f obtained from the following formulae, M_w specified in **15.2.1-1, Part C** of the Rules is to be increased in accordance with the requirements in **(a)** and **(b)**.

~~$K_v = 0.2V/\sqrt{L}$~~ $K_v = 0.2V/\sqrt{L_1}$

~~$K_f = (A_d - A_W)/Lh_B$~~ $K_f = (A_d - A_W)/L_1 h_B$

Where:

A_d : Area (m^2) projected onto a horizontal plane of exposed deck forward of 0.2~~L~~L_1 aft of the fore end (including the part forward of the fore end)

Where a forecastle is provided, the horizontal project area of the forecastle overlaps the aforementioned area.

A_w : Water plane area (m^2) corresponding to the designed maximum load line within the forward 0.2~~L~~L_1

h_B : Vertical distance (m) from designed maximum load line to exposed deck at the side of fore end

(a) Where K_v exceeds 0.28

C_2 specified in **15.2.1-1, Part C** of the Rules is to be replaced with the value given in **Table C15.1.1-1** according to the values of K_v and x which is the distance (m) from aft end of L to the position of the considered hull transverse section. For intermediate values of K_v and/or x, the value is to be determined by interpolation.

Table C15.1.1-1 Modified Value of C_2

K_v	X		
	0.65~~L~~L_1	0.75~~L~~L_1	1.0~~L~~L_1
0.28	1.0	5/7	0
0.32 and over	1.0	0.8	0

(b) Where ($K_v + K_f$) exceeds 0.40

C_2 specified in **15.2.1-1, Part C** of the Rules is to be replaced with the value given in **Table C15.1.1-2** according to the values of ($K_v + K_f$) and x only under sagging conditions. For intermediate values of ($K_v + K_f$) and/or x, the value is to be determined by interpolation.

Table C15.1.1-2 Modified Value of C_2

$K_v + K_f$	X		
	0.65~~L~~L_1	0.75~~L~~L_1	1.0~~L~~L_1
0.40	1.0	5/7	0
0.50 and over	1.0	0.8	0

((5) is omitted.)

C15.4 Buckling Strength

Paragraph C15.4.1 has been amended as follows.

C15.4.1 General

~~**1** "Main members related to longitudinal strength" stated in **15.4.1-1, Part C** of the Rules refer to the following.~~

~~(1) For the examination of compressive, bending and torsional buckling strength: longitudinal frames, beams and stiffeners; longitudinal bulkhead plating; and strength deck, bottom, and side shell plating of a longitudinal system in the midship part~~

~~(2) For the examination of shear buckling strength: side shell plating and longitudinal bulkhead plating within a reasonable distance forward and aft of each transverse bulkhead between bottom and deck plating~~

~~(3) Members other than those in **(1)** and **(2)** above, of which the buckling strength is deemed necessary to be examined according to **15.4, Part C** of the Rules~~

~~**2** Carlings (100×10 FB as standard) are to be fitted in a longitudinal direction at the carling spaces which satisfy the following formula to the side plating of a transverse system when the strength deck and bottom plating is of a transverse system, and the strength deck plating of a transverse system in the midship part; except where approved otherwise by the Society.~~

$$16.6\left(\frac{t}{10S}\right)^2\left(1+\frac{S^2}{C^2}\right)^2 \geq \alpha\gamma$$

~~t : Thickness (mm) of deck or shell plating~~

~~C : Spacing (m) of carling~~

~~S : Spacing (m) of transverse beams~~

~~α : As given by the following~~

~~$\frac{-\left(M_{S.\min}+M_W(-)\right)}{Z_D}\times 10^3$ (N/mm^2) for strength deck~~

~~$\frac{\left(M_{S.\max}+M_W(+)\right)}{Z_B}\times 10^3$ (N/mm^2) for bottom shell~~

~~$M_{S.\min}$ and $M_{S.\max}$: Min. and Max. values respectively, of longitudinal bending moment (kN-m) in still water as required in **15.2.1-1, Part C of the Rules**~~

~~$M_W(-)$ and $M_W(+)$: As specified in **15.2.1-1, Part C of the Rules**~~

~~Z_D and Z_B : Actual section moduli (cm^3) of transverse section of hull whose values are determined against the strength deck and ship bottom according to the requirements in **15.2.3, Part C of the Rules**~~

~~γ: 1.0 for strength deck plating and bottom shell plating, and the value given by the following for side shell plating:~~

~~$\frac{y_1}{y_D}$ for members located above the neutral axis of athwartship considered~~

~~$\frac{y_2}{y_B}$ for members located below the neutral axis of athwartship considered~~

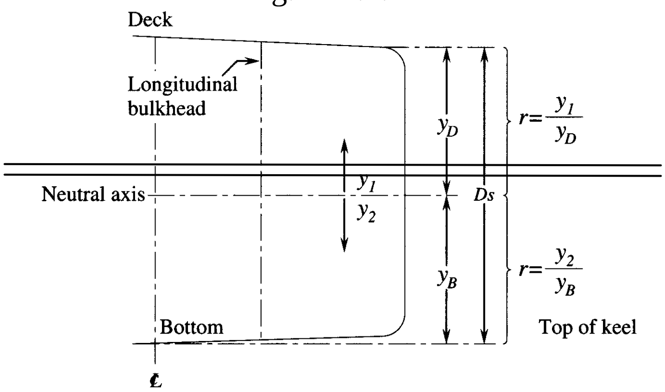
~~y_D: Vertical distance (m) from neutral axis to deck~~

~~y_B: Vertical distance (m) from base line to neutral axis~~

~~y_1: Vertical distance (m) from neutral axis to upper edge of each strake, but it does not need to be greater than y_D~~

~~y_2: Vertical distance (m) from neutral axis to lower edge of each strake, but it does not need to be greater than y_B~~

~~Fig. C15.4.1-1~~



1 "Other measures as deemed appropriate by the Society" specified in **15.4.1-3, Part C of the Rules** refer to buckling strength assessments in **(1)** and apply to plate members in transverse system. However, in cases where buckling strength is assessed by **(1)**, the transverse section of the hull in which the plates are located is to satisfy the requirements in **(2)** regarding hull girder ultimate strength.

(1) Buckling Strength Assessment

(a) Criteria of Buckling Strength Assessment

Buckling strength of plate panels is to satisfy the following criteria. "Plate panel" refers to the part of the plating between stiffeners and/or primary supporting members where all edges are forced to remain straight due to the surrounding structure/neighbouring plates.

$\eta_{plate} \leq 1$

η_{plate}: Buckling utilisation factor, to be taken as follows:

$$\eta_{plate} = \frac{\sigma_a}{\sigma_{cy}}$$ for compressive stress

$\eta_{plate} = \dfrac{|\tau_a|}{\tau_c}$ for shear stress

σ_a : Compressive stress working on the plates considered, as given in **15.4.2-1, Part C of the Rules**. However, σ_a may be taken at mid-point of the length of the plate panel, and edge stress ratio ψ_y of plate panel may be regarded as 1.

τ_a : Shear stress working on the plates considered, as given in **15.4.2-2, Part C of the Rules**

σ_{cy} : Ultimate buckling stress (N/mm^2) of plate panels in direction parallel to the shorter edge of the buckling panel as defined in **(b)ii)**

τ_c : Ultimate buckling stress (N/mm^2) of plate panels subject to shear, as defined in **(b)ii)**

(b) Ultimate Buckling Stress

i) Boundary Condition for Plates

The boundary conditions for plates are to be considered as simply supported, see cases 2 and 15 of **Table 4, Annex C32.2.7 "Guidance for Buckling Strength Assessment"**. If the boundary conditions differ significantly from simple support, a more appropriate boundary condition can be applied according to the different cases of **Table 4, Annex C32.2.7 "Guidance for Buckling Strength Assessment"** subject to the agreement of the Society.

ii) Ultimate Buckling Compressive Stress and Ultimate Buckling Shear Stress

Ultimate buckling compressive stress σ_{cy} (N/mm^2) of plates is to be taken as follows:

$$\sigma_{cy} = C_y \sigma_{YP}$$

Ultimate buckling shear stress τ_c (N/mm^2) of plates is to be taken as follows:

$$\tau_c = C_\tau \frac{\sigma_{YP}}{\sqrt{3}}$$

σ_{YP} : Specified minimum yield stress (N/mm^2) of the plate

C_y, C_τ : Reduction factors defined in **Table 4, Annex C32.2.7 "Guidance for Buckling Strength Assessment"**. In addition, c_1 and reference degree of slenderness λ used for calculating C_y and C_τ are to be taken as follows:

$$c_1 = \left(1 - \frac{1}{\alpha}\right) \geq 0$$

α : Aspect ratio of the plate panel, to be taken as follows:

$$\alpha = \frac{a}{b}$$

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

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

$$\lambda = \sqrt{\frac{\sigma_{YP}}{K\sigma_E}}$$

K: Buckling factor K_y or K_τ, as defined in **Table 4, Annex C32.2.7 "Guidance for Buckling Strength Assessment"**. However, buckling factor K_y which is calculated according to case 2 of **Table 4, Annex C32.2.7 "Guidance for Buckling Strength Assessment"** to be multiplied by correction factor F_{tran}. Correction factor F_{tran} is to be taken as follows:

- For plate panels of side shell:
  - When the two adjacent frames are supported by one tripping bracket fitted in way of the adjacent plate panels:
    $F_{tran} = 1.25$
  - When the two adjacent frames are supported by two tripping brackets each fitted in way of the adjacent plate panels:
    $F_{tran} = 1.33$
  - Elsewhere:
    $F_{tran} = 1.15$
- For plate panels other than side shell, when ends of stiffeners arranged at longer side of plate panels have lug-connections:
  $F_{tran} = 1.15$
- Elsewhere:
  $F_{tran} = 1$

σ_E: Elastic buckling reference stress, to be taken as follows:

$$\sigma_E = \frac{\pi^2 E}{12(1-\nu^2)}\left(\frac{t_p}{b}\right)^2$$

E: Young's modulus (N/mm^2), to be taken as 2.06×10^5

ν: Poisson's ratio, to be taken as 0.3

t_p: Thickness of plate panels (mm) considering standard deductions specified in **Table C15.2, Part C of the Rules**. In cases where plates within a plate panel are different in thickness, area-averaged thickness may be used.

(2) Hull Girder Ultimate Strength Assessment

The following formula is to be satisfied:

$$\gamma_S M_S + \gamma_W M_W \le \frac{M_U}{\gamma_M \gamma_{DB} \gamma_{CORR}}$$

γ_S: Partial safety factor for the longitudinal bending moment in still water, to be taken as follows:

$\gamma_S = 1.0$

γ_W : Partial safety factor for wave induced longitudinal bending moment, to be taken as follows

$\gamma_W = 1.2$

M_S, M_W : Longitudinal bending moment in still water and wave induced longitudinal bending moment as given in **15.2.1-1, Part C of the Rules**.

M_U: Hull girder ultimate bending moment capacity, calculated by the method defined in **Annex C32.2.8-1"Guidance for the Hull Girder Ultimate Strength Assessment"**. M_U is to be calculated using gross scantling. In addition, the following is to be used for calculation in lieu of the load-end shortening curve $\sigma_{CR5} - \varepsilon$ defined in **2.2.3-7, Annex C32.2.8-1"Guidance for the Hull Girder Ultimate Strength Assessment"**.

$$\sigma_{CR5} = \min \begin{cases} \sigma_{YP}\,\Phi \\ \Phi\,\sigma_{YP}\left[\dfrac{s}{\ell}\left(\dfrac{2.25}{\beta_E} - \dfrac{1.25}{\beta_E^2}\right) + \left(1 - \dfrac{s}{\ell}\right)\left(\dfrac{0.06}{\beta_E} + \dfrac{0.6}{\beta_E^2}\right)\right] \end{cases}$$

σ_{YP} : Minimum yield stress of the material of the considered plate (N/mm^2)

Φ, β_E, s, ℓ : As specified in **2.2.3-7, Annex C32.2.8-1"Guidance for the Hull Girder Ultimate Strength Assessment"**

γ_M : Partial safety factor for the hull girder ultimate strength, to be taken as follows

$\gamma_M = 1.05$

γ_{DB} : Partial safety factor for the hull girder ultimate bending moment capacity, considering the effect of double bottom bending, to be taken as follows

・For hogging condition : $\gamma_{DB} = 1.1$

・For sagging condition : $\gamma_{DB} = 1.0$

γ_{CORR} : Partial safety factor considering corrosion, to be taken as follows

$\gamma_{CORR} = 1.1$

C32 CONTAINER CARRIERS

Section C32.3 has been amended as follows.

C32.3 Torsional Strength

C32.3.1 ~~General~~Application

1 ~~The torsional strength of the hull is to comply with the following **(1)** or **(2)**:~~"Torsional strength assessments deemed appropriate by the Society" in **32.3.1-2, Part C of the Rules** means that the following relationship is satisfied at each sectional position from collision bulkheads to the watertight bulkheads at the fore ends of machinery spaces.

~~(1) The torsional strength of the hull at each sectional position from the collision bulkhead to the watertight bulkhead at the fore end of the machinery space is to be such that the following relationship is satisfied.~~

$$\sqrt{(0.75\sigma_V)^2 + \sigma_H^2 + \sigma_\omega^2} + \sigma_S \leq \frac{1000}{5.72K}$$

where

σ_S, σ_V and σ_H : As obtained from the following formula

However, warping stress is ~~to be~~ added to σ_S ~~when torsional moment is generated in the ship~~in cases where torsional moment by unbalanced loading of cargoes is considered.

$$\sigma_S = 1000\frac{|M_S|}{Z_V}$$

$$\sigma_V = 1000\frac{M_W}{Z_V}$$

$$\sigma_H = 1000\frac{M_H}{Z_H}$$

M_S, M_W : Vertical still water bending moment and vertical wave induced bending moment for the load cases "hogging" and "sagging" as specified in **32.2.3-8, Part C of the Rules**

M_H : As obtained from the following formula:

~~$0.45C_1L^2d(C_b+0.05)C_H$~~ $0.45C_1L_1^2d(C_b+0.05)C_H$ $(kN\text{-}m)$

C_H : Coefficient, as given in **Table C32.3.1-1**, based on the ratio of L_1 to x, where x is the distance (m) from the aft end of L_1 to the section under consideration. Intermediate values are to be determined by interpolation.

Z_V : Section modulus (cm^3) of strength deck based upon a gross scantling approach with respect to longitudinal bending of the hull at the position of the section under consideration

Z_H : Section modulus (cm^3) of hatch side based upon a gross scantling approach with respect to horizontal bending of the hull at the position of the section under consideration

C_1 : As specified in ~~15.2.1-1~~**32.3.4-1, Part C of the Rules**

Table C32.3.1-1 Coefficient C_H

x/L_1	0.0	0.4	0.7	1.0
C_H	0.0	1.0	1.0	0.0

σ_ω : Warping stress (N/mm^2) due to torsion of the hull calculated according to the following formula for ships of ordinary construction using the dimensions and scantlings at the midship section.
Values for other types are to be in accordance with the discretion of the Society.

$$\sigma_\omega = 0.000318 \frac{\omega l_C M_T}{I_\omega + 0.04 l_C^2 J}$$

M_T : As given by the following formula:

$$~~M_T = 7.0K_2C_w^2B^3\left(1.75+1.5\frac{e}{D_S}\right)~~ \; 7.0K_2{C_W}^2B^3\left(1.75+1.5\frac{e}{D_S}\right) \quad (kN\text{-}m)$$

~~C_w~~ C_W : ~~Water plane area coefficient~~As specified in **32.3.4-2, Part C of the Rules**

e : As specified in **C32.3.4** or as given by the following formula:

$$e = e_1 - \frac{d_0}{2}$$

e_1 : As given by the following formula:

$$e_1 = \frac{(3D_1 - d_1)d_1t_d + (D_1 - d_1)^2 t_S}{3d_1t_d + 2(D_1 - d_1)t_S + B_1t_b/3}$$

d_0 : Height of double bottom (m)

d_1 : Breadth of double hull side (m)

D_1 : As given by the following formula:

$$D_1 = D_S - \frac{d_0}{2}$$

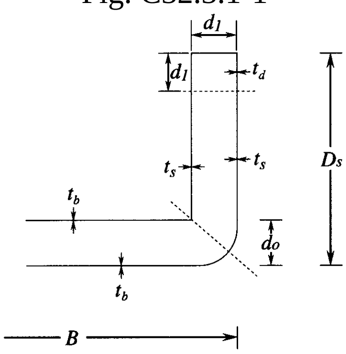
B_1 : As given by the following formula:

$$B_1 = B - d_1$$

t_d, t_s, t_b : Mean thickness (m) of deck, ship side, and bottom based upon a gross scantling approach specified in **Fig. C32.3.1-1**

Mean thickness may be determined by including all the longitudinal strength members located within this range.

Fig. C32.3.1-1



K_2 : As given by the following formulae:

$$K_2 = \sqrt{1-\left(\frac{300-L_1}{300}\right)^2} \quad \text{for ships with } L_1 < 300\ m$$

1.0 for ships with $L_1 \geq 300\ m$

ω: As given by the following formula:

$$\omega = \frac{B_1}{2}(D_1 - e_1) + \frac{d_1}{2}(D_1 + e_1)$$

l_C : Distance (m) from the collision bulkhead to watertight bulkhead of the fore end of the machinery room

I_ω : As given by the following formula:

$$I_\omega = B_1^2\{d_1 t_d I_d + (D_1 - d_1)t_S I_S + B_1 t_b I_b\}$$

I_d : As given by the following formula:

$$I_d = (D_1 - e_1)\left\{\frac{3}{2}(D_1 - e_1) - d_1\right\} + \frac{d_1^2}{3}$$

I_S : As given by the following formula:

$$I_S = (D_1 - d_1)\left\{\frac{1}{3}(D_1 - d_1) - e_1\right\} + e_1^2$$

I_b : As given by the following formula:

$$I_b = \frac{e_1^2}{6}$$

J : As given by the following formula

However, the mean thicknesses of t'_d, t'_S, t'_b (m) based upon a gross scantling approach are to be calculated using only the strength deck, side shell, bottom shell, inner bottom and longitudinal bulkhead plating. Other longitudinal strength members are not to be included.

$$J = \frac{2\{Bd_0 + 2(D_S - d_0)d_1\}^2}{3d_1/t'_d + 2(D_1 - d_1)/t'_S + B_1/t'_b}$$

K : Coefficient corresponding to the kind of steel

e.g., 1.0 for mild steel, the values specified in **1.1.7-2(1), Part C of the Rules** for high tensile steel

2 Notwithstanding the requirements of **-1** above, the torsional strength assessments specified in **32.3, Part C of the Rules** may be carried out in cases where deemed appropriate by the Society.

~~(2) Torsional strength assessments are to be carried out in accordance with the **"Guidelines for Hull Girder Torsional Strength Assessment"** in the **"Guidelines for Container Carrier Structures"** In such cases, the vertical wave induced bending moment to be considered is specified in **32.2.3-6 of the Rules**.~~

~~**2** Notwithstanding the requirements of **-1** above, torsional strength assessments specified in **-1(2)** above are to be carried out for any of the following cases.~~

~~(1) Ships not less than 290m in length L_1;~~

~~(2) Ships exceeding 32.26m in breadth B; or~~

~~(3) When deemed necessary by the Society.~~

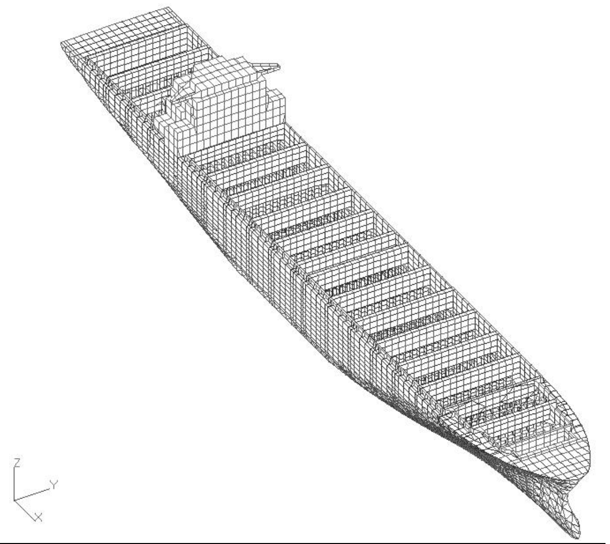
C32.3.4 Loads

The location of "shear centre" referred to in **32.3.4-2(2), Part C of the Rules** may be obtained by calculating the point of action of shear force so that the torsional moment is not generated in cross sections when horizontal shear force is acting. **Annex C32.2.3-4 "GUIDANCE FOR CALCULATION OF SHEAR FLOW"** may be applied to calculate the location of the shear centre.

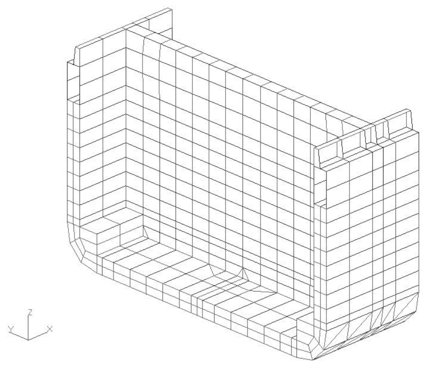
C32.3.5 Modelling for Structural Analysis

1 Examples of structural models are shown in **Fig. C32.3.5-1**.

Fig. C32.3.5-1 Structural Model



(a) Overview



(b) Around Bulkhead

2 For the meshing of element required in **32.3.5-5, Part C of the Rules**, the following **(1)** and **(2)** are to be taken as the standard size of the meshing.

(1) The length of one edge of the meshing is to be roughly the distance between floors.

(2) The aspect ratio of the meshing is to be standardized as 1.0. (Meshings with aspect ratios quite different from 1.0 are to be avoided as much as possible).

3 Regarding the application of **32.3.6-2, Part C of the Rules**, boundary conditions that constrain the translational and rotational deflections are to be given at locations where reaction forces are considered to be small. Examples of such boundary conditions are shown in **Fig. C32.3.5-2**.

Fig. C32.3.5-2. Examples of boundary conditions for torsional moments

(a) Example 1

(b) Example 2

C32.3.6 Calculation of Stresses due to Vertical Bending Moment and Horizontal Bending Moment

1 Regarding the application of **32.3.5-6, Part C of the Rules**, boundary conditions which do not generate torsional deformation are to be given in order to calculate stress due to horizontal bending moments. Examples of boundary conditions for vertical bending moments and horizontal bending moments are shown in **Fig. C32.3.6-1** and **Fig. C32.3.6-2**.

Fig. C32.3.6-1 Examples of Boundary Conditions for Vertical Bending Moments

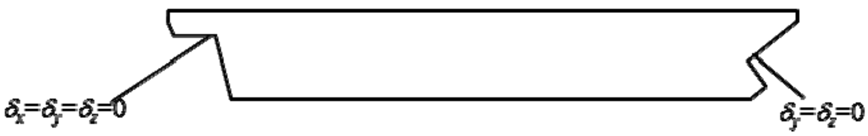
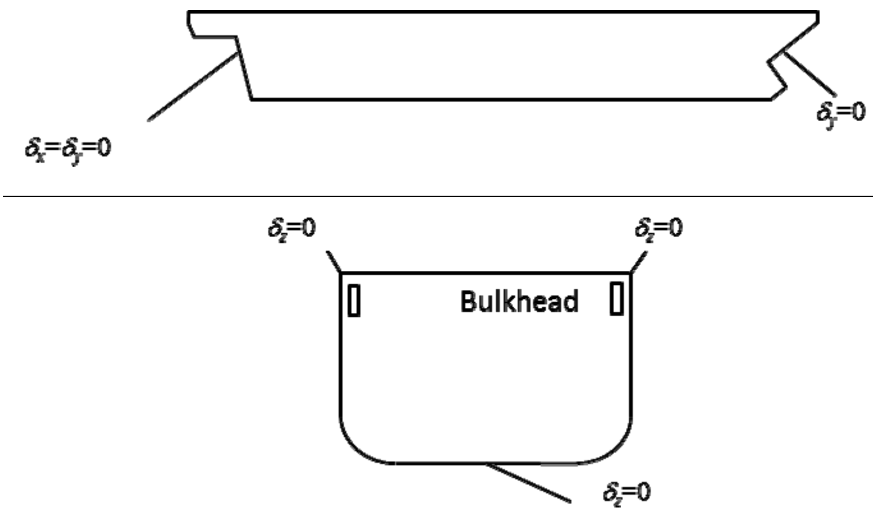


Fig. C32.3.6-2 Examples of Boundary Conditions for Horizontal Bending Moments

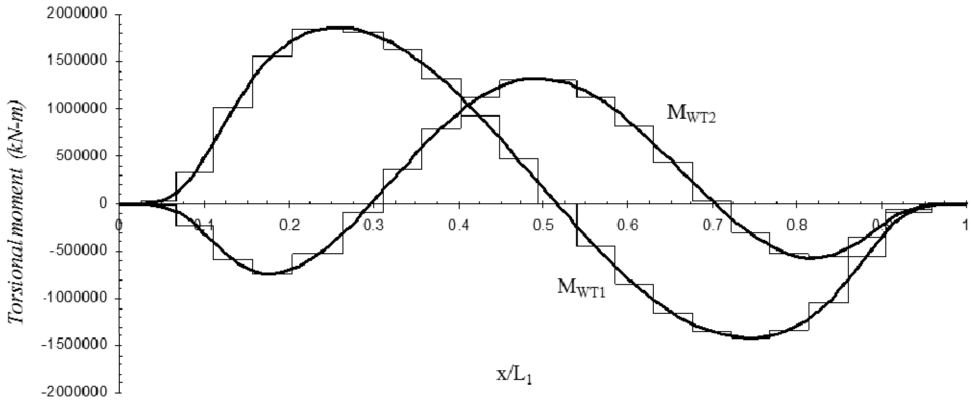


C32.3.7 Calculation of Warping Stresses due to Torsional Moment

1 Regarding the application of **32.3.7, Part C of the Rules**, 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. C32.3.7-1**.

Fig. C32.3.7-1 Torsional Moment Acting on a Hull Girder
(Approximated Torsional Step Moment)



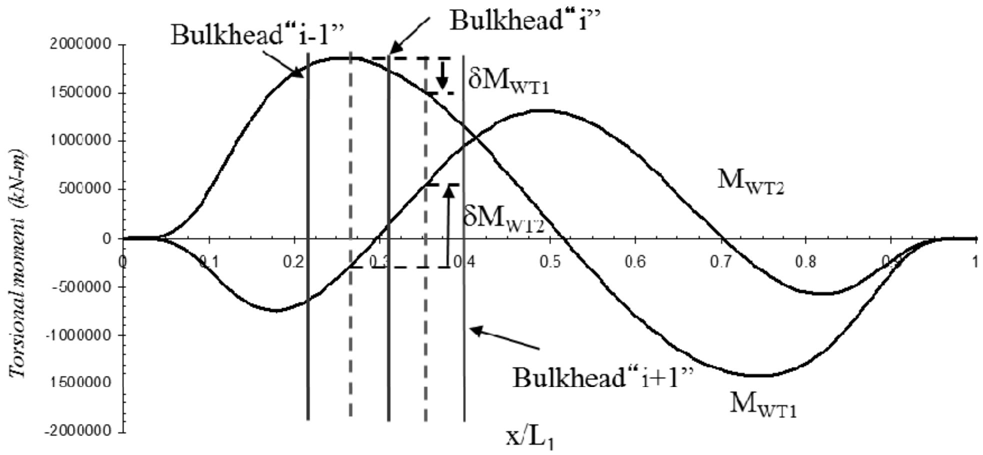
(2) Torsional moments applied to bulkheads are the net change in torsional moment over the effective range of the bulkhead. The effective range of a bulkhead is the distance between the midpoints of the two adjacent bulkheads. The torsional moments at bulkhead "*i*" are specified as the following formulae (See **Fig. C32.3.7-2**):

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

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

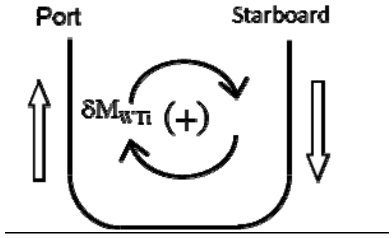
X_i : X-coordinate of bulkhead "*i*"

Fig. C32.3.7-2. Torsional moment applied to 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. C32.3.7-3**.

Fig. C32.3.7-3 Torsional moment reproduction due to shear force



C32.3.9 Yield Strength Assessment

Average stress corresponding to standard mesh size as specified in **C32.3.5-2** may be used in cases where mesh finer than standard mesh size is used.

C32.3.10 Buckling Strength Assessment

1 The requirements in **C32.9.9** are applied correspondingly for buckling assessments.

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

(1) Bilge strakes longitudinally stiffened and the longitudinal stiffeners attached to said bilge strakes are to satisfy the following **(a)** and **(b)**. These requirements may be applied in cases where the bilge strake net thickness is not less than 14.5 *mm* and the bilge radius is not greater than 8*m*.

(a) The evaluated stress determined in accordance with **32.3.8, Part C of the Rules** is not greater than 0.9 times the specified minimum yield stress of the relevant steel or 320 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 thickness (*mm*)

S: Stiffener spacing (*m*). To be taken as the girth length.

R: Bilge radius (*m*)

(2) The evaluated stress determined in accordance with **32.3.8, Part C of the Rules** is not to be greater than 0.9 times the buckling strength obtained using non-linear analysis, etc.

Annex C34.1.2 GUIDANCE FOR PREPARATION OF LOADING MANUAL

1.2 Contents to be Included in the Introduction

1.2.4 Allowable Values for Torsional Moment of Hull due to Uneven Cargo Stowage

Sub-paragraph -1 has been amended as follows.

1 For ships to which the requirements in ~~**Chapter**~~ **32.3.1-1, Part C of the Rules** apply, the values of torsional moment of hull due to uneven cargo stowage ~~which is considered in the requirements in C32.3.1~~ are to be specified as the allowable value in the manual. In cases where the values of torsional moments of hull due to uneven cargo stowage are to be considered for ships subject to the requirements in **C32.3.1**, the torsional moments are to be taken as the allowable values in the manual.

Appendix C1 REFERENCE DATA FOR DESIGN

Section 1.7 has been amended as follows.

1.7 Standard Value of ~~Twisting~~Torsional Moment of Hull due to Uneven Cargo Stowage in Container Carriers (C32.3.1 of the Guidance)

1.7.1

"The ~~twisting~~torsional moment generated in the hull due to uneven cargo stowage" to be considered in applying the requirements of **C32.3.1 of the Guidance** ~~is to~~may be the following M_{TC} value, as a standard:

$$M_{TC} = 0.23 L N_R W_C \quad (kN\text{-}m)$$

Where:

N_R : Maximum number of rows of containers loaded in a cargo hold

W_C : Mean weight per 20 *ft* container which is normally taken as 100 *kN*

The warping stress (N/mm^2) acting on the hull due to M_{TC} may be obtained from the following formula:

$$\sigma_{\omega c} = 0.000318 \frac{\omega l_C M_{TC}}{I_\omega + 0.04 l_C^2 J}$$

Where:

ω, l_C, I_ω and J : As specified in **C32.3.1 of the Guidance**

EFFECTIVE DATE AND APPLICATION

1. The effective date of the Guidance is 1 December 2017.
2. Notwithstanding the amendments to the Guidance, the current requirements apply to ships for which the date of contract for construction is before the effective date.