CHINA CLASSIFICATION SOCIETY

RULES FOR CONSTRUCTION OF SEA-GOING SHIPS ENGAGED ON DOMESTIC VOYAGES

AMENDMENTS

2023

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PART TWO HULL

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.2 Definitions

1.1.2.20 Load line length L_L (in m) is the ship's length as defined in the Technical Regulations for the Statutory Surveys of Sea-going Ships Engaged on Domestic Voyages, PART THREE~~, Chapter 1, 2.1(1)~~.

1.1.2.21 Position 1 is as defined in the Technical Regulations for the Statutory Surveys of Sea-going Ships Engaged on Domestic Voyages, PART THREE ~~upon exposed freeboard and raised quarterdecks, and upon exposed superstructure decks situated forward of a point located a quarter of the load line length from the forward perpendicular~~.

1.1.2.22 Position 2 is as defined in the Technical Regulations for the Statutory Surveys of Sea-going Ships Engaged on Domestic Voyages, PART THREE~~upon exposed superstructure decks situated abaft a quarter of the ship's length from the forward perpendicular and located at least one standard height of superstructure above the freeboard deck, and upon exposed superstructure decks situated forward of a quarter of the load line length from the forward perpendicular and located at least two standard heights of superstructure above the freeboard deck~~.

Section 4 WELD DESIGN FOR HULL STRUCTURES

1.4.2 Welding consumables

1.4.2.3 Low hydrogen ~~electrodes~~ welding consumables are to be used for the welding of the following structural members and components:

(1) Circumferential butt welds in the joining of block sections and butt welds of girders;

(2) End and side joints of the shell of ships with ice strengthening;

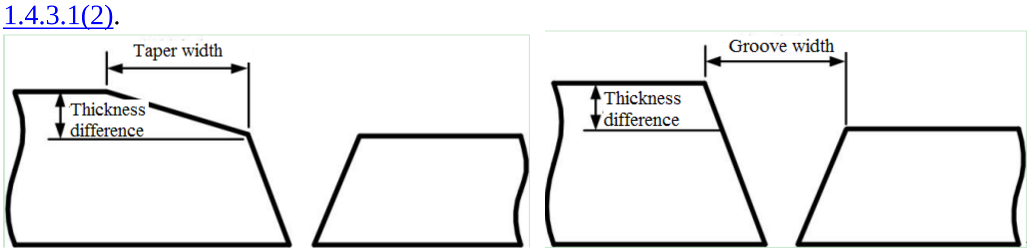
(3) Masts, derricks, boat davits, bollards and other outfits subjected to heavy loads and all other highly stressed fittings;

(4) Components for which high rigidity is required, such as stems, stern frames, propeller shaft brackets, and joints between them and the shell plating and the hull framing;

(5) Main engine seatings and the associated structural members.

1.4.3 Butt, lap and slot welds

1.4.3.1 Where plates of different thicknesses are to be butt welded and the difference in thickness is ~~equal to or~~ greater than 4 mm, the edge of the thicker plate is to be tapered so as to ensure a uniform transition. The width of taper is not to be less than 3 times the difference in thickness, as shown in Figure 1.4.3.1(1). Where the difference in thickness is ~~less~~ more than 4 mm and the groove width is not less than 3 times the difference in thickness, taper may not be necessary and the transition may be achieved within the width of the weld, as shown in Figure 1.4.3.1(2).



(1) (2)

Figure 1.4.3.1 Butt welding of steel plates of different thickness

1.4.4 Fillet welds

1.4.4.13 Single-sided continuous fillet welding may be acceptable for dry spaces in deckhouse. Where this is adopted, the fillet leg length K is to be 2 times the value calculated in 1.4.4.2, where *d* / *l* is to be taken as 1.

~~1.7.3.2 For ships equal to or greater than 65 m in length, the thickness of shell plating and decks is to be determined by taking the values of the reduction factors F_d and F_b in Section 2 of Chapter 2 of this PART, where the values are less than 1, the thickness of shell plating and main deck within the range of 0.4L amidships is not to be reduced in accordance with the requirements in 1.7.3.1 of this Section.~~

1.7.3.2 For ships equal to or greater than 65 m in length, where the values of the reduction factors F_d and/or F_b required in Section 2 of Chapter 2 of PART TWO are less than 1, the following requirements are to be complied with when calculating the thickness of shell plating and main deck within 0.4L amidships:

(1) where the value of F_d is less than 1, the thickness of main deck and sheer strake is not to be reduced in accordance with the requirements of 1.7.3.1 of this Section;

(2) where the value of F_b is less than 1, the thickness of bottom plating and bilge strake is not to be reduced in accordance with the requirements of 1.7.3.1 of this Section;

(3) where the value of F_d or F_b is less than 1, the thickness of side shell plating is not to be reduced in accordance with the requirements of 1.7.3.1 of this Section.

1.7.3.4 The requirements for ~~minimum~~ thickness of plating after reduction

(1) For ships of less than 65 m in length, the ~~minimum~~ thickness of shell plating is to be not less than 5 mm.

(2) For ships of less than 65 m in length, the ~~minimum~~ thickness of strength deck is to be not less than 5 mm and the ~~minimum~~ thickness of other decks is to be not less than 4 mm.

(3) For ships of less than 65 m in length, the ~~minimum~~ thickness of inner bottom plating in double bottom is to be not less than 5 mm.

(4) For ships of less than 65 m in length, the ~~minimum~~ thickness of weathertight steel hatch covers is to be not less than 5 mm.

CHAPTER 2 HULL STRUCTURES

Section 15 STRENGTHENING AT ENDS OF SHIP

2.15.1 Fore peak strengthening

2.15.1.6 Where a fore peak space is used as a tank and the breadth of the tank at its widest point exceeds 0.5B (B being the breadth of ship), efficient supporting members or wash bulkheads are to be fitted to support the panting beams. The wash bulkheads are to comply with the requirements of 2.13.10.2 of this Chapter.

2.15.1.7 Where the length of the fore peak space exceeds 10 m, additional transverse strengthening in the form of transverse wash bulkheads or web frames is to be provided. Transverse wash bulkheads are to comply with the provisions in 2.13.10.2 of this Chapter while web frames are to comply with the provisions in 2.7.2.8 of this Chapter.

Section 20 HATCHWAYS AND HATCH COVERS

2.20.2 Weathertight steel hatch covers

2.20.2.4 Strength calculation

(2) General requirements for FEM calculations

For strength calculations of hatch covers by means of finite elements, the cover geometry is to be idealized as realistically as possible. Element size is to be appropriate to account for effective breadth. In no case element width is to be larger than stiffener spacing. In way of force transfer points and cutouts the mesh has to be refined where applicable. The ratio of element length to width is not to exceed 4.

The element height of webs of primary supporting members is not to exceed one-third of the web height. Stiffeners and supporting plates against pressure loads have to be included in the idealization. Stiffeners may be modelled using shell elements, plane stress elements or beam elements. Buckling stiffeners may be disregarded for the stress calculation.

① A right-handed coordinate system is to be used with:

the *x*-axis measured in the longitudinal direction, positive forward;

the *y*-axis measured in the transverse direction, positive to port from the centerline;

the *z*-axis measured in the vertical direction, position upward.

② The FEM is to be performed with net scantlings.

③ The finite element model is to be limited as follows:

(a) for symmetry of the hatch cover girders, ~~or~~ loads and supporting boundary conditions about only the x-axis or y-axis, it may be limited to a half of the hatch cover for check;

(b) for non-symmetry of hatch cover girders, ~~or~~ loads or supporting boundary conditions about any of the axes, the whole hatch cover may be taken for strength evaluation, see Figure 2.20.2.4(1).

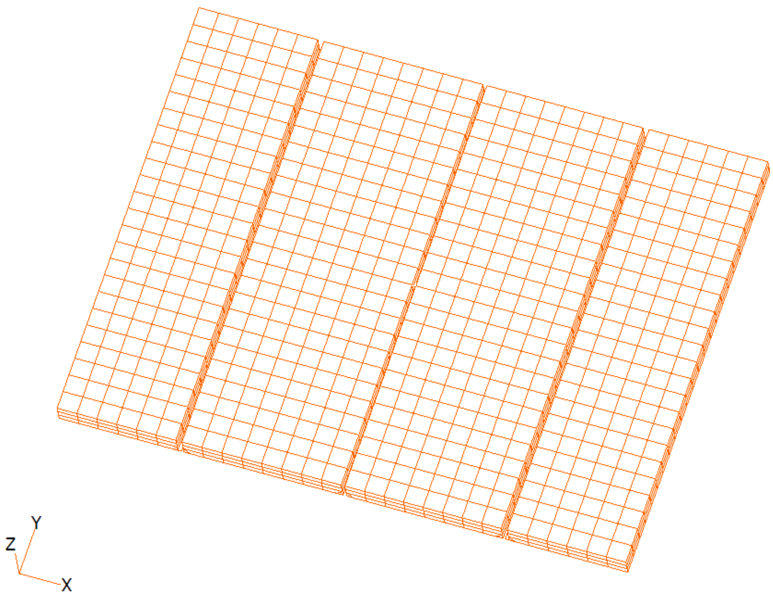


Figure 2.20.2.4(1) Finite Element Hatch Cover Model

④ The model element is to comply with the following requirements:

(a) all plating, including girders and stiffeners, is to be represented by the finite element model;

(b) all plating, such as top plates, bottom plates, brackets, and girder webs, face plates of primary supporting members is to modeled using plate elements, triangular elements are to be avoided where possible;

(c) all stiffeners are to be modeled using beam, rod or plate elements.

⑤ The element mesh size is to be controlled as follows:

(a) the mesh size is not to be greater than the spacing of stiffeners;

(b) the girders are to be represented by at least 3 elements in the depth;

(c) triangular and distorted quadrilateral elements with corner angles less than 60 degrees and greater than 120 degrees are to be avoided.

⑥ Boundary conditions are to be determined as follows:

(a) for symmetry of the hatch cover girders and loads about the x-axis, the longitudinal displacement of nodes in the symmetric plane and the rotations about the *y* and *z* axes are to be taken as 0 respectively, i.e. $\delta_x = \theta_y = \theta_z = 0$, as shown in Figure 2.20.2.4(2);

(b) for symmetry of the hatch cover girders and loads about the *y*-axis, the transverse displacement of nodes in the symmetric plane and rotation about the *x* and *z* axes are to be taken as 0 respectively i.e. $\delta_y = \theta_x = \theta_z = 0$, as shown in Figure 2.20.2.4(2);

(c) boundary nodes in way of bearing pads on the hatch coamings are generally to be fixed against displacement in the *z* direction, i.e. $\delta_z = 0$;

(d) lifting stoppers are to be fixed against displacements in the direction determined by the stoppers;

(e) hinges in folding type hatch covers are to be represented as rigid links which tie together displacements in the *z* direction.

Section 22 STRENGTHENED FOR HEAVY CARGOES

2.22.1 General requirements

2.22.1.1 This Section applies to ~~dry cargo~~ ships with strengthened for heavy cargoes.

2.22.1.2 Ships of loading rate γ not greater than 0.833m^3/t (see 1.1.2.15 of Chapter 1) are to comply with the requirements of this Section, except when loaded by steel coils on a wooden support.

2.22.1.3 Special considerations are to be given to strengthening requirements where the inner bottom plating of the cargo hold is loaded by bulky cargo or bearing concentrated load.

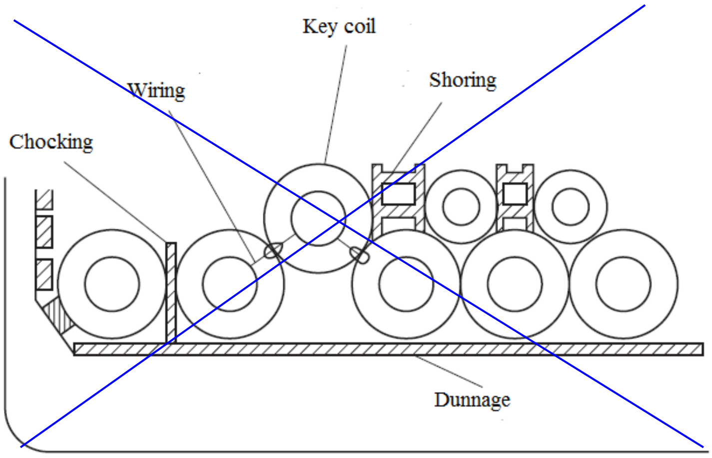
Section 24 ~~INNER BOTTOM~~STRUCTURAL STRENGTHENING LOADED BY STEEL COILS ON A WOODEN SUPPORT

2.24.1 General requirements

2.24.1.1 The thickness of inner bottom plating, bilge hopper sloping plate and inner hull plating up to a height not less than the one corresponding to the top of upper tier in touch with hopper or inner hull plating as well as section modulus and shear area of stiffeners for ships intended to carry steel coils are to comply with the requirements of this Section.

2.24.1.2 The provision is determined based on the assumption of Figure 2.24.1.2 as the standard means of securing steel coils on the dunnage.

2.24.1.3 All steel coils are presumed to be of the same characters.



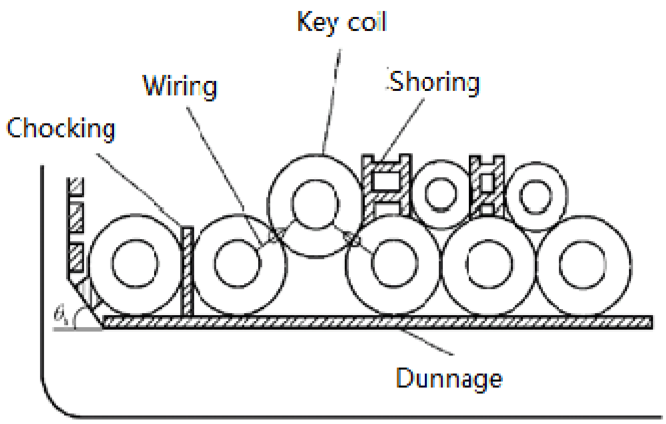


Figure 2.24.1.2 Inner Bottom Loaded by Steel Coils

2.24.2 Accelerations

2.24.2.1 In order to calculate the accelerations, the following coordinates are to be used for the transverse and vertical positions of calculated point:

$$y_{G-SC} = \begin{cases} B_h/4 & \text{for port} \\ -B_h/4 & \text{for starboard} \end{cases}$$

$$z_{G-SC} = h_{DB} + \left\{1 + (n_1 - 1)\frac{\sqrt{3}}{2}\right\}\frac{d_{SC}}{2}$$

where: B_h — breadth in m, at the mid of the hold, of the cargo hold at the level of connection of bilge hopper plate with side shell or inner hull;

d_{sc} — diameter of steel coils, in m;

h_{DB} — depth of double bottom, in m.

Vertical acceleration a_v, in m/s^2, are to be calculated by the formulae defined in 1.5.2 of Section 5, Chapter 1 of this PART and tangential acceleration a_R due to roll, in m/s^2, is to be calculated by the following formula:

$$a_R = \varphi_m \left(\frac{2\pi}{T_R}\right)^2 \sqrt{y_{G-SC}{}^2 + R^2}$$

where: φ_m, maximum angle of roll, T_R, roll period — see the formulae defined in 1.5.2 of Section 5, Chapter 1 of this PART;

$$R = z_{G-SC} - \min\left(\frac{D}{4} + \frac{d}{2}, \frac{D}{2}\right)$$

where: d — draught, in m.

2.24.3 Inner bottom plating

2.24.3.1 The thickness of plating of longitudinally framed inner bottom is not to be less than the value obtained, in mm, from the following formula:

$$t = K_1 \sqrt{\frac{(g + 0.5a_v)F_{SC}K}{235\lambda_p}} + 2.5 \quad \text{mm}$$

$$t = K_1 \sqrt{\frac{(g + 0.5a_v)F_{SC}}{\lambda_p R_{eH}}} + t_c \quad \text{mm}$$

where: K_1— coefficient taken equal to:

$$K_1 = \sqrt{\frac{1.7slK_2 - 0.73s^2K_2^2 - (l - l')^2}{2l'(2s + 2lK_2)}}$$

t_c ——corrosion addition, in mm, generally taken 2.5mm, to be taken 5 mm where the cargo holds are designed for loading/unloading by grabs;

a_v ——vertical acceleration, in m/s^2, calculated according to the formula defined in 1.5.2, Section 5, Chapter 1 of this PART;

g ——acceleration due to gravity, g = 9.81 m/s^2;

F_{SC}——equivalent mass of steel coils, in kg, taken equal to:

$$F_{SC} = K_S \frac{W_{SC} n_1 n_2}{n_3}, \text{ for } n_2 \le 10 \text{ and } n_3 \le 5$$

$$F_{SC} = K_S n_1 W_{SC} \frac{l}{l_s}, \text{ for } n_2 > 10 \text{ and } n_3 > 5$$

λ_p ——permissible bending stress coefficient of plating, generally taken 0.8, to be taken 0.9 as the calculated structural member is not contributing to the hull girder longitudinal strength;

l — length of long edge of elementary plate panel taken along the side length, in m;

s — length of short edge of elementary plate panel taken along the side length in way of middle of span l, in m;

K_s— coefficient, taken equal to:

K_s =1.4 when steel coils are lined up in one tier with a key coil;

K_s =1.0 in other cases;

W_{SC}— mass of one steel coil, in kg;

K — material factor;

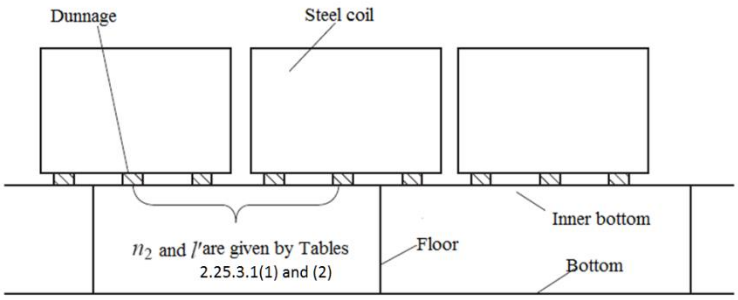
R_{eH}——minimum yield stress of material, in N/mm^2;

n_1— number of tiers of steel coils;

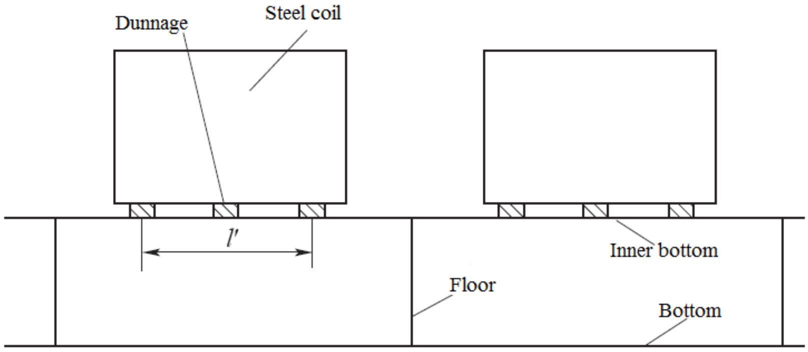
n_2— number of load points per elementary plate panel of inner bottom (see Figure 2.24.3.1). ~~When n3 ≤ 5, n_2 may be obtained from Table 2.24.3.1(1) according to values of n3 and l/ls.~~ For steel coil loading related to floor plates of inner bottom (see Figure 2.24.3.1(2)), $n_2 = n_3$; for steel coil loading irrelevant to floor plates of inner bottom (see Figure 2.24.3.1(1)), n_2 is to be consistent with Table 2.24.3.1(1). For cases not included in Table 2.24.3.1(1), n_2 is to be determined in accordance with the following formula:

$$\frac{n_2-1}{n_3}+INT\left(\frac{n_2-1}{n_3}\right)\cdot 0.2<\frac{l}{l_s}\leq\frac{n_2}{n_3}+INT\left(\frac{n_2}{n_3}\right)\cdot 0.2$$

where: $INT(\ )$ is the integral function, taking the integral parts of values.



(1)



(2)

Figure 2.24.3.1 Loading Condition of Steel Coils

n_3— number of dunnages supporting one steel coil;

l_s— length of a steel coil, in m;

K_2— coefficient taken equal to:

$$K_2=-\frac{s}{l}+\sqrt{\left(\frac{s}{l}\right)^2+1.37\left(\frac{l}{s}\right)^2\left(1-\frac{l'}{l}\right)^2+2.33}$$

l'— distance, in m, between outermost load points per elementary plate panel in ship's length (see Figure 2.24.3.1). ~~When n2 ≤10 and n3 ≤ 5, l5 may be obtained from Table 2.24.3.1(2), according to the values of l, ls, n2 and n3. When n2 > 10 or n3 > 5, l' is to be taken equal to l.~~ For steel coil loading related to floor plates of inner bottom (see Figure 2.24.3.1(2)), l' is to be the distance between the dunnages of the external ends supporting the steel coils; for steel coil loading irrelevant to floor plates of inner bottom (see Figure 2.24.3.1(1)), l' is to be consistent with Table 2.24.3.1(2). For cases not included in Table 2.24.3.1(2), l' is to be determined in accordance with the following formula:

$$l' = \left(\frac{n_2 - 1}{n_3} + 0.2 \cdot INT\left(\frac{n_2}{n_3}\right)\right) l_s$$

where: $INT(\ )$ is the integral function, taking the integral parts of values.

Number $n2$ of Load Points per Elementary Plate Panel **Table 2.24.3.1(1)**

n_2	$n_3 = 2$	$n_3 = 3$	$n_3 = 4$	$n_3 = 5$
1	$0 < \frac{l}{l_s} \le 0.5$	$0 < \frac{l}{l_s} \le 0.33$	$0 < \frac{l}{l_s} \le 0.25$	$0 < \frac{l}{l_s} \le 0.2$
2	$0.5 < \frac{l}{l_s} \le 1.2$	$0.33 < \frac{l}{l_s} \le 0.67$	$0.25 < \frac{l}{l_s} \le 0.5$	$0.2 < \frac{l}{l_s} \le 0.4$
3	$1.2 < \frac{l}{l_s} \le 1.7$	$0.67 < \frac{l}{l_s} \le 1.2$	$0.5 < \frac{l}{l_s} \le 0.75$	$0.4 < \frac{l}{l_s} \le 0.6$
4	$1.7 < \frac{l}{l_s} \le 2.4$	$1.2 < \frac{l}{l_s} \le 1.53$	$0.75 < \frac{l}{l_s} \le 1.2$	$0.6 < \frac{l}{l_s} \le 0.8$
5	$2.4 < \frac{l}{l_s} \le 2.9$	$1.53 < \frac{l}{l_s} \le 1.87$	$1.2 < \frac{l}{l_s} \le 1.45$	$0.8 < \frac{l}{l_s} \le 1.2$
6	$2.9 < \frac{l}{l_s} \le 3.6$	$1.87 < \frac{l}{l_s} \le 2.4$	$1.45 < \frac{l}{l_s} \le 1.7$	$1.2 < \frac{l}{l_s} \le 1.4$
7	$3.6 < \frac{l}{l_s} \le 4.1$	$2.4 < \frac{l}{l_s} \le 2.73$	$1.7 < \frac{l}{l_s} \le 1.95$	$1.4 < \frac{l}{l_s} \le 1.6$
8	$4.1 < \frac{l}{l_s} \le 4.8$	$2.73 < \frac{l}{l_s} \le 3.07$	$1.95 < \frac{l}{l_s} \le 2.4$	$1.6 < \frac{l}{l_s} \le 1.8$
9	$4.8 < \frac{l}{l_s} \le 5.3$	$3.07 < \frac{l}{l_s} \le 3.6$	$2.4 < \frac{l}{l_s} \le 2.65$	$1.8 < \frac{l}{l_s} \le 2.0$
10	$5.3 < \frac{l}{l_s} \le 6.0$	$3.6 < \frac{l}{l_s} \le 3.93$	$2.65 < \frac{l}{l_s} \le 2.9$	$2.0 < \frac{l}{l_s} \le 2.4$

Distance between Load Points in Ship Length Direction per Elementary Plate Panel of Inner Bottom

Table 2.24.3.1(2)

n_2	n_3			
	2	3	4	5
1	Actual breadth of dunnage			
2	$0.5l_s$	$0.33l_s$	$0.25l_s$	$0.2l_s$
3	$1.2l_s$	$0.67l_s$	$0.50l_s$	$0.4l_s$
4	$1.7l_s$	$1.20l_s$	$0.75l_s$	$0.6l_s$
5	$2.4l_s$	$1.53l_s$	$1.20l_s$	$0.8l_s$
6	$2.9l_s$	$1.87l_s$	$1.45l_s$	$1.2l_s$
7	$3.6l_s$	$2.40l_s$	$1.70l_s$	$1.4l_s$
8	$4.1l_s$	$2.73l_s$	$1.95l_s$	$1.6l_s$
9	$4.8l_s$	$3.07l_s$	$2.40l_s$	$1.8l_s$

10	$5.3l_s$	$3.60l_s$	$2.65l_s$	$2.0l_s$

2.24.4 Bilge hopper sloping plate and inner hull plate

2.24.4.1 The thickness of plating of longitudinally framed bilge hopper sloping plate and inner hull is not to be less than the value obtained, in mm, from the following formula:

$$t = K_1\sqrt{\frac{a_{hopper}F'_{SC}K}{235\lambda_p}} + 2.5 \quad mm$$

$$t = K_1\sqrt{\frac{a_{hopper}F'_{SC}}{\lambda_p R_{eH}}} + t_c \quad mm$$

where: $K1$— coefficient, defined in 2.24.3;

t_c ——corrosion addition, in mm, generally taken 2.5 mm, to be taken 3.5 mm for bilge hopper sloping plate and inner hull plate within 1.5 m height from the lowest point of inner bottom where the cargo holds are designed for loading/unloading by grabs;

K — material factor;

R_{eH}——minimum yield stress of material, N/mm^2;

a_{hopper} ——factor taken equal to:

$$a_{hopper} = -a_R \sin\left(\tan^{-1}\left|\frac{y_{G-SC}}{R}\right| - \theta_h\right) + g\cos(\theta_h - \varphi_m)$$

θ_h ——angle, in degree, between inner bottom plate and bilge hopper sloping plate or inner hull plate, see Figure 2.24.1.2;

φ_m — in degree, see formula specified in 1.5.2 of Section 5, Chapter 1 of this PART;

a_R— tangential acceleration defined in 2.24.2;

g — acceleration due to gravity, g = 9.81 m/s²;

$y_{G\text{-}SC}$— centre of gravity in transverse direction, in m, defined in 2.24.2;

R— factor, defined in 2.24.2;

F'_{SC}—equivalent mass of steel coils, in kg, taken equal to:

$$F'_{SC} = C_k \cdot \frac{W_{SC}n_2}{n_3} \quad \text{for } n_2 \le 10 \text{ and } n_3 \le 5$$

$$F'_{SC} = C_k W_{SC}\frac{l}{l_s} \quad \text{for } n_2 > 10 \text{ and } n_3 > 5$$

λ_p ——permissible bending stress coefficient of plating, defined in 2.24.3;

C_k ——coefficient, taken equal to:

$C_k = 2.2$ $C_k = 3.2$, when steel coils are lined up two or more tier, or when steel coils are lined up one tier and key coil is located second or third from bilge hopper sloping plate or inner hull plate;

$C_k = 1.2$ $C_k = 2.0$, in other cases.

2.24.5 Stiffeners of inner bottom

2.24.5.1 The section modulus W and the shear area A of single span stiffeners located on inner bottom plating are not to be less than the values obtained from the following formulae:

$$W = K_3\frac{(g + 0.5a_v)F_{SC}K}{2820} \quad cm^3$$

$$A=\frac{4\left(g+0.5a_v\right)F_{SC}}{\tau_a \sin\phi}\times 10^{-3} \qquad cm^2$$

$$W=1.1K_3\frac{\left(g+0.5a_v\right)F_{SC}}{8\lambda_s R_{eH}} \qquad cm^3$$

$$A=\frac{5\left(g+0.5a_v\right)F_{SC}}{0.9\tau_{eH}\sin\phi}\times 10^{-3} \qquad cm^2$$

where: K_3— coefficient, defined in Table 2.24.5.1, to be taken as 2l/3 $2l_e/3$ for $n_2 > 10$;

l — length of long edge of elementary plate panel taken along the side length, in m;

l_e ——effective span of stiffeners, in m, see 1.2.3, Section 2, Chapter 1 of this PART;

a_v— vertical acceleration, in m/s^2, calculated according to the formula defined in 1.5.2, Section 5, Chapter 1 of this PART;

g — acceleration due to gravity, g = 9.81 m/s^2;

F_{SC}—equivalent mass of steel coils, in kg, defined in 2.24.3;

K — material factor;

R_{eH}——minimum yield stress of material, in N/mm^2;

λ_s ——permissible bending stress coefficient of stiffeners, taken 0.9;

τ_a τ_{eH} ——shear yield stress of material strength, in N/mm^2, taken equal to:

$$\tau_a=\frac{235}{\sqrt{3K}}$$

$$\tau_{eH}=\frac{R_{eH}}{\sqrt{3}}$$

ϕ ——angle between stiffener web and shell plating, in degree, to be taken at the middle of span of stiffener.

Coefficient K_3 **Table 2.24.5.1**

n_2	1	2	3	4	6	7	8	9	10
K_3	l	$l-\frac{l'^2}{l}$	$l-\frac{2l'^2}{3l}$	$l-\frac{5l'^2}{9l}$	$l-\frac{7l'^2}{15l}$	$l-\frac{4l'^2}{9l}$	$l-\frac{3l'^2}{7l}$	$l-\frac{5l'^2}{12l}$	$l-\frac{11l'^2}{27l}$

n_2	1	2	3	4	6	7	8	9	10
K_3	l_e	$l_e-\frac{l'^2}{l_e}$	$l_e-\frac{2l'^2}{3l_e}$	$l_e-\frac{5l'^2}{9l_e}$	$l_e-\frac{7l'^2}{15l_e}$	$l_e-\frac{4l'^2}{9l_e}$	$l_e-\frac{3l'^2}{7l_e}$	$l_e-\frac{5l'^2}{12l_e}$	$l_e-\frac{11l'^2}{27l_e}$

2.24.6 Stiffeners located on bilge hopper sloping plate or inner hull plate

2.24.6.1 The section modulus W and the net shear area A of single span stiffeners located on bilge hopper sloping plate and inner hull plate are not to be less than the values obtained from the following formulae:

$$W=K_3\frac{a_{hopper}F'_{SC}K}{2820} \qquad cm^3$$

$$A=\frac{4a_{hopper}F'_{SC}}{\tau_a\sin\phi}\times 10^{-3} \qquad cm^2$$

$$W=1.1K_3\frac{a_{hopper}F'_{SC}}{8\lambda_s R_{eH}} \qquad cm^3$$

$$A = \frac{5a_{hopper}F'_{SC}}{0.9\tau_{eH}\sin\phi}\times 10^{-3} \quad \text{cm}^2$$

where: K_3— coefficient, defined in Table 2.24.5.1, to be taken as ~~$2l/3$~~ $2l_e/3$ for $n_2 > 10$;

l_e ——effective span of stiffeners, in m, see 1.2.3, Section 2, Chapter 1 of this PART;

~~K — material factor;~~

R_{eH}——minimum yield stress of material, in N/mm^2;

a_{hopper} ——coefficient, defined in 2.24.4.1;

~~τ_a~~ τ_{eH} ——shear yield stress of material ~~strength~~, in N/mm^2, see 2.24.5.1;

λ_s ——permissible bending stress coefficient of stiffeners, see 2.24.5.1;

F'_{SC}——equivalent mass of steel coils, in kg, defined in 2.24.4;

ϕ ——angle, in degree, defined in 2.24.5.

CHAPTER 3 EQUIPMENT AND OUTFITS

Section 1 RUDDERS

3.1.4 Rudder stock scantlings

3.1.4.3 Before significant reductions in rudder stock diameter due to the application of steels with specified minimum yield stresses exceeding 235 N/mm^2 are granted, CCS may require the evaluation of the rudder stock deformations. Large deformations of the rudder stock are to be avoided in order to avoid excessive edge pressures in way of bearings.

3.1.6 Rudder stock couplings

3.1.6.3 Cone couplings with key

(5) Notwithstanding the requirements of 3.1.6.3(2) and 3.1.6.3(4), where a key is fitted to the coupling between stock and rudder and it is considered that the entire rudder torque is transmitted by the key at the couplings, the scantlings of the key as well as the push-up force and push-up length are to be ~~subject to special consideration~~ calculated according to the torque transmitted (not to be greater than the design yielding torque of the rudder stock.

3.1.7 Pintles

3.1.7.4 Pintle housing

The length of the pintle housing in the gudgeon is not to be less than the pintle diameter d_p. d_p is to be measured on the outside of ~~liners~~ shaft sleeves.

The thickness of the pintle housing is not to be less than 0.25 d_p.

Section 2 ANCHORING AND MOORING EQUIPMENT

3.2.1 Equipment number

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

$$N = \Delta^{\frac{2}{3}} + 2(Bh + S_{fun}) + \frac{A}{10}$$

where: Δ — moulded displacement, in t, to the summer load waterline;

B — moulded breadth, in m;

h — effective height, in m, from the summer load waterline to the top of the uppermost house, i.e.:

$$h = a + \sum h_i$$

where: a — vertical distance at hull side, in m, measured from the summer load waterline amidships to the upper deck;

Section 7 SUPPORT STRUCTURE FOR DECK EQUIPMENT

3.7.3 Supporting structure for cranes, derricks and lifting masts

3.7.3.11 For calculation and analysis requirements and modeling method, refer to 3.7.2.5 and 3.7.2.6 of this Section. The thicknesses of structural members in the model are as built ones.

3.7.4 Supporting structures for components used in emergency towing arrangements

3.7.4.7 For calculation and analysis requirements and modeling method, refer to 3.7.2.5 and 3.7.2.6 of this Section. The thicknesses of structural members in the model are as built ones.

3.7.5 Supporting structures for other deck equipment or fittings which are subject to specific approval

3.7.5.2 Support for lifting appliances for personnel is to be provided as follows:

(1) in general, lifesaving appliances (lifeboats, life rafts and rescue boats) are to be stowed on a purpose built cradle, seat or deployment appliance. The design load imposed on the ship structure is to be established by the supplier of the lifesaving appliance (to include 2.2 times of bearing reaction and torque under maximum working load as a minimum). For calculation and analysis requirements and modeling method, refer to 3.7.2.5 and 3.7.2.6 of this Section. The thicknesses of structural members in the model are as built ones. The calculated stresses are not to exceed the permissible values given in Table 3.7.3.12. The supplier of the life-saving appliance is to provide corresponding calculation information;

Appendix 1 GUIDELINES FOR CALCULATION OF BENDING MOMENT AND SHEAR FORCE DISTRIBUTION

2 The Forces on Rudder–Rudder Stock

2.5 Semi spade rudder with 2-conjugate elastic support

……

Rudder horn shear stress calculation

For a generic section of the rudder horn, located between its lower and upper bearings, the following stresses are to be calculated:

τ_s ——shear stress, in N/mm2, to be obtained from the following formula:

$$\tau_s = \frac{F_{A1}}{A_H} \quad \text{N/mm}^2$$

τ_T ——torsional stress, in N/mm2, to be obtained for hollow rudder horn from the following formula:

$$\tau_T = \frac{M_T 10^{-3}}{2F_T t_H} \quad \text{N/mm}^2$$

For solid rudder horn, τ_T is to be ~~considered on a case by case basis~~ calculated based on the specific geometrical shape.

CHAPTER 12 BARGES

Section 1 GENERAL PROVISIONS

12.1.1 Application

12.1.1.1 The barges defined in this Chapter are non-self-propelled ships pushed or towed by other ships and divided into the following types:

(1) Barges carrying general dry cargo in cargo holds;

(2) Barges carrying cargo oil in cargo tanks;

(3) Shipborne barges carrying general dry cargo in cargo holds and carried on board a barge carrier;

(4) Specially designed pontoons for the carriage of cargo on deck.

(5) Barges dedicated to transporting marine engineering jacket structure and landing jacket into water by the stern for launching of jacket.

14.9.3 Deck hinges and hydraulic installations

14.9.3.7 The dynamic load induced by the ship's motions in waves and acting on deck hinges and hydraulic installations is to be obtained from the dynamic calculation and statistic analysis in accordance with sea conditions for predicted operations. Where the significant wave height is no more than 3 m in sea conditions for predicted operations, the dynamic load may also be calculated in accordance with the following formulas:

Horizontal dynamic force of deck hinges: $F_{dh} = 0.28 fB^2 L$ kN

Vertical dynamic force of deck hinges : $F_{dv} = 0.055 fB^2 L^2 / d$ kN

where: L——ship length, in m;
B——ship width, in m;
d——distance between deck hinges, in m;
f——coefficient, taken f=1.5.

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CHAPTER 1 GENERAL

Section 2 GENERAL PROVISIONS

1.2.9 Clean energy and power

1.2.9.4 Ships using methyl/ethyl as fuel are, in addition to the relevant provisions of this PART, to comply with relevant requirements of ~~Pt. 1 of the Guidelines for Ships Using Alternative Fuel~~ the Guidelines for Ships Using Methanol/Ethanol Fuel.

CHAPTER 11 SHAFTING AND PROPELLERS

Section 2 SHAFTING

11.2.2 Diameter of shafts

R_m — specified tensile strength of shaft material, in N/mm^2. For intermediate shaft, when carbon and manganese steel is used, it is to be taken as 760 N/mm^2 for R_m> 760 N/mm^2; when alloy steel is used, it is to be taken as 800 N/mm^2 for R_m> 800 N/mm^2. For special approval of alloy steel used for intermediate shaft material, the tensile strength of shaft material may be greater than 800 N/mm^2, but less than 950 N/mm^2, where such approval of the material comply with the relevant requirements for torsional fatigue test①, cleanliness②and inspection. The requirements of 5.1.1.1, 5.3.2.1, 5.3.2.3 and 5.3.4.5 for the cleanliness of material, and the requirements of 5.1.6 for the inspection in Chapter 5, PART ONE of CCS Rules for Materials and Welding are to be complied with. For screwshaft and tube shaft, it is to be taken as 600 N/mm^2 for R_m> 600 N/mm^2.

Section 3 SHAFT TRANSMISSION UNITS

11.3.7 Z propulsion arrangement

11.3.7.1 Z propulsion arrangement is to be provided with means to control its propulsion direction ~~controlled~~ from bridge, machinery control station (if any) and on the spot. Indicators of direction of thrust are to be provided in these control locations.

~~11.3.7.10 Hydraulic system is also to satisfy the relevant requirements in 13.1.7 of this PART.~~

11.3.7.1~~1~~0 Z propulsion arrangement together with its main parts and accessories are to be subject to material test and non-destructive test according to CCS Rules for Materials and Welding.

11.3.7.1~~2~~1 Steering gear of Z propulsion arrangement is to comply with the requirements of Section 1, Chapter 13 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

Section 4 PROPELLERS

11.4.4 Fitting of propellers to screwshafts

The outside diameter of the threaded end for the propeller retaining nut is not to be less than 60% of the calculated ~~major taper~~ diameter of the propeller shaft.

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① Torsional fatigue test is to meet the requirements of ~~5.4.5~~7.4.6 of Guidelines for Inspection of Forged Steel.

② Cleanliness is to meet the requirements of ~~5.4.5~~7.4.6 of Guidelines for Inspection of Forged Steel.

CHAPTER 12 SHAFT VIBRATION AND ALIGNMENT

Section 2 TORSIONAL VIBRATION

R_m — specified tensile strength of shaft material, in N/mm^2. For intermediate shaft, when carbon and manganese steel is used, it is to be taken as 600 N/mm^2 for R_m> 600 N/mm^2; when alloy steel is used, it is to be taken as 800 N/mm^2 for R_m> 800 N/mm^2. For special approval of alloy steel used for intermediate shaft material, the tensile strength of shaft material may be greater than 800 N/mm^2, but less than 950 N/mm^2, where such approval of the material comply with the relevant requirements for torsional fatigue test[①], cleanliness[②] and inspection. The requirements of 5.1.1.1, 5.3.2.1, 5.3.2.3 and 5.3.4.5 for the cleanliness of material, and the requirements of 5.1.6 for the inspection in Chapter 5, PART ONE of CCS Rules for Materials and Welding are to be complied with. For screwshaft and tube shaft, it is to be taken as 600 N/mm^2 for R_m> 600 N/mm^2;

Section 5 SHAFTING ALIGNMENT

12.5.5 Shafting alignment procedure

12.5.5.4 After stern bearing is pressed and fitted, slope at stern bearing is to be measured. After the integrated stern tubes are poured and installed, slope at stern bearing is to be measured.

① Torsional fatigue test is to meet the requirements of ~~5.4.5~~7.4.6 of Guidelines for Inspection of Forged Steel.

② Cleanliness is to meet the requirements of ~~5.4.5~~7.4.6 of Guidelines for Inspection of Forged Steel.

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PART FOUR
ELECTRICAL INSTALLATIONS

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.3.1(3) Analysis for coordination of protective devices in compliance with the requirements of 2.5.1.1 and 2.5.4.1 of this PART (for ships with operational conditions of generators having a total capacity (including single generator operation, long-term parallel operation and short-term parallel transferred load) of more than 250 kVA, which may be omitted for non-self-propelled ships.)

CHAPTER 2　ELECTRICAL INSTALLATIONS IN SHIPS

Section 9　SAFETY SYSTEMS FOR SHIPS AND PERSONS ONBOARD

2.9.3.4　The ~~pre-discharge alarm and the release of the~~ fixed fire-extinguishing system for the protection of machinery spaces where main propulsion engine and main generator set are located is to be designed such that any action other than the release of fire extinguishing media are not to lead to automatic shutdown of ventilation fans and oil pumps in these machinery spaces, such as opening the release box (cabinet) door during fire drills.

Section 12　CABLES

2.12.3.4　Where cables for services, required to be operable under fire conditions, including their supply cables, pass through high fire risk areas[①], and in addition for passenger ships, main vertical fire zones, other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the service in any other area or zone. This may be achieved by either of the following:

Section 18　ADDITIONAL REQUIREMENTS FOR SHIPS CARRYING DANGEROUS GOODS

2.18.3.2　Cables required in 2.18.8.2 and the electrical equipment not inferior to that required as follows are permitted in the hazardous areas specified in 2.18.3.1 of this Section (unless otherwise specified in 2.18.5):

(1) general electrical equipment
　— degree of protection IP55;
　— maximum surface temperature 200°C; or
(2) certified explosion-proof electrical equipment
　— degree of protection IP55;
　— temperature class T3.

2.18.4.3　Cables required in 2.18.8.2 and the electrical equipment not inferior to that required in Table 2.18.4.3 are permitted in the hazardous areas specified in 2.18.4.1 and 2.18.4.2 of this Section (unless otherwise specified in 2.18.5).

2.18.5　Carriage of solid dangerous goods in bulk and MHB only

2.18.5.1　Where solid dangerous goods in bulk (solid dangerous goods capable of creating explosive gas atmosphere) and MHB are to be carried, electrical equipment installed in hazardous areas are to be in compliance with the minimum requirements of Table 2.18.5.1.

Characteristics of Electrical Equipment for Use in Hazardous Areas (Example)

Table 2.18.5.1

Dangerous goods	IMO class	Dominant risk[①]	Protection against explosive dust atmosphere	Protection against explosive gas atmosphere	
			Degree of protection	Explosion group	Temperature class

① The "high fire risk areas" are defined as follows:
(1) machinery spaces as defined in SOLAS Reg. II-2/3.30, excluding spaces having little or no fire risk as defined in SOLAS Reg. II-2/9.2.2.3.2.2 (10) (including the interpretations for tables 9.3, 9.4, 9.5, 9.6, 9.7 and 9.8 given in MSC/Circ.1120 as amended by MSC.1/Circ.1436 and MSC.1/Circ.1510);
(2) spaces containing fuel treatment equipment or other highly flammable substances;
(3) galley and pantries containing cooking appliances;
(4) laundry containing drying equipment;
(5) spaces as defined in SOLAS Reg. II-2/9.2.2.3.2.2(8), (12), and (14) for ships carrying more than 36 passengers.

Dangerous goods	IMO class	Dominant risk[①]	Protection against explosive dust atmosphere	Protection against explosive gas atmosphere	
			Degree of protection	Explosion group	Temperature class
Aluminium ferrosilicon powder UN1395	4.3	H_2	—	IIC	T2
Aluminium silicon powder uncoated UN1398	4.3	H_2	—	IIC	T2
Aluminium smelting by-products or Aluminium remelting by-products UN3170	4.3	H_2	—	IIC	T2
Aluminium smelting/remelting by-products, processed	MHB(WF and/or WT and/or CR)	H_2	—	IIC	T1
Ammonium nitrate UN1942	5.1	Combustible	—	Intrinsically safe equipment	—
Ammonium nitrate based fertilizer UN2067	5.1	Combustible	—	Intrinsically safe equipment	—
Ammonium nitrate based fertilizer UN2071	9		—	Intrinsically safe equipment	—
Ammonium nitrate based fertilizer (non-hazardous)	-		—	Intrinsically safe equipment	—
Brown coal briquettes	MHB (CB and/or SH)	Dust, methane	IP55	IIA	T4
Coal	MHB (CB and/or SH and/or WF and/or CR)	Dust, methane	IP55	IIA	T4
Direct reduced iron (A)	MHB (SH and/or WF)	H_2	—	IIC	T2
Direct reduced iron (B)	MHB (SH and/or WF)	H_2	—	IIC	T2
Direct reduced iron (C)	MHB (SH and/or WF)	H_2	—	IIC	T2
Ferrophosphorus (including briquettes)	MHB (WF and/or WT)	H_2	—	IIC	T1
Ferrosilicon, with at least 25% but less than 30% silicon, or 90% or more silicon (including briquettes)	MHB (WF and/or WT)	H_2	—	IIC	T1
Ferrosilicon UN1408, with 30% or more but less than 90% silicon(including briquettes)	4.3	H_2	—	IIC	T1
Iron oxide, spent or sponge iron, spent UN1376	4.2	Dust	IP55	IIA	T2
Seed cake, containing vegetable oil UN1386	4.2	Hexane	—	IIA	T3
Seed cake UN2217	4.2	Hexane	—	IIA	T3
Seed cakes and other residues of processed oily vegetables	MHB (SH)	Dust	IP55	IIA	T3
Silicomanganese (low-carbon)	MHB(WF and/or WT and/or TX)	H_2	—	IIC	T1
Solidified fuels recycled from paper and plastics	MHB (SH)	Combustible	IP55	—	T3
Sugarcane biomass pellets	MHB(CB and/or WF and/or WT and/or OH)	Combustible, dust	IP55	IIA	T3

Dangerous goods	IMO class	Dominant risk[①]	Protection against explosive dust atmosphere	Protection against explosive gas atmosphere	
			Degree of protection	Explosion group	Temperature class
Sulphur UN1350 (crushed lump and coarse grained)	4.1	Combustible, dust	IP55	—	T4
Zinc Ashes UN1435	4.3	H_2	—	IIC	T2
Wood torrefied	MHB(CB and/or SH and/or CR)	Combustible, dust	IP55	—	T3
Wood pellets, containing additives and/or binders	MHB(WF)	Dust	IP55	—	T3
Wood pellets, not containing any additives and/or binders	MHB(OH)	Dust	IP55	—	T3

Note: ① The term "risk" relates only to the risk of explosion due to dangerous goods and electrical appliances.