RULES
FOR THE CLASSIFICATION OF SHIPS

Part 3 – HULL EQUIPMENT

July 2019
By the decision of the General Committee of Croatian Register of Shipping,

RULES FOR THE CLASSIFICATION OF SHIPS
Part 3 – Hull equipment

have been adopted on 17th June 2019 and shall enter into force on 1st July 2019
REVIEW OF AMENDMENTS IN RELATION TO PREVIOUS EDITION OF THE RULES

RULES FOR THE CLASSIFICATION OF SHIPS
Part 3 – HULL EQUIPMENT

All major changes throughout the text in respect to the Rules for the classification of ships, Part 3 – Hull Equipment, edition 2018, throughout the text are shaded.

Items not being indicated as corrected have not been changed.

The grammatical and print errors, have also been corrected throughout the text of subject Rules but are not indicated as a correction.
The subject Rules include the requirements of the following international Organisations:

**International Maritime Organization (IMO)**

**Conventions:**  
International Convention for the Safety of Life at Sea 1974 (SOLAS 1974) and all subsequent amendments up to and including the 2010 amendments (MSC.291(87))  
International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 thereto (MARPOL 73/78) and all subsequent amendments up to and including the 2006 amendments (MEPC. 141(54))

**International Association of Classification Societies (IACS)**

**Unified Requirements (UR):**  

**Unified Recommendations:**  

**Unified Interpretations:**  


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1 GENERAL

1.1 APPLICATION

1.1.1 This Part of the Rules for the classification of ships (hereinafter referred to as: the Rules) applies to equipment, arrangements and outfit of sea-going ships sailing in a displacement condition.

1.1.2 As to hydrofoil ships, hovercraft, and other similar ships, the requirements of this Part of the Rules are applicable to the extent that is practicable and reasonable, and the equipment, arrangements and outfit of these ships are subject to special consideration by the CROATIAN REGISTER OF SHIPPING (hereinafter referred to as: the Register).

1.1.3 The application of this Part of the Rules to the installations and equipment of the ships with length up to 45 m, engaged in navigation area 6, 7 and 8 in period from 1st April to 31st October only, may be agreed with the Register, on the case to case basis.

1.2 DEFINITIONS AND EXPLANATIONS

Those relating to general terminology of the Rules are given in Part 1 - General requirements, Chapter 1 - General information.

1.2.1 Waterlines

1.2.1.1 Damage waterline - the waterline of a damaged ship after flooding of corresponding separate compartments or their combinations as provided in the Rules, Part 5 - Subdivision, 2.

1.2.1.2 Summer load waterline - the waterline the upper edge of which passes through the centre of the ring of the load line mark when there is no fore-and-aft or athwart ships inclination.

1.2.1.3 Summer timber load waterline - the waterline indicated by the upper edge of the assigned summer timber load line.

1.2.1.4 Subdivision load waterline - the waterline used in determining the subdivision of the ship.

1.2.1.5 Deepest subdivision load waterline - the subdivision load waterline which corresponds to the summer draught to be assigned to the ship, see the Rules, Part 5 - Subdivision, 2.2.

1.2.2 Main dimensions

1.2.2.1 Length of ship (\(L\)) - the distance on the summer load waterline, in \([m]\), from the fore side of stem to the after side of the rudderpost, or the centre of the rudder stock if there is no rudderpost. \(L\) is to be not less than 96% and need not exceed 97% of the extreme length on the summer load waterline. In ships with unusual stem or stern arrangements, the length \(L\) is to be specially considered.

1.2.2.2 Subdivision length of ship (\(L_s\)) - the length, in \([m]\), measured between perpendiculars taken at the extremities of the deepest subdivision load line.

1.2.2.3 Draught of ship (\(d\)) - the vertical distance, in \([m]\), measured amidships from the top of the plate keel, or from the intersection of the inner surface of the shell with the bar keel (the outer surface of a non-metal shell) to the summer load line.

1.2.2.4 Depth of ship (\(D\)) - the vertical distance, in \([m]\), measured amidships, from the top of the plate keel or from the intersection of the inner surface of the outer shell with the bar keel, to the top of the freeboard deck beams at sides.

On ships with rounded gunwales, moulded depth is taken to be the distance to the intersection of the continuation of a line extending from the level of the upper freeboard deck and the outer edge of the side, as though the gunwale were of angular design.

If the upper freeboard deck has longitudinal steps and the raised part of the deck is above the point at which the lateral height of the ship is to be measured, the lateral height is measured up to the continuation of a line from the lower part of the deck and parallel to the upper part of the deck at ship's sides.

1.2.2.5 Breadth of ship (\(B\)) - maximum breadth of ship, in \([m]\), measured amidships from outside of frame to outside of frame in a ship with metal shell and to the outer surface of the hull in a ship with a shell of any other material.

1.2.3 Superstructures and deckhouses

1.2.3.1 Superstructure - a decked structure on the freeboard deck extending from side to side of the ship or with the side plating not being inboard of the shell plating more than 0,04-\(B\).

Superstructures may either be complete, i.e. extending the full length of the ship \(L\), or they may cover only a certain part of that length.

One or more tiers of such complete or detached superstructures may be erected.

1.2.3.2 Deckhouse - a decked structure above the strength deck the side plating being inboard of the shell plating more than 0,04-\(B\), with doors, windows, or other similar openings in the outer bulkheads.

1.2.3.3 Trunk ï a deck structure on the upper deck, not reaching at least one of the sides by a distance exceeding 4% of the breadth \(B\) and having no doors, windows or other similar openings in the external bulkheads.

1.2.4 Tightness

1.2.4.1 Watertight - the term pertaining to closing appliances of openings, which means that under specified pressure the liquid is not to penetrate through the closed openings into the ship.

1.2.4.2 Weathertight - the term pertaining to closing appliances of openings, which means that in any sea conditions water is not to penetrate through the openings inside the ship. Such closing appliances shall withstand a hose test on condition that the outlet of the nozzle is equal to or over 12
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mm in diameter and the head in the hose provided for water jet ejected upwards of not less than 0.2 MPa. The distance from the tested position is up to 1.5 m.

1.2.5 Decks

1.2.5.1 Upper deck - the uppermost continuous deck extending from fore to aft. The upper deck may be stepped.

1.2.5.2 Raised quarterdeck - the after upper part of a stepped deck, the forward lower part of which is taken as a portion of freeboard deck.

1.2.5.3 Freeboard deck - the deck from which the freeboard is measured.

In a ship having a deck with step, the lowest line of this deck and the continuation of the line parallel to upper part of the deck is taken as a freeboard deck.

1.2.5.4 Superstructure deckhouse or trunk deck - the deck forming the top of a superstructure, deckhouse or trunk.

1.2.5.5 Superstructure decks of the first, second, etc. tiers - the decks forming the top of the superstructures of the first, second, etc. tiers, counting from the freeboard deck.

1.2.5.6 Bulkhead deck - the deck up to which the main transverse watertight subdivision bulkheads are carried.

The bulkhead deck may be discontinuous, i.e. with step or steps formed both by main transverse watertight bulkheads reaching the keel and transverse watertight bulkheads not reaching the keel.

1.2.5.7 Lower decks - the decks below the upper deck.

1.2.5.8 Weather deck - deck which is completely exposed to the weather from above and from at least two sides.

1.2.6 Amidships and perpendiculars

1.2.6.1 Amidships - at the middle of the ship's length $L$.

1.2.6.2 Forward and after perpendicular - the vertical line passing in the centre line at the fore and after end of the ship's length $L$.

1.2.7 Type A and Type B ships

1.2.7.1 Type A ship - is one which:
- designed to carry only liquid cargoes in bulk.
- has a high integrity of the exposed deck with only small access openings to cargo compartments, closed by watertight gasketed covers made of steel or an equivalent material, and
- has low permeability of loaded cargo compartments.

Type A ship must also have certain other features, specified in the ICLL (International Convention on Load Lines, 1966, as amended).

1.2.7.2 Type B ship - a ship which does not meet requirements regarding Type A ships, and which is assigned a freeboard according to the ICLL, 1966.

1.2.8 Active means of the ship's steering - auxiliary means which develop a thrust at an angle of the centre line plane of the ship of the zero or small speed, irrespective of the ship's propulsive device operation and which are provided with their own drive motor.

1.3 SCOPE OF SUPERVISION

1.3.1 General provisions on the ship's supervision, surveys and classification are given in the Rules, Part 1 - General requirements, Chapter 1 - General information. General provisions which apply to supervision during construction, surveys and classification of ships as well as provisions which apply to technical documentation submitted to the Register are specified in the Rules, Part 1 - General requirements, Chapter 1 to Chapter 5.

1.3.2 The following items included into ship's equipment and arrangements are subject to the supervision during their manufacture:

1.3.2.1 Rudder:
- rudder stock,
- rudder blade,
- propeller nozzle,
- rudder shafts
- pintles of rudder and propeller nozzles,
- pintle bushes,
- fastenings (bolts and nuts with horizontal flanged couplings and nuts with tapered couplings, bolts and nuts for connecting the rudder shaft and stern post),
- parts limiting deviation of the angle of the rudder blade and rudder nozzle,
- rudder stock bearings,
- active means of ship steering.

1.3.2.2 Anchoring arrangement:
- anchor,
- chain cables or ropes,
- anchor stoppers,
- devices for securing and releasing the inboard end of chain cable or rope,
- anchor hawse pipes.

1.3.2.3 Mooring arrangement:
- mooring ropes,
- mooring bollards, belaying cleats, fairleads, chocks, rollers and stoppers.

1.3.2.4 Towing arrangement:
- towing lines,
- towing bollards, bits, fairleads, chocks, and stoppers,
- towing hooks and towing rails with fastenings for their securing to ship's hull,
- towing snatch-block.

1.3.2.5 Signal masts:
- metal, non-metallic masts,
.2 standing ropes, 
.3 permanent attachments to masts and decks (eyeplates, hoops, etc.). 
.4 loose gear of masts and rigging (shackles, turnbuckles etc.).

1.3.2.6 Closing appliances of openings in hull, superstructures and deckhouses:
.1 side and deck scuttles, 
.2 side shell doors, 
.3 doors in superstructures and deckhouses, 
.4 companion hatches, skylights and ventilating trunks, 
.5 ventilators, 
.6 manholes to deep and other tanks, 
.7 hatchway covers in dry cargo ships, 
.8 cargo tank hatchway covers in ships of carriage of liquid cargoes in bulk, 
.9 doors in watertight subdivision bulkheads.

1.3.2.7 Equipment of ship’s spaces:
.1 ceiling and battens in cargo holds, 
.2 exit doors from ship’s spaces in escape routes, 
.3 stairways and vertical ladders, 
.4 guards rails, bulwarks and gangways 
.5 fixed and portable securing devices for cargo securing.

1.3.3 Survey of the manufacture of the items specified in 1.3.2.1.6, 1.3.2.1.8, 1.3.2.1.9, 1.3.2.2.5, 1.3.2.3.2, 1.3.2.4.2, 1.3.2.5, 1.3.2.6.5 and 1.3.2.7 is confined to consideration of the related technical documentation.

1.3.4 Where items specified in 1.3.2 are fitted the following documents are to be submitted:
.1 assembly drawing, 
.2 calculations, 
.3 detail drawings if parts or assemblies are not manufactured in accordance with approved standards and specifications.

1.3.5 Materials for structural elements listed in Table 1.3.5-1 are to be in accordance the requirements of the Rules, Part 25 - Metallic materials.

Materials for other items of equipment and arrangements, unless expressly provided otherwise in the Rules, shall meet the requirements specified in the design documentation approved by Register.

Welding of structural elements of ship’s equipment is to be performed as specified in the Rules, Part 26 - Welding and Part 2 - Hull.

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Notes:
(1) The grades of rolled steel plates and profiles are to be selected in accordance with the Rules, Part 2 - Hull and Part 25 - Metallic materials.
(2) Welded structures and joints shall comply with the Rules, Part 2 - Hull and Part 26 - Welding.

1.3.6 The following equipment and arrangements are subject to survey while the ship is under construction:
.1 rudder, 
.2 anchor arrangement, 
.3 mooring arrangement, 
.4 towing arrangement, 
.5 masts and rigging, 
.6 openings in the hull, superstructures and deckhouses, and their closing appliances, 
.7 arrangement and equipment of ship compartments, 
.8 fixed and portable securing devices for cargo securing, 
.9 active means of ship’s steering.
1.4 PERMISSIBLE STRESSES

1.4.1 Wherever the working stresses are mentioned in the text of this Part of the Rules, they mean equivalent stresses calculated from the formula:

\[ \sigma_v = \sqrt{\sigma^2 + 3\tau^2}, \quad \text{[N/mm}^2\text{]} \],

where:

- \( \sigma_v \) = equivalent stress, \text{[N/mm}^2\text{]};
- \( \sigma \) = normal stress, \text{[N/mm}^2\text{]};
- \( \tau \) = shear stress, \text{[N/mm}^2\text{]}.

1.4.2 Permissible stresses with which the equivalent stresses are to be compared when verifying the strength conditions are established here in fractions of the yield point \( R_{el} \) of material used. The yield point is not to be taken as more than 0.7 times the ultimate strength of material, unless expressly stated otherwise.
2 RUDDER

2.1 GENERAL

2.1.1 Basic assumptions

2.1.1.1 The following requirements apply to ordinary profile rudders, and to some enhanced profile rudders with special arrangements for increasing the rudder force.

2.1.1.2 These requirements apply to rudders made of steel.

2.1.2 Design considerations

2.1.2.1 Effective means are to be provided for supporting the weight of the rudder without excessive bearing pressure, e.g. by a rudder carrier attached to the upper part of the rudder stock. The hull structure in way of the rudder carrier is to be suitably strengthened.

2.1.2.2 Suitable arrangements are to be provided to prevent the rudder from lifting.

2.1.2.3 In rudder trunks which are open to the sea, a seal or stuffing box is to be fitted above the deepest load waterline, to prevent water from entering the steering gear compartment and the lubricant from being washed away from the rudder carrier. If the top of the rudder trunk is below the deepest waterline, two separate stuffing boxes are to be provided.

2.1.3 Materials

2.1.3.1 Welded parts of rudders are to be made of approved rolled hull materials.

2.1.3.2 Material factor $k$ for normal and high tensile steel plating may be taken into account when specified in each individual rule requirement. The material factor $k$ is to be taken as defined in the Rules, Part 2-Hull, 1.4.2.2, unless otherwise specified.

2.1.3.3 Steel grade of plating materials for rudders and rudder horns are to be in accordance with the Rules, Part 2-Hull, 1.4.2.4.

2.1.3.4 Rudder stocks, pintles, coupling bolts keys and cast parts of rudders are to be made of rolled, forged or cast carbon manganese steel in accordance with the Rules, Part 25 - Metallic materials, 3.

2.1.3.5 For rudder stock, pintles, keys and bolts the minimum yield stress is not to be less than 200 N/mm$^2$. The requirements of these requirements are based on a material's yield stress of 235 N/mm$^2$. If material is used having $R_{	ext{eff}}$ differing from 235 N/mm$^2$, the material factor $k$ is to be determined as follows:

\[ k = \left( \frac{235}{R_{	ext{eff}}} \right)^{e} \]

where:

\[ e = \begin{cases} 0.75 & \text{for } R_{	ext{eff}} > 235 \text{ N/mm}^2 \end{cases} \]

2.1.4 Welding and design details

2.1.4.1 Slot-welding is to be limited as far as possible. Slot welding is not to be used in areas with large in-plane stresses transversely to the slots or in way of cut-out areas of semi-spade rudders.

When slot welding is applied, the length of slots is to be minimum 75 mm with breadth of $2t$, where $t$ is the rudder plate thickness, in [mm]. The distance between ends of slots is not to be more than 125 mm. The slots are to be fillet welded around the edges and filled with a suitable compound, e.g. epoxy putty. Slots are not to be filled with weld.

Continuous slot welds are to be used in lieu of slot welds. When continuous slot welding is applied, the root gap is to be between 6-10 mm. The bevel angle is to be at least 15°.

2.1.4.2 In way of the rudder horn recess of semi-spade rudders, the radii in the rudder plating are not to be less than 5 times the plate thickness, but in no case less than 100 mm. Welding in side plate is to be avoided in or at the end of the radii. Edges of side plate and weld adjacent to radii are to be ground smooth.

2.1.4.3 Welds between plates and heavy pieces (solid parts in forged or cast steel or very thick plating) are to be made as full penetration welds. In way of highly stressed areas e.g. cut-out of semi-spade rudder and upper part of spade rudder, cast or welding on ribs is to be arranged. Two sided full penetration welding is normally to be arranged. Where back welding is impossible welding is to be performed against ceramic backing bars or equivalent. Steel backing bars may be used and are to be continuously welded on one side to the heavy piece.

2.1.4.4 Requirements for welding and design details of rudder trunks are described in the Rules, Part 2-Hull, 12.3.4.1.

2.1.4.5 Requirements for welding and design details when the rudder stock is connected to the rudder by horizontal flange coupling are described in 2.6.1.4.

2.1.4.6 Requirements for welding and design details of rudder horns are described in the Rules, Part 2-Hull, 12.3.3.2.7.

2.1.5 Equivalence

2.1.5.1 The Register may accept alternatives to requirements given in these requirements, provided they are deemed to be equivalent.

2.1.5.2 Direct analyses adopted to justify an alternative design are to take into consideration all relevant modes of failure, on a case by case basis. These failure modes may include, amongst others: yielding, fatigue, buckling and fracture.
Possible damages caused by cavitation are also to be considered.

2.1.5.3 If deemed necessary by the Register, lab tests, or full scale tests may be requested to validate the alternative design approach.

2.1.6 Rudder area

In order to achieve sufficient manoeuvring capability the size of the movable rudder area is recommended to be not less than obtained from the following formula:

\[ A = 0.0175 \cdot C_1 \cdot C_2 \cdot C_3 \cdot C_4 \cdot L \cdot d, \quad [m^2] \]

where:

- \( C_1 \) = factor depending upon the ship type:
  - 0.9 for tankers and bulk carriers having a displacement of more than 50 000 t;
  - 1.7 for tugs and trawlers
  - 1.0 for other ships;
- \( C_2 \) = factor for the rudder type:
  - 0.9 for semi-spade rudders
  - 0.8 for double rudders (per rudder)
  - 1.0 for other type;
- \( C_3 \) = factor depending upon the:
  - 1.0 for NACA-profiles and plate rudder
  - 0.8 for hollow profiles
- \( C_4 \) = factor depending upon the rudder arrangement:
  - 1.0 for rudders in the propeller jet
  - 1.5 for rudders outside the propeller jet.

For semi-spade rudders 50% of the projected area of the rudder horn may be included into rudder area.

2.2 RUDDER FORCE AND RUDDER TORQUE

2.2.1 Rudder blades without cut-outs

(see Fig. 2.2.1.1)

2.2.1.1 The rudder force upon which the rudder scantlings are to be based is to be determined according to the following formula:

\[ C_R = 132 \cdot A \cdot v^2 \cdot k_1 \cdot k_2 \cdot k_3 \]

where:

- \( C_R \) = rudder force, in [N];
- \( A \) = area of rudder blade, in \( [m^2] \)
- \( v \) = maximum service speed, in [knots], with ship on summer load waterline. When the speed is less than 10 knots, \( v \) is to be replaced by the expression:

\[ v_{\text{min}} = \frac{(v + 20)}{3} \]

For the astern condition the maximum astern speed is to be used, however, in no case less than:

\[ v_{\text{astern}} = 0.5 \cdot v \]

\[ k_1 = \text{factor depending on the aspect ratio} \ A; \]

\[ k_1 = \frac{(A + 2)}{3}, \] with \( A \) not to be taken greater than 2;

\[ A = \frac{b^2}{A_r}, \]

\[ b = \text{mean height of the rudder area, in} \ [m]. \]

Mean breadth and mean height of rudder are calculated according to Fig. 2.2.1.1.

\[ A_r = \text{sum of rudder area} \ A \ \text{and area of rudder post or rudder horn, if any, within the height} \ b, \ \text{in} \ [m^2]; \]

\[ k_2 = \text{factor depending on the type of the rudder profile according to Table 2.2.1.1-1}; \]

\[ k_3 = 0.8 \ \text{for rudders outside the propeller jet}; \]

\[ = 1.15 \ \text{for rudders behind a fixed propeller nozzle}; \]

\[ = 1.0 \ \text{otherwise}. \]
### Table 2.2.1.1-1

<table>
<thead>
<tr>
<th>Profile / type of rudder</th>
<th>$k_2$</th>
<th>Ahead condition</th>
<th>Astern condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>NACA 1 00 series Gottingen</td>
<td>1.10</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>Hollow profiles</td>
<td>1.35</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>Flat side profiles</td>
<td>1.10</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>High lift rudders</td>
<td>1.70</td>
<td>To be specially considered; if not known: 1.30</td>
<td></td>
</tr>
<tr>
<td>Fish tails</td>
<td>1.40</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>Single plate</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Mixed profiles (e.g. HSVA)</td>
<td>1.21</td>
<td>0.90</td>
<td></td>
</tr>
</tbody>
</table>

#### 2.2.2 Rudder blades with cut-outs (semi-spades rudders)

**2.2.2.1** The total rudder force $C_R$ is to be calculated according to 2.2.1.1. The pressure distribution over the rudder area, upon which the determination of rudder torque and rudder blade strength are to be based, is to be derived as follows:

The rudder area may be divided into two rectangular or trapezoidal parts with areas $A_1$ and $A_2$, so that $A = A_1 + A_2$ (see fig. 2.2.2).

![Figure 2.2.2](image)

The levers $r_1$ and $r_2$ are to be determined as follows:

- $r_1 = c_1 (\alpha - K_1)$, in [m];
- $r_2 = c_2 (\alpha - K_2)$, in [m];
- $c_1, c_2$ = mean breadth of partial areas $A_1, A_2$ determined, where applicable, in accordance with Fig. 2.2.1.1

For parts of a rudder behind a fixed structure such as the rudder horn:

- $\alpha = 0.25$ for ahead condition
- $\alpha = 0.55$ for astern condition

The resulting force of each part may be taken as:

- $C_{R1} = C_R \times \frac{A_1}{A}$, [N]
- $C_{R2} = C_R \times \frac{A_2}{A}$, [N]

**2.2.2.2** The resulting torque of each part may be taken as:

- $Q_{R1} = C_{R1} \cdot r_1$, [Nm]
2.2.2.3 The total rudder torque is to be calculated for both the ahead and astern condition according to the formula:

\[ Q_R = Q_{R1} + Q_{R2}, \]  

[Nm]

For ahead condition \( Q_R \) is not to be taken less than:

\[ Q_{R\text{min}} = 0.1 \cdot C_R \cdot A_1 \cdot c_1 + A_2 \cdot c_2 \]

2.3 RUDDER STRENGTH CALCULATION

2.3.1 The rudder force and resulting rudder torque as given in 2.2 causes bending moments and shear forces in the rudder body, bending moments and torques in the rudder stock, supporting forces in pintle bearings and rudder stock bearings and bending moments, shear forces and torques in rudder horns and heel pieces. The rudder body is to be stiffened by horizontal and vertical webs enabling it to act as bending girder.

2.3.2 The bending moments, shear forces and torques as well as the reaction forces are to be determined by a direct calculation or by an approximate simplified method considered appropriate by the Register. For rudders supported by sole pieces or rudder horns these structures are to be included in the calculation model in order to account for the elastic support of the rudder body. Guidelines for calculation of bending moment and shear force distribution are given in 2.4.2.3 to 2.4.2.5.

2.4 RUDDER STOCK SCANTLINGS

2.4.1 The diameter of rudder stock

The rudder stock diameter required for the transmission of the rudder torque is to be dimensioned such that the torsional stress is not exceeding the following value:

\[ \tau_t = 68/k, \]  

[N/mm²]

The rudder stock diameter for the transmission of the rudder torque is therefore not to be less than:

\[ d_e = 4.2 \cdot \sqrt{Q_R \cdot k}, \]  

[mm]

where:

\[ Q_R = \text{total rudder torque, in [Nm], as calculated in 2.2.1 and 2.2.2.} \]

\[ k = \text{material factor for the rudder stock as given in 2.1.3.5.} \]

2.4.2 Rudder stock scantlings due to combined loads

2.4.2.1 If the rudder stock is subjected to combined torque and bending, the equivalent stress in the rudder stock is not to exceed 118/k.

\[ k = \text{material factor for the rudder stock as given in 2.1.3.5.} \]

The equivalent stress is to be determined by the formula:

\[ \sigma_e = \sqrt{\sigma_b^2 + 3\tau_t^2}, \]  

[N/mm²]

Bending stress:

\[ \sigma_b = \frac{10.2 \cdot 10^3 \cdot M}{d_e^3}, \]  

[N/mm²]

Torsional stress:

\[ \tau_t = \frac{5 \cdot 10^1 \cdot Q}{d_e^2}, \]  

[N/mm²]

The rudder stock diameter is therefore not to be less than:

\[ d_e = d_i \cdot \sqrt{1 + \frac{4}{3} \left( \frac{M}{Q} \right)^2}, \]  

[mm]

where:

\[ M = \text{bending moment, in [Nm], at the station of the rudder stock considered.} \]

2.4.2.2 When calculating the diameter of the rudder stock, cognizance must be taken of SOLAS II-1/29.3.3 and 29.4.3.

In this regard, the diameter mentioned in SOLAS II-1/29.3, 29.4.3 and 29.14 should be taken as having been calculated for rudder stock of mild steel with a yield strength of 235 N/mm² (i.e. with a material factor \( k = 1 \)). See also IACS Unified Interpretation SC153.

2.4.3 Before significant reductions in rudder stock diameter due to the application of steels with yield stresses exceeding 235 N/mm² are granted, the Register 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.

2.5 RUDDER BLADE

2.5.1 Permissible stresses

The section modulus and the web area of a horizontal section of the rudder blade are to be such that the following stresses will not be exceeded:

a) In general, except in way of rudder recess sections where b) applies:

- bending stress:
  \[ \sigma_b \leq 110/k, \]  
  [N/mm²]

- shear stress:
  \[ \tau \leq 50/k, \]  
  [N/mm²]

- equivalent stress:
  \[ \sigma_e = \sqrt{\sigma_b^2 + 3\tau^2} \leq 120/k, \]  
  [N/mm²]

\[ k = \text{material factor for the rudder plating as given in 2.1.3.2.} \]
b) In way of the the recess for the rudder horn pintle on semi-spade rudders

- bending stress: 
  \[ \sigma_b \leq 75, \quad \text{N/mm}^2 \]
- shear stress:
  \[ \tau \leq 50, \quad \text{N/mm}^2 \]
- equivalent stress:
  \[ \sigma_e = \sqrt{\sigma_b^2 + 3\tau^2} \leq 100, \quad \text{N/mm}^2 \]

Note: The stresses in b) apply equally to high tensile and ordinary steels.

2.5.2 Rudder plating

The thickness of the rudder side, top and bottom plating is not to be less than:

\[ t = 5.5 \cdot s \cdot \beta \cdot \sqrt{k} \cdot \left[ \frac{d + C_h 10^{-4}}{A} + 2.5 \right], \quad \text{[mm]} \]

where:
- \( d \) = summer load line draught, in [m];
- \( C_h \) = rudder force, in [N], according 2.2.1;
- \( A \) = rudder area, in [m²];
- \( \beta = \sqrt{1.1 - 0.5 \left( \frac{s}{b} \right)^2} \); max 1.0, if \( b/s \geq 2.5 \);
- \( s \) = smallest unsupported width of plating, in [m];
- \( b \) = greatest unsupported with plating in [m];
- \( k \) = material factor for the rudder plating as given in 2.1.3.2.

The thickness of the nose plates may be increased to the discretion of the Register. The thickness of web plates is not to be less than the greater of 70% of the rudder side plating thickness and 8 mm.

The rudder plating in way of the solid part is to be of increased thickness per 2.5.3.4.

2.5.3 Connections of rudder blade structure with solid parts

2.5.3.1 Solid parts in forged or cast steel, which house the rudder stock or the pintle, are normally to be provided with protrusions, except where not required as indicated below.

These protrusions are not required when the web plate thickness is less than:
- 10 mm, for web plates welded to the solid part on which the lower pintle of a semi-spade rudder is housed and for vertical web plates welded to the solid part of the rudder stock coupling of spade rudders.
- 20 mm, for other web plates.

2.5.3.2 The solid parts are in general to be connected to the rudder structure by means of two horizontal web plates and two vertical web plates.

2.5.3.3 Minimum section modulus of the connection with the rudder stock housing.

The section modulus of the cross-section of the structure of the rudder blade, in [cm³], formed by vertical web plates and rudder plating, which is connected with the solid part where the rudder stock is housed is to be not less than:

\[ W_s = c_s \cdot d_c \cdot \left[ \frac{H_E - H_x}{H_E} \right] k_s 10^{-4}, \quad \text{[cm}³\text{]} \]

where:
- \( c_s \) = coefficient, to be taken equal to:
  - 1.0 if there is no opening in the rudder plating or if such openings are closed by a full penetration welded plate
  - 1.5 if there is an opening in the considered cross-section of the rudder
- \( d_c \) = rudder stock diameter, in [mm]
- \( H_E \) = vertical distance between the lower edge of the rudder blade and the upper edge of the solid part, in [m]
- \( H_x \) = vertical distance between the considered cross-section and the upper edge of the solid part, in [m]
- \( k \) = material factor for the rudder blade plating as given in 2.1.3.2.
- \( k_s \) = material factor for the rudder stock as given in 2.1.3.5.

The actual section modulus of the cross-section of the structure of the rudder blade is to be calculated with respect to the symmetrical axis of the rudder.

The breadth of the rudder plating, in [m], to be considered for the calculation of section modulus is to be not greater than:

\[ b = s_x + 2 H_x / 3, \quad \text{in [m]} \]

where:
- \( s_x \) = spacing between the two vertical webs, in [m], see Fig. 2.5.3.3.

Where openings for access to the rudder stock nut are not closed by a full penetration welded plate, they are to be deducted.
### Table 2.5.3.5

<table>
<thead>
<tr>
<th>Type of rudder</th>
<th>Thickness of vertical web plates, in [mm]</th>
<th>Thickness of rudder plating, in [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rudder blade without opening</td>
<td>Rudder blade with opening</td>
<td>Rudder blade without opening</td>
</tr>
<tr>
<td>Rudder supported by sole piece</td>
<td>1.2 t</td>
<td>1.6 t</td>
</tr>
<tr>
<td>Semi-spade and spade rudders</td>
<td>1.4 t</td>
<td>2.0 t</td>
</tr>
</tbody>
</table>

\[ t = \text{thickness of the rudder plating, in [mm], as defined in 2.5.2} \]

The increased thickness is to extend below the solid piece at least to the next horizontal web.

### 2.5.4 Single plate rudders

#### 2.5.4.1 Mainpiece diameter

The mainpiece diameter is calculated according to 2.4.1 and 2.4.2 respectively. For spade rudders the lower third may taper down to 0.75 times stock diameter.

#### 2.5.4.2 Blade thickness

The blade thickness is not to be less than:

\[ t_B = 1.5 \cdot s \cdot v \sqrt{k} + 2.5, \quad [\text{mm}] \]

where:

- \( s \) = spacing of stiffening arms, in [m]; not to exceed 1 m;
- \( v \) = speed of ship, in [knots]; (see 2.2.1.1)
- \( k \) = material factor for the rudder plating as given in 2.1.3.2

#### 2.5.4.3 Arms

The thickness of the arms is not to be less than the blade thickness:

\[ t_a = t_b, \quad [\text{mm}] \]

The section modulus is not to be less than:

\[ W_a = 0.5 s C_l v^2 k, \quad [\text{cm}^3] \]

\( C_l \) = horizontal distance from the aft edge of the rudder to the centreline of the rudder stock, in [m];

\( k \) = material factor as given in 2.1.3.2 or 2.3.5 respectively.

---

![Figure 2.5.3.3 Cross-section of the connection between rudder blade structure and rudder stock housing](image-url)

2.5.3.4 The thickness of the horizontal web plates connected to the solid parts, in \([\text{mm}]\), as well as that of the rudder blade plating between these webs, is to be not less than the greater of the following values:

\[ t_H = 1.2 t, \quad [\text{mm}], \]

\[ t_H = 0.045 d_S^2 / s_H, \quad [\text{mm}]. \]

where:

- \( t \) = defined in 2.5.2,
- \( d_S \) = diameter, in \([\text{mm}]\), to be taken equal to:
  - \( d_a \), as per 2.4.2, for the solid part housing the rudder stock,
  - \( d_p \), as per 2.7.1, for the solid part housing the pintle,
- \( s_H \) = spacing between the two horizontal web plates, in \([\text{mm}]\).  

The increased thickness of the horizontal webs is to extend fore and aft of the solid part at least to the next vertical web.

2.5.3.5 The thickness of the vertical web plates welded to the solid part where the rudder stock is housed as well as the thickness of the rudder side plating under this solid part is to be not less than the values obtained, in \([\text{mm}]\), from Table 2.5.3.5.
2.6 RUDDER STOCK COUPLINGS

2.6.1 Horizontal flange couplings

2.6.1.1 The diameter of the coupling bolts is not to be less than:

\[ d_b = 0.62 \sqrt[3]{ \frac{d \cdot k_s}{n \cdot e_m \cdot k_b}} \quad [\text{mm}] \]

where:
- \( d \) = stock diameter, taken equal to the greater of the diameters \( d_t \) or \( d_c \) according to 2.4.1.1 and 2.4.1.2, in [mm];
- \( n \) = total number of bolts, which is not to be less than 6;
- \( e_m \) = mean distance of the bolt axes from the centre of bolt system, in [mm];
- \( k_s \) = material factor for the rudder stock as given in 2.3.1.5;
- \( k_b \) = material factor for the bolts as given in 2.3.1.5.

2.6.1.2 The thickness of the coupling flanges is not to be less than determined by the following formula:

\[ t_f = d_b \cdot \sqrt{ \frac{k_f}{k_b}} \quad [\text{mm}] \]

where:
- \( k_f \) = material factor for the coupling flanges as given in 2.3.1.5;
- \( k_b \) = material factor for the bolts as given in 2.3.1.5.

2.6.1.3 The width of material between the perimeter of the bolt holes and the perimeter of the flange is not to be less than 0.67 \( d_b \).

2.6.1.4 The welded joint between the rudder stock and the flange is to be made in accordance with Fig. 2.6.1.4 or equivalent.

2.6.1.5 Coupling bolts are to be fitted bolts and their nuts are to be locked effectively.

2.6.2 Vertical flange couplings

2.6.2.1 The diameter of coupling bolts is not to be less than:

\[ d_b = 0.81 \cdot \frac{d}{\sqrt{n}} \cdot \sqrt{\frac{k_s}{k_b}} \quad [\text{mm}] \]

where:
- \( d \) = stock diameter, in [mm], in way of coupling flange;
- \( n \) = total number of bolts, which is not to be less than 8;
- \( k_s \) = material factor for the rudder stock as given in 2.3.1.5;
- \( k_b \) = material factor for the bolts as given in 2.3.1.5.

2.6.2.2 The first moment of area of the bolts about the centre of the coupling, in [m], is to be not less than:

\[ m = 0.00043 \cdot d^2 \quad [\text{cm}^3] \]

2.6.2.3 The thickness of the coupling flanges is to be not less than the bolt diameter, and the width of the flange material between the perimeter of the bolt holes and the perimeter of the flange is to be not less than 0.67 \( d_b \).

2.6.2.4 Coupling bolts are to be fitted bolts and their nuts are to be locked effectively.
2.6.3 Cone couplings with key

2.6.3.1 Tapering and coupling length

Cone couplings without hydraulic arrangements for mounting and dismounting the coupling should have a taper \( c \) on diameter of 1:8-1:12, where

\[
c = \frac{d_0 - d_u}{l}, \quad \text{see Fig. 2.6.3.1}
\]

The cone coupling is to be secured by a slugging nut. The nut is to be secured, e.g. by a securing plate.

The cone shapes are to fit exactly. The coupling length \( \ell \) is to be, in general, not less than \( 1.5d_0 \).

![Figure 2.6.3.1 Cone coupling with key](image)

2.6.3.2 Dimensions of key

For couplings between stock and rudder a key is to be provided, the shear area of which, in [cm²], is not to be less than:

\[
a_s = \frac{17.55 \cdot Q_F}{d_i \cdot R_{est}^2} \times 10^3
\]

where:

\[
Q_F = \text{design yield moment of rudder stock, in [Nm]}
\]

\[
Q_F = 0.02664 \cdot \frac{d_1^3}{k}
\]

Where the actual diameter \( d_{ar} \) is greater than the calculated diameter \( d_c \), the diameter \( d_{ar} \) is to be used. However, \( d_{ar} \) applied to the above formula need not be taken greater than 1.145 \( d_c \).

\[
d_i = \text{stock diameter, in [mm], according to 2.4.1},
\]

\[
k = \text{material factor for stock as given in 2.1.3.5},
\]

\[
d_i = \text{mean diameter of the conical part of the rudder stock, in [mm], at the key},
\]

\[
R_{est} = \text{minimum yield stress of the key material, in [N/mm²].}
\]

The effective surface area, in [cm²], of the key (without rounded edges) between key and rudder stock or cone coupling is not to be less than:

\[
a_s = \frac{5 \cdot Q_F}{d_i^2 \cdot R_{est}^2} \times 10^3
\]

where:

\[
R_{est} = \text{minimum yield stress of the key, stock or coupling material, in [N/mm²], whichever is less.}
\]

2.6.3.3 The dimensions of the slugging nut are to be as follows (see Fig. 2.6.3.1):

- external thread diameter: \( d_g \geq 0.65 \cdot d_u \)
- height of nut: \( h_s \geq 0.6 \cdot d_e \)
- outer diameter of nut: \( d_n \geq 1.2 \cdot d_e \) or \( 1.5 \cdot d_c \) whichever is the greater.

2.6.3.4 Push up

It is to be proved that 50% of the design yield moment is solely transmitted by friction in the cone couplings. This can be done by calculating the required push-up pressure and push-up length according to 2.6.4.2 and 2.6.4.3 for a torsional moment \( Q'_F = 0.5Q_F \).

2.6.3.5 Notwithstanding the requirements in 2.6.3.2 and 2.6.3.4, 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 at the discretion of the Register.

2.6.4 Cone couplings with special arrangements for mounting and dismounting the couplings

2.6.4.1 Where the stock diameter exceeds 200 mm, the press fit is recommended to be effected by a hydraulic pressure connection. In such cases the cone is to be more slender, \( c \approx 1:12 \) to \( \approx 1:20 \).

In case of hydraulic pressure connections the nut is to be effectively secured against the rudder stock or the pin-

For the safe transmission of the torsional moment by the coupling between rudder stock and rudder body the push-up pressure and the push-up length are to be determined according to 2.6.4.2 and 2.6.4.3 respectively.
2.6.4.2 Push-up pressure

The push-up pressure is not to be less than the greater of the two following values:

\[ P_{req1} = \frac{2Q_F}{d_m \cdot \ell \cdot \pi \cdot \mu_0} \times 10^3 \, [N/mm^2] \]

\[ P_{req2} = \frac{6M_p}{\ell^2 \cdot d_m} \times 10^3 \, [N/mm^2] \]

where:

- \( Q_F \) = design yield moment of rudder stock, as defined in 2.6.3.2, in [Nm],
- \( d_m \) = mean cone diameter in [mm], see Fig. 2.6.3.1,
- \( \ell \) = cone length, in [mm],
- \( \mu_0 \) = frictional coefficient, equal to 0.15,
- \( M_p \) = bending moment in the cone coupling (e.g. in case of spade rudders), in [Nm].

It has to be proved by the designer that the push-up pressure does not exceed the permissible surface pressure in the cone. The permissible surface pressure, in [N/mm²], is to be determined by the following formula:

\[ P_s = \frac{0.95 R_{elf} \left(1 - \alpha^2\right)}{\sqrt{3} + \alpha^2} \times p_b \, [N/mm^2] \]

where:

- \( p_b \) = minimum yield stress of the material of the gudgeon, in [N/mm²],
- \( \alpha = d_w/d_o \),
- \( d_w = \) diameter of the gudgeon, in [mm], see Fig. 2.6.3.1.

2.6.4.3 Push-up length

The push-up length \( \Delta \ell \), in [mm], is to comply with the following formula:

\[ \Delta \ell_1 = \frac{P_{req} \cdot d_m}{E \left(1 - \alpha^2\right) \cdot c} + 0.8 \cdot R_{tm} \times \frac{c}{2} \, [mm] \]

\[ \Delta \ell_2 = \frac{P_{perm} \cdot d_m}{E \left(1 - \alpha^2\right) \cdot c} + 0.8 \cdot R_{tm} \times \frac{c}{2} \, [mm] \]

where:

- \( P_{req} \) = required push-up force, in [N], for the cone,
- \( P_{perm} \) = permissible push-up force, in [N],
- \( E \) = Young’s modulus, in [N/mm²],
- \( c \) = taper on diameter, defined in 2.6.3.1,
- \( \alpha = d_w/d_o \)
- \( \mu_0 \) = frictional coefficient, equal to 0.15,
- \( R_{tm} = \) mean roughness, in [mm], taken equal to 0.01.

Note:
In case of hydraulic pressure connections the required push-up force \( P_e \), in [N], for the cone may be determined by the following formula:

\[ P_e = P_{req} \cdot d_m \cdot \pi \cdot \ell \cdot \left(\frac{c}{2} + 0.02\right) \]

The value 0.02 is a reference for the friction coefficient using oil pressure. It varies and depends on the mechanical treatment and roughness of the details to be fixed.

Where due to the fitting procedure a partial push-up effect caused by the rudder weight is given, this may be taken into account when fixing the required push-up length, subject to approval by the Register.

2.7 PINTLES

2.7.1 Scantlings

The pintle diameter, in [mm], is not to be less than:

\[ d_p = 0.35 \sqrt{B \cdot k_p} \]

where:

- \( B \) = relevant bearing force, in [N],
- \( k_p = \) material factor for pintle as given in 2.1.3.3.
2.7.2 Couplings

2.7.2.1 Tapering

Pintles are to have a conical attachment to the gudgeons with a taper on diameter not greater than:

- 1:8 - 1:12, for keyed and other manually assembled pintles applying locking by slugging nut,
- 1:12 - 1:20, on diameter for pintles mounted with oil injection and hydraulic nut.

2.7.2.2 Push-up pressure for pintle bearings

The required push-up pressure for pintle bearings, in \([\text{N/mm}^2]\), is to be determined by the following formula:

\[
P_{\text{req}} = 0.4 \times \frac{B_1 \cdot d_0}{d_n^2 \cdot \ell}, \quad \text{[N/mm}^2]\]

where:

- \(B_1\) = supporting force in the pintle bearing, in [N]
- \(d_0\) = pintle diameter, in [mm], see Fig. 2.6.3.1.

The push up length is to be calculated similarly as in 2.6.4.3, using required push-up pressure and properties for the pintle bearing.

2.7.3 The minimum dimensions of threads and nuts are to be determined according to 2.6.3.3

2.7.4 Pintle housing

The length of the pintle housing in the gudgeon is not to be less than the pintle diameter \(d_p\). The thickness of the pintle housing is not to be less than 0.25 \(d_p\).

2.7.5 For recommended maximum allowable rudder pintle clearance see IACS Rec. No.61.

2.8 RUDDER STOCK BEARING, RUDDER SHAFT BEARING AND PINTLE BEARING

2.8.1 Liners and bushes

2.8.1.1 Rudder stock bearing

Liners and bushes are to be fitted in way of bearings. The minimum thickness of liners and bushes is to be equal to:

\[
t_{\text{min}} = \begin{cases} 
8 \text{ mm, for metallic materials and synthetic material}, \\
22 \text{ mm, for lignum material}.
\end{cases}
\]

2.8.1.2 Pintle bearing

The thickness of any liner or bush, in [mm], is neither to be less than:

\[
t = 0.01\sqrt{B}
\]

where:

- \(B\) = relevant bearing force, in [N],

nor than the minimum thickness defined in 2.8.1.1.

2.8.2 Minimum bearing surface

An adequate lubrication is to be ensured.

The bearing surface \(A_b\) (defined as the projected area: length \(\times\) outer diameter of liner) is not to be less than:

\[
A_b = \frac{P}{q_a}, \quad \text{[mm}^2]\]

where:

- \(P\) = reaction force, in [N], in bearing as determined in 2.3.2;
- \(q_a\) = allowable surface pressure according to the Table 2.8.2.

The maximum surface pressure \(q_a\) for the various combinations is to be taken as reported in the table below. Higher values than given in the table may be taken in accordance with maker’s specifications if they are verified by tests.

<table>
<thead>
<tr>
<th>Bearing material</th>
<th>(q_a) [N/mm(^2)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>lignum vitae</td>
<td>2.5</td>
</tr>
<tr>
<td>white metal, oil lubricated</td>
<td>4.5</td>
</tr>
<tr>
<td>synthetic material with hardness between 60 and 70 Shore D(^1)</td>
<td>5.5(^2)</td>
</tr>
<tr>
<td>Steel (^{1,2}), bronze and hot-pressed bronze-graphite materials</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Notes:

1) Indentation hardness test at 23°C and with 50% moisture, according to a recognised standard. Synthetic bearing materials is to be of approved type.
2) Surface pressures exceeding 5.5 N/mm\(^2\) may be accepted in accordance with bearing manufacturer's specification and tests, but in no case more than 10 N/mm\(^2\).
3) Stainless and wear-resistant steel in an approved combination with stock liner.

2.8.3 Bearing dimensions

The length/diameter ratio of the bearing surface is not to be greater than 1.2.

The bearing length \(L_p\) of the pintle is to be such that:

\[
D_p \leq L_p \leq 1.2 \times D_p
\]

where:
\[ D_p = \text{actual pintle diameter measured on the outside of liners.} \]

2.8.4 Bearing clearances

With metal bearings, clearances should not be less than \( \frac{d_p}{1000} + 1.0 \text{ mm on the diameter. If non-metallic bearing material is applied, the bearing clearance is to be specially determined considering the material’s swelling and thermal expansion properties. This clearance is not to be taken less than 1.5 mm on bearing diameter unless a smaller clearance is supported by the manufacturer’s recommendation and there is documented evidence of satisfactory service history with a reduced clearance.} \]

2.9 GUIDELINES FOR CALCULATION OF BENDING MOMENT AND SHEAR FORCE DISTRIBUTION

2.9.1 General

The evaluation of bending moments, shear forces and support forces for the system rudder/rudder stock may be carried out for some basic rudder types as outlined in 2.9.2 - 2.9.6.

2.9.2 Spade rudder

2.9.2.1 Data for the analysis

\[ l_{10} + l_{30} = \text{lengths of the individual girders of the system, in [m], see Fig. 2.9.2,} \]
\[ I_{10} + I_{30} = \text{moments of inertia of these girders, in [cm^4].} \]

Load of rudder body:
\[ P_R = \frac{C_R}{l_{10} \cdot 10^3}, \quad \text{[kN/m]} \]

2.9.2.2 Moments and forces

The moments and forces may be determined by the following formulae:

\[ M_b = C_R \left[ \frac{l_{20} + l_{30} \cdot (2x_1 + x_2)}{3(x_1 + x_2)} \right], \quad \text{[Nm],} \]
\[ B_3 = \frac{M_b}{l_{30}}, \quad \text{[N].} \]
\[ B_2 = C_R + B_4, \quad \text{[N].} \]

![Figure 2.9.2 Spade rudder](image)
2.9.3  Spade rudder with trunk

2.9.3.1  Data for the analysis

\[ l_{10} \times I_{10} = \text{lengths of the individual girders of the system, in [m], see Fig. 2.9.3,} \]
\[ l_{30} \times I_{30} = \text{moments of inertia of these girders, in [cm}^4]. \]

Load of rudder body:
\[ P_R = \frac{C_R}{(l_{10} + l_{30}) \cdot 10^3}, \quad [\text{kN/m}]. \]

2.9.3.2  Moments and forces

For spade rudders with rudders trunks the moments, in [Nm], and forces, in [N], may be determined by the following formulae:

\[ M_{CR1} = C_{R1} \left( C_{G1Z} - I_{10} \right), \quad [\text{Nm}], \]
\[ M_{CR2} = C_{R2} \left( I_{10} - C_{G2Z} \right), \quad [\text{Nm}], \]

where:
\[ C_{R1} = \text{rudder force over the rudder blade area} \ A_1, \]
\[ C_{R2} = \text{rudder force over the rudder blade area} \ A_2, \]
\[ C_{G1Z} = \text{vertical position of the centre of gravity of the rudder blade area} \ A_1, \text{ from base}, \]
\[ C_{G2Z} = \text{vertical position of the centre of gravity of the rudder blade area} \ A_2, \text{ from base}. \]

\[ B_3 = \frac{(M_{CR2} - M_{CR1})}{(l_{20} + l_{30})}, \]
\[ B_2 = C_R + B_3 \]

\[ Z = \ell_{10} \]

\[ Z = 6.18 \frac{I_{50}}{\ell_{50}^3}, \quad [\text{kN/m}]. \]

2.9.4  Rudder supported by sole piece

2.9.4.1  Data for the analysis

\[ \ell_{10} \times \ell_{50} = \text{lengths of the individual girders of the system in [m],} \]
\[ I_{10} \times I_{50} = \text{moments of inertia of these girders, in [cm}^4]. \]

For rudders supported by a sole piece the length \( \ell_{20} \) is the distance between lower edge of rudder body and centre of sole piece and \( I_{50} \) the moment of inertia of the pintle in the sole piece.

\[ I_{50} = \text{moment of inertia of sole piece around the } z\text{-axis, in [cm}^4]; \]
\[ \ell_{50} = \text{effective length of sole piece, in [m]}; \]

Load of rudder body:
\[ P_R = \frac{C_R}{(\ell_{10} \cdot 10^3)}, \quad [\text{kN/m}], \]
\[ Z = \text{spring constant of support in the sole piece} \]
\[ Z = 6.18 \frac{I_{50}}{\ell_{50}^3}, \quad [\text{kN/m}]. \]

2.9.4.2  Moments and forces

Moments and shear forces are indicated in Fig. 2.9.4

\[ \ell_{20} = \text{distance between lower edge of rudder body and centre of sole piece and} \]
\[ I_{50} = \text{moment of inertia of the pintle in the sole piece}. \]

\[ M_R \text{ is the greatest of the following values:} \]
\[ M_{CR1} = C_{R1} (C_{G1Z} - I_{10}), \quad [\text{Nm}], \]
\[ M_{CR2} = C_{R2} (I_{10} - C_{G2Z}), \quad [\text{Nm}], \]

\[ Z = 6.18 \frac{I_{50}}{\ell_{50}^3}, \quad [\text{kN/m}]. \]
2.9.5 Semi spade rudder with one elastic support

2.9.5.1 Data for the analysis

- \( \ell_{10} - \ell_{50} \): lengths of the individual girders of the system in [m];
- \( I_{10} - I_{50} \): moments of inertia of these girders in \([cm^4]\);
- \( Z \): spring constant of support in the rudder horn;
- \( Z = \frac{1}{(f_b + f_t)} \): for the support in the rudder horn (Fig. 2.9.5-1);
- \( f_b \): unit displacement of rudder horn, in [m], due to a unit force of 1 kN acting in the centre of support;
- \( f_b = 1.3 \frac{d^3}{(6.18 L_e)} \): (guidance value);
- \( I_n \): moment of inertia of rudder horn around the x-axis, in \([cm^4]\), (see also Fig. 2.9.5-1);
- \( f_t \): unit displacement due to torsion;
- \( f_t = \frac{d \cdot \sigma_{u} \mu_{i}}{t_{i} / (3.14 \cdot 10^8 \cdot F_T^2)} \): [m/kN];
- \( F_T \): mean sectional area of rudder horn, in \([m^2]\);
- \( u_i \): breadth, in [mm], of the individual plates forming the mean horn sectional area;
- \( t_i \): thickness within the individual breadth \( u_i \) in [mm];
- \( d \): height of the rudder horn, in m, defined in Fig. 2.9.5-1. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, to the mid-line of the lower rudder horn pintle;
- \( e \): distance as defined in Fig. 2.9.5-2

Load of rudder body:

- \( P_{R10} = C_{R1} / (\ell_{10} \times 10^3) \), [kN/m];
- \( P_{R20} = C_{R2} / (\ell_{20} \times 10^3) \), [kN/m];

for \( C_{R1}, C_{R2}, C_{R2} \), see 2.2.

2.9.5.2 Moments and forces

Moments and shear forces are indicated in Fig. 2.9.4.

2.9.5.3 Rudder horn

The loads on the rudder horn are as follows:

- \( M_b \): bending moment = \( B_1 z \), [Nm],
- \( M_{\text{max}} \): bending moment = \( B_1 d \), [Nm],
- \( q \): shear force = \( B_1 e(z) \), [N],
- \( M_T(z) \): torsional moment = \( B_1 e(z) \), [Nm],

An estimate for \( B_1 \) is:

- \( B_1 = C_R \sigma_b / (\ell_{20} + \ell_{30}) \), [N]
2.9.6 Semi spade rudder with 2-conjugate elastic support

2.9.6.1 Data for the analysis

$K_{11}$, $K_{22}$, $K_{12}$: rudder horn compliance constants calculated for rudder horn with 2-conjugate elastic supports (Fig. 2.9.6-1). The 2-conjugate elastic supports are defined in terms of horizontal displacements, $y_i$, by the following equations:

- at the lower rudder horn bearing:
  \[ y_1 = -K_{12} B_2 - K_{22} B_1 \]
- at the upper rudder horn bearing:
  \[ y_2 = -K_{11} B_2 - K_{12} B_1 \]

where:

$y_1, y_2$: horizontal displacements, in [m], at the lower and upper rudder horn bearings, respectively.

$B_1, B_2$: horizontal support forces, in [kN], at the lower and upper rudder horn bearings, respectively.

$K_{11}, K_{22}, K_{12}$: obtained, in [m/kN], from the following formulae:

\[
K_{11} = 1.3 \left( \frac{\lambda}{3EI_v} + \frac{e^2 \lambda}{GJ_v} \right)
\]
\[
K_{22} = 1.3 \left( \frac{\lambda}{3EI_v} + \frac{e^2 \lambda}{2EI_v} \right) + \frac{e^2 \lambda}{GJ_v}
\]
\[ K_{zz} = 1.3 \left( \frac{\lambda^3}{3EJ_{t0}} + \frac{\lambda^2(d-\lambda)}{EJ_{t0}} + \frac{\lambda(d-\lambda)^2}{3EJ_{\lambda_2}} + \frac{e^2d}{GJ_h} \right) \]

\[ d \quad \text{height of the rudder horn, in [m], defined in Fig. 2.9.6-1. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, to the mid-line of the lower rudder horn pintle.} \]

\[ \lambda \quad \text{length, in [m], as defined in Fig. 2.9.6-1. This length is measured downwards from the upper rudder horn end, at the point of curvature transition, to the mid-line of the upper rudder horn bearing. For } \lambda = 0, \text{ the above formulae converge to those of spring constant } Z \text{ for a rudder horn with 1-elastic support, and assuming a hollow cross section for this part.} \]

\[ e \quad \text{rudder-horn torsion lever, in [m], as defined in Fig. 2.9.6-1 (value taken at } z = \frac{d}{2}). \]

\[ J_{1h} \quad \text{moment of inertia of rudder horn about the } x \text{ axis, in [m}^4], \text{ for the region above the upper rudder horn bearing. Note that } J_{1h} \text{ is an average value over the length } \lambda \text{ (see Fig. 2.9.6-1).} \]

\[ J_{2h} \quad \text{moment of inertia of rudder horn about the } x \text{ axis, in [m}^4], \text{ for the region between the upper and lower rudder horn bearings. Note that } J_{2h} \text{ is an average value over the length } d - \lambda \text{ (see Fig. 2.9.6-1).} \]

\[ J_{th} \quad \text{torsional stiffness factor of the rudder horn, in [m}^4]. \]

For any thin wall closed section:

\[ J_0 = \frac{4 \cdot F_t^2}{\sum \frac{u_i}{t_i}} \]

\[ F_t \quad \text{mean of areas enclosed by outer and inner boundaries of the thin walled section of rudder horn, in [m}^2]. \]

\[ u_i \quad \text{length, in [mm], of the individual plates forming the mean horn sectional area.} \]

\[ t_i \quad \text{thickness, in [mm], of the individual plates mentioned above.} \]

Note that the \( J_0 \) value is taken as an average value, valid over the rudder horn height.

Load of rudder body:

\[ P_{R10} = C_{R1} \ell (\ell_{10} \times 10^5) \text{ [kN/m];} \]

\[ P_{R20} = C_{R1} \ell (\ell_{10} \times 10^5) \text{ [kN/m];} \]

for \( C_{R1}, C_{R1}, C_{R2}, \) see 2.2.

**2.9.6.2 Moments and forces**

Moments and shear forces are indicated in Fig. 2.9.6-1.

**2.9.6.3 Rudder horn bending moment**

The bending moment acting on the generic section of the rudder horn is to be obtained, in [Nm], from the following formulae:

- between the lower and upper supports provided by the rudder horn:

\[ M_H = F_{A1} \ z \]

- above the rudder horn upper-support:

\[ M_H = F_{A1} \ z + F_{A2} \ (z - d_u) \]

where:

\[ F_{A1} = \text{support force at the rudder horn lower-support, in [N], to be obtained according to Fig. 2.9.6-1, and taken equal to } B_1. \]

\[ F_{A2} = \text{support force at the rudder horn upper-support, in [N], to be obtained according to Fig. 2.9.6-1, and taken equal to } B_2. \]

\[ z \quad \text{distance, in m, defined in Fig. 2.9.6-2, to be taken less than the distance } d, \text{ in [m], defined in the same figure.} \]

\[ d_u \quad \text{distance, in [m], between the rudder-horn lower and upper bearings (according to Fig. 2.9.6-1, } d_u = d - \lambda \text{ ).} \]

**2.9.6.4 Rudder horn shear force**

The shear force \( Q_H \) acting on the generic section of the rudder horn is to be obtained, in [N], from the following formulae:

- between the lower and upper rudder horn bearings:

\[ Q_H = F_{A1} \]

- above the rudder horn upper-bearing:

\[ Q_H = F_{A1} + F_{A2} \]

where:

\[ F_{A1}, F_{A2} = \text{support forces, in [N].} \]

The torque acting on the generic section of the rudder horn is to be obtained, in [Nm], from the following formulae:

- between the lower and upper rudder horn bearings:

\[ M_T = F_{A1} \ e(z) \]

- above the rudder horn upper-bearing:

\[ M_T = F_{A1} \ e(z) + F_{A2} \ e(z) \]

where:

\[ F_{A1}, F_{A2} = \text{support forces, in [N],} \]
\( e(z) \) = torsion lever, in [m], defined in Fig. 2.9.6-2.

2.9.6.5 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:

\[ \tau_s = \text{shear stress, in [N/mm}^2\text{]}, \] to be obtained from the following formula:

\[ \tau_s = \frac{F_{s1}}{A_H} \]

\[ \tau_T = \text{torsional stress, in [N/mm}^2\text{]}, \] to be obtained for hollow rudder horn from the following formula:

\[ \tau_T = \frac{M_T \cdot 10^3}{2 \cdot F_T \cdot t_H} \]

For solid rudder horn, \( \tau_T \) is to be considered by the Register on a case by case basis.

For a generic section of the rudder horn, located in the region above its upper bearing, the following stresses are to be calculated:

\[ \tau_s = \text{shear stress, in [N/mm}^2\text{]}, \] to be obtained from the following formula:

\[ \tau_s = \frac{F_{s1} + F_{s2}}{A_H} \]

\[ \tau_T = \text{torsional stress, in [N/mm}^2\text{]}, \] to be obtained for hollow rudder horn from the following formula:

\[ \tau_T = \frac{M_T \cdot 10^3}{2 \cdot F_T \cdot t_H} \]

2.9.6.6 Rudder horn bending stress calculation

For the generic section of the rudder horn within the length \( d \), the following stresses are to be calculated:

\[ \sigma_B = \text{bending stress, in [N/mm}^2\text{],} \] to be obtained from the following formula:

\[ \sigma_B = \frac{M_H}{W_X} \]

where:

\[ M_H = \text{bending moment at the section considered, in [Nm]}; \]
\[ W_X = \text{section modulus, in [cm}^3\text{], around the X-axis (see Fig. 2.9.6-2)}. \]

Figure 2.9.6-1 Semi spade rudder with one elastic support
2.10 PROPELLER NOZZLES

2.10.1 General

The following requirements are applicable to propeller nozzles having an inner diameter up to 5 m.

Special attention is to be given to the support of fixed nozzles at the hull structure.

2.10.2 Design pressure

The design pressure for propeller nozzles is to be determined by the following formula:

\[ p_d = c \times p_s, \quad [\text{kN/m}^2] \]

where:

\[ p = \varepsilon \frac{P_s}{A_p}, \quad [\text{kN/m}^2]; \]

\[ P_s = \text{maximum shaft power, in [kW]}; \]

\[ A_p = \text{propeller disc area, in } [\text{m}^2]; \]

\[ D = \frac{D^2 \cdot \pi}{4}; \]

\[ D = \text{propeller diameter, in [m]}; \]

\[ \varepsilon = \text{factor according to the following formula:} \]

\[ \varepsilon = 0.21 - 2 \cdot 10^{-4} \frac{P_s}{A_p}, \]

\[ t_{\text{min}} = 0.1; \]

\[ c = 1.0 \text{ in zone 2}; \]

\[ c = 0.5 \text{ in zones 1 and 3}; \]

\[ c = 0.35 \text{ in zone 4}; \]

For nozzle zones see Fig. 2.10.2.

2.10.3 Plate thickness

2.10.3.1 The thickness of the nozzle shell plating is not to be less than:

\[ t = 5 \cdot s \cdot \sqrt{p_s} + 2.5, \quad [\text{mm}] \]

\[ t_{\text{min}} = 7.5 \text{ mm} \]

where:

\[ s = \text{spacing of ring stiffeners, in [m]} \]

2.10.3.2 The web thickness of the internal stiffening ring is not to be less than the nozzle plating for zone 3, however, in no case be less than 7.5 mm.

2.10.4 Section modulus

The section modulus of the cross section shown in Fig. 2.10.2 around its neutral axis is not to be less than:

\[ W = n \cdot d^2 \cdot b \cdot v^2, \quad [\text{cm}^3] \]

where:

\[ d = \text{inner diameter of nozzle, in [m]}; \]

\[ b = \text{length of nozzle, in [m]}; \]

\[ n = 0.7 \text{ for fixed nozzles}; \]

\[ n = 1.0 \text{ for rudder nozzles}; \]

\[ v = \text{speed of ship according 2.2.1.1}. \]

2.10.5 Welding

The inner and outer nozzle shell plating is to be welded to the internal stiffening rings as far as practicable by
2.11 REQUIREMENTS FOR THE SHIPS WITH POLAR AND ICE CLASS NOTATION

2.11.1 For the ships with polar class notations see the Rules, Part 29 – Polar Class Ships and Ice Class Ships, 3.11.

2.11.2 For the ships with ice class notations see the Rules, Part 29 – Polar Class Ships and Ice Class Ships, 8.11.
3 ANCHORING ARRANGEMENT

3.1 GENERAL PROVISIONS

3.1.1 The anchoring equipment required herewith is intended for temporary mooring of a ship within a harbour or sheltered area when the ship is awaiting berth, tide, etc. IACS Recommendation No. 10 ‘Anchoring, Mooring and Towing Equipment’ may be referred to for recommendations concerning anchoring equipment for ships in deep and unsheltered water.

3.1.2 The equipment is therefore not designed to hold a ship off fully exposed coasts in rough weather or to stop a ship, which is moving or drifting. In this condition the loads on the anchoring equipment increase to such a degree that its components may be damaged or lost owing to the high energy forces generated, particularly in large ships.

3.1.3 The anchoring equipment required herewith is designed to hold a ship in good holding ground in conditions such as to avoid dragging of the anchor. In poor holding ground the holding power of the anchors is significantly reduced.

3.1.4 The Equipment Number \( E_n \) formulae for anchoring equipment as given in 3.2.1, 3.2.3 and 3.2.4 are based on an assumed maximum current speed of 2.5 m/s, maximum wind speed of 25 m/s and a minimum scope of chain cable of 6, the scope being the ratio between length of chain paid out and water depth. For ships with an equipment length, as defined in 3.2.2, greater than 135 m, alternatively the required anchoring equipment can be considered applicable to a maximum current speed of 1.54 m/s, a maximum wind speed of 11 m/s and waves with maximum significant height of 2 m.

---

### Table 3.1.2-1 Anchoring and mooring equipment

<table>
<thead>
<tr>
<th>Equipment number</th>
<th>Stockless anchor</th>
<th>Stud link chain cables</th>
<th>Stream wire or chain</th>
<th>Bow line</th>
<th>Mooring line</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Min. diameter</td>
<td>Length</td>
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- **Equipment letter**
- **Equipment No.**
- **Stud link chain wires**
- **Stream wire or chain**
- **Bow line**
- **Mooring line**

---

2019
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<th>Stream wire or chain</th>
<th>Tow line a</th>
<th>Mooring line b</th>
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</tr>
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</table>

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1. Chain cables or wire ropes may be used, chain cable breaking load or actual breaking strength of rope being not less than 44 kn. Towing lines are recommendations only.
2. Guidance for mooring lines for ships with equipment number $E_n \geq 2000$ is given in IACS Rec. No.10.
3. Value is applicable for ships with equipment number $930 < E_n < 2000$. 2019
3.1.5 It is assumed that under normal circumstances a ship uses only one bow anchor and chain cable at a time.

3.1.6 For all ships of unrestricted service, except fishing vessels, the equipment for anchoring, mooring and towing is to be selected from Table 3.1.2-1, and for fishing vessels from Table 3.1.2-2.

3.1.7 When determining the equipment of ships with restricted area of navigation, 3.6 are to be observed.

3.1.8 Manufacture of anchors and anchor chain cables is to be in accordance with the *Rules, Part 25 - Metallic materials*, Sections 6 and 7.

### 3.2 EQUIPMENT NUMBER

3.2.1 The equipment of anchors and chain cables for ships of unrestricted service, except floating cranes and tugs, as given in tables above, is to be based on an Equipment Number $En$ calculated as follows:

$$ E_n = \Delta^{0.3} + 2Bh + 0.1A, $$

where:

- $\Delta$ = 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 spring line of the uppermost house; for the lowest tier $\delta=0.5\gamma$, for the second tier $\delta=0.8\gamma$, for the third tier $\delta=1.0\gamma$, where $\gamma$ is the distance from the summer load waterline to the top of the uppermost house; for the lowest tier $\delta=0.5\gamma$, for the second tier $\delta=0.8\gamma$, for the third tier $\delta=1.0\gamma$,
- $A$ = area, in $[m^2]$, in profile view, of the hull, superstructures and houses above the summer load waterline which are within the Equipment length of the vessel and also have a breadth greater than $B/4$, see also 3.2.2.

3.2.2 The equipment of anchors and anchor chain cables for ships restricted in area of navigation is to be selected from Table 3.1.2-1, and for vessels exceeding the equipment of ships of unrestricted service, except floating cranes and tugs, from Table 3.1.2-2.

#### Table 3.1.2-2 Equipment for fishing vessels

<table>
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<th>Equipment number Stockless bower anchors</th>
<th>Stud link chain cables for anchors</th>
<th>Mooring line</th>
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</table>
3.2.2 When calculating \( h \), sheer and trim are to be ignored, i.e. \( h \) is the sum of freeboard amidships plus the height (at centreline) of each tier of houses having a breadth greater than \( B/4 \).

If a house having a breadth greater than \( B/4 \) is above a house with a breadth of \( B/4 \) or less then the wide house is to be included but the narrow house ignored.

Screens or bulwarks 1.5 m or more in height are to be regarded as parts of houses when determining \( h \) and \( A \).

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

With regard to determining \( A \), when a bulwark is more than 1.5 m high, the area shown as \( A_2 \) (see Fig. 3.2.2) is to be included in \( A \).

The equipment length of the vessels is the length between perpendiculars but is not to be less than 96% nor greater than 97% of the extreme length on the summer waterline (measured from the forward end of the waterline).

The total length of chain given in Tables 3.1.2-1 and 3.1.2-2 is to be divided in approximately equal parts between the two bower anchors.

3.3 ANCHORS

3.3.1 General

The bower anchors are to be connected to their chain cables and positioned on board ready for use.

The stream anchor should be ready to be connected with its cable.

Ships with Equipment Number of 205 and less may have the second bower anchor as spare one on condition that provision is made for its quick getting ready for use.

Unmanned barges and pontoons where length is less than 30 m the anchor may be dispensed with and where length is greater than 30 m may have only one bower anchor.

3.3.2 Anchor mass

The mass, per anchor, of bower anchor given in the Tables 3.1.2-1 and 3.1.2-2 is required for anchors of equal mass.

The mass of individual anchor may vary to 7% of the Table mass provided that the total mass of anchors is not less than that required for anchors of equal mass.

When special type of anchors designated high holding power anchor of proven superior holding ability are used as bower anchors, the mass of each anchor may be 75% of the mass required for ordinary stockless bower anchors in the Tables 3.1.2-1 and 3.1.2-2.
The mass of the stocked anchor, when used, and that of stream anchor, excluding the stock, is to be 80% of the mass required in the Tables 3.1.2-1 and 3.1.2-2 for stockless bower anchors and the mass of the stock is to be 20%.

The mass of the heads of stockless anchor including pins and fittings are not to be less than 60% of the total mass of the anchor.

### 3.3.3 High holding power anchors (HHP)

#### 3.3.3.1 A high holding power anchor is an anchor with a holding power of at least twice that of an ordinary stockless anchor of the same mass. A HHP anchor is to be suitable for ship's use and is not to require prior adjustment or special placement on the sea bottom.

#### 3.3.3.2 For approval and/or acceptance as a high holding power anchor satisfactory full scale tests according to 3.3.3.2 - 3.3.3.6 are to be made confirming that the anchor has a holding power of at least twice that of an ordinary stockless anchor of the same mass.

#### 3.3.3.3 Full scale tests are to be carried out at sea on various types of bottom, normally, soft mud or silt, sand or gravel and hard clay or similar compounded material. The tests are to be applied to anchors of mass which are as far as possible representative of the full range of sizes proposed.

#### 3.3.3.4 For a definite group within the range, the two anchors selected for testing (ordinary stockless anchor and HHP anchor, respectively) are to be of approximately the same mass and tested in association with the size of chain required for that anchor mass. Where an ordinary stockless anchor is not available, for testing of HHP anchors a previously approved HHP anchor may be used in its place. The length of the cable with each anchor is to be such that the pull on the shank remains horizontal. For this purpose a scope of 10 is considered normal but a scope of not less than 6 may be accepted. Scope is defined as the ratio of length of cable to depth of water.

#### 3.3.3.5 Three tests are to be taken for each anchor and each type of bottom. The stability of the anchor and ease of breaking out are to be noted where possible. Tests are to be carried out from a tug but alternatively shore based tests may be accepted. The pull is to be measured by dynamometer. Measurements of pull, based on the RPM/bollard pull curve of the tug may be accepted as an alternative to a dynamometer.

#### 3.3.3.6 For approval and/or acceptance for a range of HHP anchor sizes, tests are to be carried out for at least two anchor sizes. The mass of the maximum size approved is not to be more than 10 times the mass of the largest size tested.

#### 3.3.3.7 The holding power test load is not to exceed the proof load of the anchor.

### 3.3.4 Manufacture

#### 3.3.4.1 Anchors may be of forged, cast or welded construction. Fabricated anchors are to be manufactured in accordance with approved welding procedures using approved welding consumables and carried out by qualified welders.

#### 3.3.4.2 Materials, manufacture, testing and certification of anchors is to be in accordance with the Rules, Part 25 - Metallic materials, Section 6.

### 3.3.5 Testing

#### 3.3.5.1 Anchors of all sizes are to be proof tested with the test loads stipulated in the Table 3.3.5.1.

#### 3.3.5.2 The proof load is to be applied on the arm or on the palm at a spot which, measured from the extremity of the bill, is one-third of the distance between it and the centre of the crown, see figure below. In the case of stockless anchors, both arms are to be tested at the same time, first on one side of the shank, then reversed and tested on the other.

#### 3.3.5.3 Before application of proof test load the anchors are to be examined to be sure that castings are reasonably free of surface imperfections of harmful nature. After proof load testing the anchors are to be examined for cracks and other defects. On completion of the proof load tests the anchors made in more than one piece are to be examined for free rotation of their heads over the complete angle. In every test the difference between the gauge lengths (as shown in Fig. 3.3.5.3) where one-tenth of the required load was applied first and where the load has been reduced to one-tenth of the required load from the full load may be permitted not to exceed 1%.

#### 3.3.5.4 The HHP anchor is to be proof tested with load required by Table 3.3.5.1 for an anchor mass equal to 1.33 times the actual mass of the HHP anchor. The proof loading procedure and examination procedure for HHP anchors are to comply with those for ordinary anchors, 3.3.5.1 - 3.3.5.3.

![Figure 3.3.5.3](image-url)
### Table 3.3.5.1 Proof loads for anchors

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1) Proof loads for intermediate mass are to be determined by linear interpolation.

### 3.4 CHAIN CABLES AND ROPES FOR BOWSER ANCHORS

#### 3.4.1 The anchor chain cable is to be as required by the Tables 3.1.2-1 and 3.1.2-2 for the calculated Equipment Number for the ship. The chain cable is to be tested in accordance with Table 3.4.4-2 to the proof loads corresponding to those for the required chain cable.

#### 3.4.2 Materials, manufacture, testing and certification of anchor chain cables is to be in accordance with the Rules, Part 25 - Metallic materials, Section 7.

#### 3.4.3 Bower anchors are to be associated with stud link chain cables for one of the grades listed in Table 3.4.3. The designation 3-grade CRS-L10 may be replaced, at discretion of the Register, by 3-grade CRS-L1a0 where Rm is greater than 300 but not exceeding 400 N/mm² or by 3-grade CRS-L1b0 where Rm is greater than 400 but not exceeding 490 N/mm².
3.4.9 The chain cables are to be composed of separate chain length, except for the chains less than 15 mm in diameter, which need not be divided into chain lengths.

The lengths of chains are to be interconnected with joining links. The use of joining shackles instead of joining links is to be specially considered by Register.

Depending on their location in the chain cable the lengths are divided into:

- anchor part fastened to the anchor (forerunner),
- intermediate lengths,
- inboard part, secured to the chain cable releasing device.

3.4.10 To be considered a separate length, the anchor part must be provided with a swivel, end link, and an adequate number of common and enlarged links. If the dimensions of the relevant part of the chain cable are sufficient to form a length, the anchor length may consist of a swivel, end link and joining link only.

On cable chains divided into lengths a swivel must be attached as close as possible to the anchor. The swivel pins shall point toward the middle of the chain cable. The chain length is to be connected to the anchor by means of an end shackle with pin.

3.4.11 The intermediate length is to be no shorter than 25 m and no longer than 27.5 m, and it is to have an odd number of links. The totals for the length of two chains given in the equipment table include only the sums of the middle lengths, without anchor and inboard lengths. If there are an odd number of intermediate lengths, then the chain cable on the right side is to have one length more than the chain cable on the left side.

3.4.12 The inboard end length of each chain shall consist of a special link of enlarged size which, however, shall pass freely through the wildcat of the anchor machinery secured to the chain cable releasing device, and of a minimum number of common and enlarged links which are necessary to constitute and independent chain length. The inboard end chain length may consist of one end link only, provided the relation between the dimensions of the chain cable parts and the chain cable-releasing device allows of such arrangement.

In all other respects the chain cables for bower anchors shall comply with the requirements of the Rules, Part 25 - Metallic materials, 7.

The end of each wire rope is to be spliced into a thimble, clamp or socket and in order to increase the anchor holding power and the damping of jerk loads, the end of each wire rope is to be connected to the anchor by means of a chain cable section of at least 12.5 meters in length and having the same strength as the wire rope, see also 3.4.8.2. The chain cable section is to be secured to the wire rope fitting and the anchor shackle by means of joining shackles being equal to the wire ropes in strength.

The length of the chain cable section may be included into 1.5 times the length of wire ropes specified in the previous paragraph.

3.4.13 The wire ropes anchors are to have at least 114 wires and not less than one natural fibre core. The wires of the ropes are to have at least thin zinc coating in accordance with applicable standards.

In all other respects, the wire ropes for anchors shall meet the requirement of the Rules, Part 25 - Metallic materials, 7.

3.4.14 Stream anchors may use the chain cables with stud or without them as well as wire ropes, which shall meet the requirements of 3.4.11 and 3.4.12.
### Table 3.4.4-1  Breaking loads and proof loads of stud link chain cables

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### Table 3.4.4-2  Test load values for stud link chain cables

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3.5 ANCHOR APPLIANCES

3.5.1 Stoppers

3.5.1.1 Each bower anchor chain cable or rope is to be provided with stopper holding the anchor in the hawse pipe when stowed for sea or, in addition, intended for holding the ship at anchor.

In ships having no anchor machinery or having the anchor machinery, which is not in compliance with the Rules, Part 9 - Machines, 6.3 stoppers must be installed for holding the ship at anchor.

3.5.1.2 Where the stopper is intended only for securing the anchor in the hawse pipe, its parts are to be calculated to withstand the chain cable strain to twice the weight of the anchor, the stresses in the stopper parts not exceeding 0.4 times the yield point of their material.

Where the stopper comprises a chain cable or rope, this is to have safety factor 5 in relation to the breaking load of the chain cable or actual breaking strength of the rope under the action of a force equal to twice the weight of the anchor.

3.5.1.3 Where the stopper is intended for riding the ship at anchor, its parts are to be calculated on assumption that the stopper is to be subjected to a force in the chain cable equal to 0.8 times its breaking load. The stresses in the stopper parts are to exceed 0.95 times the yield point of their material. Where the stopper comprises a chain cable or rope, they are to be of strength equal to that of the chain cable for which they are intended.

3.5.2 Device for securing and releasing the inboard end of the chain cables

3.5.2.1 The inboard ends of the chain cables are to be secured to the structures by fastening able to withstand a force not less than 15% nor more than 30% of the breaking load of the chain cable.

3.5.2.2 The fastening is to be provided with means suitable to permit, in case of emergency, an easy slipping of the chain cables to sea, operable from an accessible position outside the chain locker.

3.5.3 Laying of chain cables

3.5.3.1 Laying of chain cables shall provide for their run when dropping or hoisting the anchors.

3.5.3.2 The anchor shank shall easily enter the hawse pipe under the mere action of the chain cable tension and shall readily take off the hawse pipe when the chain cable is released.

3.5.3.3 It is recommended that thickness of the hawse pipe is not to be less than 0.4 times the diameter of chain cable passing through the hawse pipe.

3.5.4 Chain lockers

3.5.4.1 For stowage of each bower anchor chain lockers are to be provided.

When one chain locker is designed for two chains, it is to be provided with an internal division so that separate stowage of each chain is ensured.

For specific requirements relating to chain lockers of passenger ships in domestic service class "D" operating exclusively in the area of navigation 6 and 7, in the period from April 1 to October 31, see Section A.11.

3.5.4.2 The chain locker is to be of capacity and depth adequate to provide an easy direct lead of the cables through the chain pipes and self-stowing of the cables.

The minimum required stowage capacity without mud box for the two bower anchor chains is as follows:

\[ S = \frac{1.1d^2}{100000} \text{ [m}^3\text{]} \]

where:

\[ d = \text{chain diameter, [mm], according to Tables 3.1.2-1 and 3.1.2-2} \]
The total stowage capacity is to be distributed on two chain lockers of equal size for the port and starboard chain cables. The shape of the base areas is to be as far as possible be quadratic with a maximum edge length of 33\(d\). As an alternative, circular base areas may be selected, the diameter of which is not to exceed 30\(1.35d\).

Above the stowage of each chain locker in addition a free depth of \(h = 1500\) mm is to be provided.

3.5.4.3 The chain locker design and covers of the access openings are to be watertight as necessary to prevent accidental flooding of the chain locker which could damage essential auxiliaries or equipment (located outside the chain locker) or could affect the proper operation of the ship.

3.5.4.4 The drainage facilities for chain locker shall meet the requirements of the Rules, Part 8 - Piping, 2.11, and the lighting with the requirements of Part 12 - Electrical equipment, 6.7.

3.5.4.5 Closure of chain lockers

3.5.4.5.1 This requirement is applicable to ships with a length of 24\(m\) and above built in accordance with the 1966 Load Line Convention or the 1988 Protocol to the Load Line Convention and the keels of which are laid or which are at a similar stage of construction on or after 1 July 2003.

3.5.4.5.2 Spurling pipes and cable lockers are to be watertight up to the weather deck. Bulkheads between separate cable lockers (see Fig. 3.5.4.5.2-1), or which form a common boundary of cable lockers (see Fig. 3.5.4.5.2-2), need not however be watertight.

3.5.4.5.3 Where means of access is provided, it is to be closed by a substantial cover and secured by closely spaced bolts.

3.5.4.5.4 Where a means of access to spurling pipes or cable lockers is located below the weather deck, the access cover and its securing arrangements are to be in accordance with recognized standards* or equivalent for watertight manhole covers. Butterfly nuts and/or hinged bolts are prohibited as the securing mechanism for the access cover.

3.5.4.5.5 Spurling pipes through which anchor cables are led are to be provided with permanently attached closing appliances** to minimize water ingress.

* Examples of the recognized standards are such as:
  i) ISO 5894-1999
  ii) China: GB 11628-1989 Ship Manhole Cover
  iii) India: IS 15876-2009 "Ships and Marine Technology manholes with bolted covers"

** Examples of acceptable arrangements are such as:
  i) steel plates with cutouts to accommodate chain links or
  ii) canvas hoods with a lashing arrangement that maintains the cover in the secured position.

3.5.5 Anchor machinery

3.5.5.1 A windlass used for handling anchors, suitable for the size of chain cable and complying with the design, construction and testing criteria given in the Rules, Part 9 - Machines, 6.3 is to be fitted to the ship.

An anchor windlass must be provided if the anchor mass exceeds 35 kg.

3.5.5.2 On ships with an equipment number of 205 or less, a hand-operated anchor windlass may be installed, or other deck machinery may be used to release or hoist the anchor.

3.5.5.3 Unless located at least 2.4\(m\) above the cargo deck the windlass and the openings of chain pipes leading into the chain locker are to be fitted at distance of not less than 3\(m\) from cargo tank boundaries, if liquids having a flashpoint not exceeding 60\(^{\circ}\)C are intended to be carried.

3.5.5.4 On ships intended to carry in bulk flammable liquids having the flash point below 60\(^{\circ}\)C no deck machinery is to be fitted directly on the decks being the top of cargo tanks and bunkers.

In this case, the deck machinery is to be fitted on special foundations, the construction of which provides for free circulation of air underneath the machinery.

3.5.6 Spare parts

3.5.6.1 Every ship whose anchor arrangement includes a spare bower anchor and cable chains must have three spare joining links and one end shackle of the corresponding dimensions. If the ship has no spare bower anchor the shackle is not mandatory.

3.5.6.2 Every ship whose anchor arrangement includes a spare anchor and cable chains must have all the parts needed for connecting the wire rope to the anchor shackle.

3.5.7 Permissible weardown of chain cables

3.5.7.1 When a length of chain cable is so worn that the mean diameter of a link, at its most worn part, is reduced by 12% or more from its required nominal diameter it is to be renewed.

3.5.7.2 The mean diameter is half the value of the sum of the minimum diameter found in one cross-section of the link and of the diameter measured in a perpendicular direction in the same cross-section.
3.5.7.3 For the guidelines for maximum wear down of anchor cable fittings, joining shackles, the looseness of studs within anchor cable and the securing by welding of studs found loose during survey of chain cables links in service, see IACS Rec. 79.

3.5.8 Hull supporting structure of anchor windlass and chain stopper

3.5.8.1 The hull supporting structure of anchor windlass and chain stopper is to be sufficient to accommodate the operating and sea loads.

3.5.8.2 The operating loads are to be taken not less than:
1. for chain stoppers, 80% of the chain cable breaking load,
2. for windlasses, where no chain stopper is fitted or the chain stopper is attached to the windlass, 80% of the chain cable breaking load,
3. for windlasses, where chain stoppers are fitted but not attached to the windlass, 45% of the chain cable breaking load.

The operating loads are to be applied in the direction of the chain cable.

3.5.8.3 The sea loads are to be taken according to 7.14.3.2.

3.5.8.4 The permissible stresses for hull supporting structures of windlass and chain stopper are to be taken as defined by the Rules, Part 2-Hull, 9.2.5. However, the stresses, based on gross thickness, are not to be greater than the following permissible values:
- normal stress: 1.00 \( R_{y,b} \)
- shear stress: 0.60 \( R_{y,b} \)

where \( R_{y,b} \) is the specified minimum yield stress of the material.

3.6 EQUIPMENT FOR SHIPS IN RESTRICTED AREA OF NAVIGATION

3.6.1 All vessels, except fishing vessels

3.6.1.1 Provisions for equipment for vessels with restricted service, except fishing vessels, are based on equipment number in accordance with 3.2 and given in Table 3.6.1.1-1.

<table>
<thead>
<tr>
<th>Sailing area</th>
<th>Requirements for equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>No reduction</td>
</tr>
<tr>
<td>3, 4</td>
<td>According equipment number reduced by 15%</td>
</tr>
<tr>
<td>5, 6</td>
<td>According equipment number reduced by 25% taking in to account 3.6.1.2</td>
</tr>
<tr>
<td>7, 8</td>
<td>According to 3.6.1.3</td>
</tr>
</tbody>
</table>

3.6.1.2 Ship mentioned in 3.6.1.1 with equipment number 35 and less and of restricted navigation area 6, if they are not passenger ships may have only one bower anchor and one chain cable the length of which is two times less than that required in Table 3.1.2-1.

3.6.1.3 Provisions for equipment of ships of restricted navigation area 7 and 8 are to be determined according to Table 3.1.2-1. The anchor weight may be reduced up to 40% and chain diameter may be determined according to the reduced anchor mass.

If an anchor mass of less than 80 kg has been determined, only one anchor is required and half length of chain cable required by Table 3.1.2-1.

3.6.1.4 For ships of restricted area of navigation 5, 6, 7 and 8 stream anchor is not required.

3.6.1.5 For specific requirements relating to attestation of the anchoring equipment of passenger ships in domestic service class "D" operating exclusively in the area of navigation 6 and 7, in the period from April 1 to October 31, see Sections A.10 and A.12.

3.6.2 Fishing vessels of restricted navigation area 3, 4 and 5

3.6.2.1 Provisions for equipment of ships with length \( L \leq 40 \), are to be determined according to Table 3.6.2.1-1 based on equipment number obtained as follows:

\[ E_{ef} = L (B + D) + \Sigma 0.5 \cdot l \cdot h, \]

where:
- \( l \) = length of individual superstructure and deckhouse, m;
- \( h \) = height of individual superstructure and deckhouse at centreline, m.

Deckhouse having a breadth of less than \( B/4 \) may be ignored.

For vessels having a length of 20 m and less the equipment is to be determined for the length \( L \) in accordance with Table 3.6.2.1-1.

3.6.2.2 Provisions stated in 3.3, 3.4 and 3.5 are to also be observed.

3.6.2.3 The second anchor is considered as spare one on condition that provision is made for its quick getting ready for use.

3.6.2.4 For ships with length less than 20 m the weight of spare anchor may be 70% of the value required by Table 3.6.2.1-1.

3.6.2.5 Stream anchor is not required.

3.6.3 Fishing vessels of restricted navigation area 6, 7 and 8

3.6.3.1 Fishing vessels of this sailing area, with length less than 16 m may have only one anchor and chain cable with length two times less than in Table 3.6.2.1-1.
### Table 3.6.2.1-1 Equipment for vessels with restricted service (except fishing vessels)

<table>
<thead>
<tr>
<th>Length $L$ [m]</th>
<th>Equipment number $E_{nf}$</th>
<th>Bower anchors</th>
<th>Stud link chain cables</th>
<th>Mooring ropes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. Number</td>
<td>Weight per anchors [kg]</td>
<td>Total length [m]</td>
<td>Diameter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$d_1$ [mm]</td>
<td>$d_2$ [mm]</td>
</tr>
<tr>
<td>to 14</td>
<td>- 2</td>
<td>60</td>
<td>95</td>
<td>11.0</td>
</tr>
<tr>
<td>14-16</td>
<td>- 2</td>
<td>75</td>
<td>105</td>
<td>11.0</td>
</tr>
<tr>
<td>16-18</td>
<td>- 2</td>
<td>85</td>
<td>110</td>
<td>11.0</td>
</tr>
<tr>
<td>18-20</td>
<td>- 2</td>
<td>95</td>
<td>110</td>
<td>12.5</td>
</tr>
<tr>
<td>$L = 20 - 40$</td>
<td>to 270</td>
<td>2</td>
<td>110</td>
<td>137.5</td>
</tr>
<tr>
<td></td>
<td>270-300</td>
<td>2</td>
<td>140</td>
<td>165</td>
</tr>
<tr>
<td></td>
<td>300-330</td>
<td>2</td>
<td>180</td>
<td>165</td>
</tr>
<tr>
<td></td>
<td>330-360</td>
<td>2</td>
<td>210</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>360-400</td>
<td>2</td>
<td>250</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>400-450</td>
<td>2</td>
<td>300</td>
<td>247.5</td>
</tr>
<tr>
<td></td>
<td>450-500</td>
<td>2</td>
<td>370</td>
<td>247.5</td>
</tr>
<tr>
<td></td>
<td>over 500</td>
<td>2</td>
<td>440</td>
<td>275.0</td>
</tr>
</tbody>
</table>

**Remarks:**
- Short link cable of same proof load may be taken in lieu of stud link chain cables for ships with $E_{nf}$ less than 330.
- Explanatory notes:
  - $d_1$: Chain diameter grade CRS-L1
  - $d_2$: Chain diameter grade CRS-L2
  - $d_3$: Diameter of wire rope 6 x 24, breaking strength 1570 N/mm².
  - $d_4$: Diameter of polyamide ropes and manila ropes.
4 MOORING ARRANGEMENT

4.1 GENERAL PROVISIONS

4.1.1 The number, length and breaking strength of mooring ropes are to be determined for all ships with the exception of fishing vessels according to Table 3.1.2-1 and for fishing vessels according to Table 3.1.2-2, and Table 3.6.2.1-1. The breaking loads specified in tables are valid for wire ropes and ropes of natural fibre (manila) only.

4.1.2 For ships with a ratio $A/E_n$ exceeding 0.9, an increased number of mooring ropes compared to those specified in Table 3.1.2-1 must be provided as follows:

- 1 rope - when $0.9 < \frac{A}{E_n} \leq 1.1$,
- 2 ropes - when $1.1 < \frac{A}{E_n} \leq 1.2$,
- 3 ropes - when $\frac{A}{E_n} > 1.2$,

where:

- $E_n$ and $A$ - equipment number and area exposed to wind according to 3.2.

4.1.3 On ships with individual mooring ropes having a breaking strength exceeding 490 kN according to Table 3.1.2-1, the following ropes may be used:

- with reduced breaking strength and an increased number of ropes,
- or
- with increased breaking strength and a reduced number of ropes.

In such cases the total breaking strength of all the mooring ropes is not to be less than the total rope strength foreseen according to Table 3.1.2-1. The number of ropes is to not be less than 6, and the breaking strength of a single rope is not to be lower than 490 kN.

4.1.4 The length of the individual mooring ropes may be up to 7% less than that given in the Table 3.1.2-1 provided that the total length of all wires and ropes is not less than the sum of the individual lengths.

4.1.5 If synthetic-fibre ropes are used, the breaking strength of a rope $F_c$ is not to be less than:

$$F_c = 0.0742 \cdot \delta_c \cdot F_t^{0.89}$$

where:

- $\delta_c$ is the mean relative elongation to the breaking point of a synthetic rope, in percentages but not less than 30%,
- $F_t$ is actual breaking strength of a mooring rope, given in Table 3.1.2-1 or 3.1.2-2, in [kN].

4.1.6 Provisions for mooring ropes of non-propelled unmanned barges are as follow:

- $L < 65$ m: 2 ropes
- $L \geq 65$ m: 3 ropes

Length of the mooring ropes is to be two times of length or 80 m, whichever is greater.

4.2 MOORING ROPES

4.2.1 Mooring ropes may be made of steel wire, or of natural or synthetic fibres except on ships carrying in bulk flammable liquids with a flash point under 60°.

Operations with steel wire ropes are allowed only on those superstructure decks which are not the top of the cargo tanks and which have no cargo pipelines led over them.

Regardless of the breaking strength as specified in Tables 3.1.2-1, 3.1.2-2 or 3.6.2.1-1, fibre ropes with a diameter less than 20 mm are not acceptable.

For polyamide ropes the minimum breaking strength should be increased by 20% and for other synthetic ropes by 10% to account for strength loss due to, among others, aging and wear.

4.2.2 Wire ropes are to be of a flexible construction composed according to Table 4.2.2

<table>
<thead>
<tr>
<th>Breaking load ($BL$) [kN]</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$BL \leq 216$</td>
<td>72 wires in 6 strands with 7 fibre cores</td>
</tr>
<tr>
<td>$216 &lt; BL \leq 490$</td>
<td>144 wires in 6 strands with 7 fibre cores</td>
</tr>
<tr>
<td>$BL &gt; 490$</td>
<td>216 wires in 6 strands with 1 fibre core</td>
</tr>
</tbody>
</table>

4.2.3 Wire ropes for use in association with mooring winches where the rope is to be stored on the drum may be constructed with an independent wire rope core instead of fibre core. The number of wires in such ropes is not to be less than 216.

In all other respects these ropes shall meet the requirements of the Rules, Part 25 - Metallic materials, 8.

4.2.4 Natural fibre ropes are to be either manila or sisal. The ships having equipment number 205 and less are permitted to use hemp ropes. The use of hemp ropes in ships with equipment number over 205 is subject to special consideration in each particular case.

In all other respects these ropes shall meet the requirements of the Rules, Part 25 - Metallic materials, 2.

4.2.5 The synthetic fibre ropes may contain capron, nylon, polypropylene and other approved synthetic materials as well as combinations of fibres of different approved materials.

In all other respects, the ropes of synthetic fibre material shall meet the requirements of the Rules, Part 24 - Non-metallic materials, 2.

4.3 MOORING APPLIANCES

4.3.1 The number and position of mooring bollards, fairleads and other mooring appliances depend on the con-
struction particulars, purpose and general arrangement of the ship.

4.3.2 Bollards may be of steel or cast iron. Small ships equipped only with natural fibre or synthetic fibre ropes are permitted to use the bollards made of light alloys. As to the method of manufacture, the bollards may be welded or cast.

4.3.3 The outside diameter of the bollard column is to be not less than 10 times the diameter of the steel rope and 5.5 times the diameter of the synthetic-fibre rope; nor is to be less than one circumference of the fibre rope to be used with the bollard. The distance between the axis of the bollard column is not to be less than 25 times the diameter of the steel rope, or 3 circumferences of the fibre rope are to be used with the bollard.

4.3.4 Bollards, fairleads and other parts of mooring appliances, with the exception of rope stoppers, are to be so designed that the stresses in their parts do not exceed 0.95 times the yield point of the material.

The breaking strength of a rope stopper is to be not less than 0.15 of the breaking strength of the whole rope for which it is intended.

4.3.5 For the requirements applicable to design and construction of shipboard fittings and supporting structures used for the mooring operations, see 5.6.

4.3.6 For specific requirements relating to attestation of the mooring equipment of passenger ships in domestic service class “D” operating exclusively in the area of navigation 6 and 7, in the period from April 1 to October 31, see Section A.9.

4.4 MOORING MACHINERY

4.4.1 Specially fitted appliances, such as drums, capstans etc. may be provided for winding up mooring ropes, and as well other existing deck arrangements such as anchor windlass, cargo winches etc. provided with drums for rope coiling.

4.4.2 Decisions as to the number and type of mooring machinery are to the owner and designer’s discretion, on condition that the rated forced of the machinery does not exceed 1/3 of the breaking strength of the mooring ropes to be used on the ship and that the requirements of the Rules, Part 9 - Machines, 6.4 are satisfied.
5 TOWING ARRANGEMENT

5.1 GENERAL PROVISIONS

5.1.1 Each ship is to be provided with towing arrangement, which meets the requirements of 5.2, 5.3 and 5.6.

5.1.2 All oil tankers over 20000 tons deadweight, including combination carriers, chemical tankers and liquefied gas carriers shall comply with requirements of 5.4.

5.1.3 Tugs shall comply with requirements of 5.5.

5.2 TOWING LINE

5.2.1 Lengths and breaking loads of a towing lines specified in the Table 3.1.2-1 are recommendations only.

5.2.2 For shipborn barges the breaking strength of the towing line is determined by the formula:

\[ F_p = 16nBd, \text{ in } [\text{kN}], \]

where:

- \( n \) = number of barges towed,
- \( B \) = width of barges, in [m],
- \( d \) = draught of the barges, in [m].

The breaking strength of the rope is used in calculations of equipment strength for shipborn barges. The lines for towing barges may be stored on the barges if the shipowner so desires, or they may be kept on tugboats and not be included as part of the barge equipment.

5.2.3 Towing lines may be made of steel wire or of natural or synthetic fibres. The requirements for mooring rope as provided in 4.2 are also applicable to towing lines.

5.3 TOWING APPLIANCES

5.3.1 The number and location of towing bollards and chocks depend on the construction particulars, purpose and general arrangement of the ship.

5.3.2 The requirements for mooring bollards and chocks as provided in 4.3.2, 4.3.3 and 4.3.4 are also applicable to towing bollards and chocks.

5.4 EMERGENCY TOWING ARRANGEMENTS ON TANKERS

5.4.1 General requirements

5.4.1.1 Emergency towing arrangements shall be fitted at both ends on board every tanker listed in 5.1.2.

5.4.1.2 For tankers constructed on or after 1 July 2002:

1. the arrangements shall, at all times, be capable of rapid deployment in the absence of main power on the ship to be towed and easy connection to the towing ship. At least one of the emergency towing arrangements shall be pre-rigged ready for rapid deployment; and

2. emergency towing arrangements at both ends shall be of adequate strength taking into account the size and deadweight of the ship, and the expected forces during bad weather conditions. The design and construction and prototype testing of emergency towing arrangements shall be approved by the Administration, based on the Guidelines developed by the Organization*.

5.4.1.3 For tankers constructed before 1 July 2002, the design and construction of emergency towing arrangements shall be approved by the Administration, based on the Guidelines developed by the Organization*.

* Refer to the Guidelines on emergency towing arrangements for tankers, adopted by the Maritime Safety Committee by resolution MSC.35(63), as amended.
5.4.1.4 Towing arrangements may be (1) a packaged self contained unit, or (2) a unit comprised of individually tested components assembled onboard the vessel. Both arrangements should meet the specified strength requirements and undergo a deployment test on board the vessel as required by MSC. 35 (36). See also IACS UI SC.113.

Fixed gear such as strongpoints, fairleads, foundations and associated vessel supporting structure are to be demonstrated as adequate for the loads specified in 5.4.2.2 by means of analysis or calculations submitted to the Register. If such analysis is deemed not appropriate depending on structural configuration, proof test may be required.

5.4.1.5 Where a manufacturer requests a certificate of type approval for a complete packaged towing arrangement, one assembled unit to undergo prototype test to 2 x SWL (safe working load).

5.4.1.6 Existing emergency towing arrangements fitted in accordance with Resolution A.535(13) and approved by the Register may retain at forward location.

Table 5.4.2.1-1 Towing components

<table>
<thead>
<tr>
<th>Component</th>
<th>Forward of ship</th>
<th>Aft of ship</th>
<th>Strength requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick-up gear</td>
<td>Optional</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Towing pennant</td>
<td>Optional</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chafing gear</td>
<td>Yes</td>
<td>Depending on design</td>
<td>Yes</td>
</tr>
<tr>
<td>Fairlead</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Strongpoint</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Roller pedestal</td>
<td>Yes</td>
<td>Depending on design</td>
<td>-</td>
</tr>
</tbody>
</table>

5.4.2 Towing components, strength and technical characteristics

5.4.2.1 The towing arrangements generally shall consist of the major components specified in Table 5.4.2.1-1.

5.4.2.2 Towing components as specified in 5.4.2.1 for strength are to be designed with a working strength of at least 1000 kN for tankers of 20000 tonnes deadweight and over but less than 50000 tonnes deadweight, and at least 2000 kN for tankers of 50000 tonnes deadweight and over (working strength is defined as one half ultimate strength). The strength is to be sufficient for all relevant angels of towing line, i.e. up to 90° from the ship's centreline to port and starboard and 30° vertical downwards.

Other components are to be designed with a working strength sufficient to withstand the load to which such components may be subjected during the towing operation.

5.4.2.3 Length of the towing pennant is to be at least twice the lightest seagoing ballast freeboard at the fairlead plus 50 m.

5.4.2.4 The bow and stern strongpoint and fairleads are to be located so as to facilitate towing from either side of the bow and stern and minimise the stress on the towing system.

5.4.2.5 Fairleads opening are to be large enough to pass the largest portion of the chafing gear, towing pennant or towing line.

The fairlead has to give adequate support for the towing pennant during towing operation, which means bending 90° to port, and to starboard side and 30° vertical downwards. The bending ratio (towing pennant bearing surface diameter to towing pennant diameter) is not to be less than 7 : 1.

5.4.2.6 If a chafing chain is to be used on design of chafing gear, the following characteristics are to be provided:

.1 The chafing chain is to be stud link chain.

.2 The chafing chain is to be long enough to ensure that the towing pennant remains outside the fairlead during the towing operation. A chain extending from the strong point to a point at least 3 m beyond the fairlead should meet this criterion.

.3 One end of the chafing chain is to be suitable for connection to the strongpoint. The other end is to be fitted with a standard pear-shaped open link (see Fig. 5.4.2.6) allowing connection to a standard bow shackle.

.4 The chafing chain is to be stowed in such a way that it can be rapidly connected to the strongpoint.

Figure 5.4.2.6 Standardised pear-shaped link
5.4.2.7 A termination of the towing pennant is to be a hard eye-formed allowing connection to a standard bow shackle.

5.4.2.8 To ensure ready availability and rapid deployment, emergency towing arrangements shall comply with the following criteria:

1. The aft emergency towing arrangements are to be pre-rigged and be capable of being deployed in a controlled manner in harbour conditions not more than 15 min.

2. The pick-up gear for the aft towing pennant is to be designed at least for manual operation by one person taking into account the absence of power and the potential for adverse environmental conditions that may prevail during such emergency towing operations. The pick-up gear is to be protected against the weather and other adverse conditions that may prevail.

3. The forward emergency towing arrangement is to be capable of being deployed in harbour conditions in not more than 60 min.

4. The forward emergency towing arrangements is to be designed at last with a means of securing a towing line to the chafing gear using a suitably positioned pedestal roller to facilitate connection of the towing pennant.

5. Forward emergency towing arrangements which comply with the requirements for aft emergency towing arrangements may be accepted.

6. All emergency towing arrangements are to be clearly marked to facilitate safe and effective use even in darkness and poor visibility.

5.4.2.9 All emergency towing components are to be inspected by ship personnel at regular intervals and maintained in good working order.

5.5 SPECIAL ARRANGEMENT FOR TUGS

5.5.1 Towing hook or equivalent is normally to be located 5 to 10% of the ship's length abaft amidships, but in no circumstances is to be sited forward of the longitudinal centre of gravity of the tug in any anticipated condition of loading.

5.5.2 Towing hooks should have reliable slip arrangement i.e. quick release device which facilitate towing line release regardless of angle of heel and of direction of towing line. The towing hook has to be equipped with a mechanical, hydraulic or pneumatic slip device. The slip device is to be designed such as to guarantee that unintentional slipping is avoided.

The releasing device is to be operable from the bridge as well as in the vicinity of hook itself.

Towrope protection sleeves or other adequate means are to be provided to prevent the directly pulled towrope from being damaged by chafing / abrasion.

5.5.3 The number and type of equipment and outfit forming special arrangement for tugs which ensures towing operations under different service conditions are determined by the shipowner considering that such equipment and outfit shall satisfy the requirements of the present chapter.

5.5.4 The main determining factor in providing the tugs with a special arrangement is the rated towing pull \( F \). The numerical value of \( F \) is within the owner's and designer's discretion, and all calculations pertaining to the determination of this value are not subject to approval by the Register.

If, however, during mooring and sea trials of the tug, the towing force is found to exceed the value \( F \), Register may require strengthening of the towing arrangements units or a restriction of power during towing operations.

The bollard pull of the vessel may be verified by a bollard pull test approved by Register. The results of test are to be shown in diagram bollard pull/time (see Fig. 5.5.4.).

Figure 5.5.4

5.5.5 The required minimum breaking force \( F_{\text{min}} \) of the towrope is to be determined by the following formula:

\[
F_{\text{min}} = k \cdot F, \quad [\text{kN}];
\]

where:

\[
k = \begin{cases} 2.5 & \text{for } F \leq 200 \text{ kN}; \\ 2.0 & \text{for } 200 < F \leq 1000 \text{ kN}; \\ 1.33 \cdot F & \text{for } F > 1000 \text{ kN}; \end{cases}
\]

For \( F \) between 200 and 1000 kN, \( k \) may be interpolated linearly.

The requirements of 4.2 for mooring ropes are also applicable to the towing line.

The length of the towrope is to be chosen according to the tow formation (masses of tug and towed object), the water depth and the nautical conditions. Regulations of flag state authorities have to be observed.

The length of towing line for towing operations is to be at least 150 m.

5.5.6 All stressed parts of the towing arrangement (such as the towing hook, towing rails, etc.) as well as the fastenings for securing these parts to the ship's hull are to be designed to take a test force \( F_t \).

where:

\[
F_t = \begin{cases} 2 \cdot F, & \text{for } F \leq 500 \text{ kN}; \\ F + 500, & \text{for } 500 < F \leq 1500 \text{ kN}; \\ 1.33 \cdot F, & \text{for } F > 1500 \text{ kN}; \end{cases}
\]
The equivalent permissible stresses in these parts are not to exceed 0.85 times the upper yield stress of their material.

For the towing hook foundation it has to be additionally proven that these permissible stresses are not exceeded assuming a load equal to the minimum breaking force \( F_{\text{min}} \) of the towrope.

5.5.7 The device for protection of the hook from overloading must be adjusted to a breaking strength three times the nominal towing force.

5.5.8 Prior to installation on board the ship the towing hooks are to be tested by application of a test force \( F_t \).

5.5.9 The towing beams are to be made of pipes or other suitable sections. Wide and high beams are to be supported by (A) type tubular struts, which are to be arranged in the centreline of the ship or symmetrically in relation to it. On the bulwark, the beams are to be connected with brackets whose free edges are to be framed with a bar section or pipe.

5.5.10 The section modulus of the towing beam is not to be less than:

\[
W = 0.343 \cdot 10^2 \cdot \frac{d^2 L}{R_{\text{eff}}}, \quad [\text{cm}^3],
\]

where:
\[
\begin{align*}
d &= \text{diameter of the towing line, in [mm]}, \\
L &= \text{length of the towing line, in [m], not to be less than 300 m}, \\
l &= \text{distance between the struts or between one strut and the bulwark, in [m]}, \\
R_{\text{eff}} &= \text{yield point of the beam material, in [N/mm}^2].
\end{align*}
\]

5.5.11 The cross-sectional area of each branch of a \( \Lambda \)-shaped strut is not to be less than:

\[
f = 0.03 \frac{d^2 L}{R_{\text{eff}}}, \quad [\text{cm}^2],
\]

where:
\[
R_{\text{eff}} &= \text{yield point of the strut material, in [N/mm}^2].
\]

5.5.12 The wire stopper and its fastenings are to be such that their breaking load is not less than 1.5 times the towing force.

5.5.13 A robust and efficient fendering system is to be fitted in areas intended for pushing. The fendering system purpose is to distribute the pushing force and limit its dynamic component on the hull structure of both the tug (and the assisted ship).

5.5.14 The requirements for the design of towing winches are specified in the Rules, Part 9 - Machines, 6.5.

5.5.15 The length of towing line on winch is not to be less than 400 m.

5.6 SHIPBOARD FITTINGS AND SUPPORTING HULL STRUCTURES ASSOCIATED WITH TOWING AND MOORING ON CONVENTIONAL VESSELS

5.6.1 Application and definitions

Conventional ships are to be provided with arrangements, equipment and fittings of sufficient safe working load to enable the safe conduct of all towing and mooring operations associated with the normal operations of the ship.

This requirement is to apply to design and construction of shipboard fittings and supporting structures used for the normal towing and mooring operations. Normal towing means towing operations necessary for manoeuvring in ports and sheltered waters associated with the normal operations of the ship.

For ships, not subject to SOLAS Regulation II-1/3-4, Paragraph 1, but intended to be fitted with equipment for towing by another ship or a tug, e.g. such as to assist the ship in case of emergency as given in SOLAS Regulation II-1/3-4, Paragraph 2, the requirements designated as "other towing" in this requirement are to be applied to design and construction of those shipboard fittings and supporting structures.

This requirement is not applicable to design and construction of shipboard fittings and supporting hull structures used for special towing services defined as:

- **Escort towing**: Towing service, in particular, for laden oil tankers or LNG carriers, required in specific estuaries. Its main purpose is to control the ship in case of failures of the propulsion or steering system. It should be referred to local escort requirements and guidance given by, e.g., the Oil Companies International Marine Forum (OCIMF).

- **Canal transit towing**: Towing service for ships transiting canals, e.g. the Panama Canal. It should be referred to local canal transit requirements.

- **Emergency towing for tankers**: Towing service to assist tankers in case of emergency. For the emergency towing arrangements, ships subject to SOLAS regulation II-1/3-4, Paragraph 1 are to comply with that regulation and resolution MSC.35(63) as may be amended.

IACS Recommendation No. 10 on Anchoring, Mooring and Towing Equipment may be referred to for recommendations concerning mooring and towing.

For the requirements of SOLAS regulation II-1/3-8 relating to towing and mooring equipment, see IACS Unified Interpretation SC212.

The net minimum scantlings of the supporting hull structure are to comply with the requirements given in 5.6.2.5 and 5.6.3.5. The net thicknesses, \( t_{\text{net}} \), are the member thicknesses necessary to obtain the above required minimum net scantlings. The required gross thicknesses are obtained by adding the corrosion addition, \( t_c \), given in 5.6.5, to \( t_{\text{net}} \).
board fittings are to comply with the requirements given in 5.6.2.4 and 5.6.3.4. For shipboard fittings not selected from an accepted industry standard the corrosion addition, $t_c$, and the wear allowance, $t_w$, given in 5.6.5 and 5.6.6, respectively, are to be considered.

For the purpose of this requirement:
- **Conventional ships** means new displacement-type ships of 500 GT and above, excluding high speed craft, special purpose ships, and offshore units of all types. As per MSC.266(84), "special purpose ship" means a mechanically self-propelled ship which by reason of its function carries on board more than 12 special personnel.
- **Shipboard fittings** mean those components limited to the following: bollards and bitts, fairleads, stand rollers, chocks used for the normal mooring of the vessel and the similar components used for the normal towing of the ship. Other components such as capstans, winches, etc. are not covered by the requirements of this Section. Any weld or bolt or equivalent device connecting the shipboard fitting to the supporting structure is part of the shipboard fitting and if selected from an industry standard subject to that standard.
- **Supporting hull structures** means that part of the ship structure on/in which the shipboard fitting is placed and which is directly submitted to the forces exerted on the shipboard fitting. The supporting hull structure of capstans, winches, etc. used for the normal towing and mooring operations mentioned above is also subject to the requirements of this Section.
- **Industry standard** means international standard (ISO, etc.) or standards issued by national association which are recognised in the country where the ship is built.

### 5.6.2 Towing

#### 5.6.2.1 Strength

The strength of shipboard fittings used for normal towing operations at bow, sides and stern and their supporting hull structures are to comply with the requirements of this Section.

Where a ship is equipped with shipboard fittings intended to be used for other towing services, the strength of these fittings and their supporting hull structures are to comply with the requirements of this Section.

#### 5.6.2.2 Arrangement

Shipboard fittings for towing are to be located on stiffeners and/or girders, which are part of the deck construction so as to facilitate efficient distribution of the towing load.

Other arrangements may be accepted (for chocks in bulwarks, etc.) provided the strength is confirmed adequate for the intended service.

#### 5.6.2.3 Load considerations

The minimum design load applied to supporting hull structures for shipboard fittings is to be:

1. for normal towing operations, 1.25 times the intended maximum towing load (e.g. static bollard pull) as indicated on the towing and mooring arrangements plan.
2. for other towing service, the minimum breaking strength of the tow line according to the Tables 3.1.2-1 and 3.1.2-2 (see Notes),
3. for fittings intended to be used for, both, normal and other towing operations, the greater of the design loads according to (1) and (2).

**Notes:**

1. Side projected area including that of deck cargoes as given by the loading manual is to be taken into account for selection of towing lines and the loads applied to shipboard fittings and supporting hull structure.
2. The increase of the minimum breaking strength for synthetic ropes according to 4.2 needs not to be taken into account for the loads applied to shipboard fittings and supporting hull structure.

When a safe towing load $TOW$ greater than that determined according to 5.6.2.6 is requested by the applicant, then the design load is to be increased in accordance with the appropriate $TOW$/design load relationship given by 5.6.2.3 and 5.6.2.6.

The design load is to be applied to fittings in all directions that may occur by taking into account the arrangement shown on the towing and mooring arrangements plan.

Where the towing line takes a turn at a fitting the total design load applied to the fitting is equal to the resultant of the design loads acting on the line, see Fig. 5.6.2.3.

However, in no case does the design load applied to the fitting need to be greater than twice the design load on the line.

![Figure 5.6.2.3](image-url)
5.6.2.4 Shipboard fittings

Shipboard fittings may be selected from an industry standard accepted by the Register and at least based on the following loads.

1. For normal towing operations, the intended maximum towing load (e.g. static bollard pull) as indicated on the towing and mooring arrangements plan,
2. For other towing service, the minimum breaking strength of the tow line according to IACS Recommendation No. 10 “Anchor- ing, Mooring and Towing Equipment” (see Notes in 5.6.2.3),
3. For fittings intended to be used for, both, normal and other towing operations, the greater of the loads according to (1) and (2).

Towing bitts (double bollards) may be chosen for the towing line attached with eye splice if the industry standard distinguishes between different methods to attach the line, i.e. figure-of-eight or eye splice attachment.

When the shipboard fitting is not selected from an accepted industry standard, the strength of the fitting and of its attachment to the ship is to be in accordance with 5.6.2.3 and 5.6.2.5. Towing bitts (double bollards) are required to resist the loads caused by the towing line attached with eye splice. For strength assessment beam theory or finite element analysis using net scantlings is to be applied, as appropriate. Corrosion additions are to be as defined in 5.6.5. A wear down allowance is to be included as defined in 5.6.6. At the discretion of the Register, load tests may be accepted as alternative to strength assessment by calculations.

5.6.2.5 Supporting hull structure

5.6.2.5.1 Arrangement

The reinforced members beneath shipboard fittings are to be effectively arranged for any variation of direction (horizontally and vertically) of the towing forces acting upon the shipboard fittings, see Fig. 5.6.2.5.1 for a sample arrangement. Proper alignment of fitting and supporting hull structure is to be ensured.

5.6.2.5.2 Acting point of towing force

The design load applied to supporting hull structure is to be in accordance with 5.6.2.3.

The acting point of the towing force on shipboard fittings is to be taken at the attachment point of a towing line or at a change in its direction. For bollards and bitts the attachment point of the towing line is to be taken not less than 4/5 of the tube height above the base, see Fig. 5.6.2.5.2.

5.6.2.5.3 Allowable stresses

Allowable stresses under the design load conditions as specified in 5.6.2.3 are as follows:

1. for strength assessment with beam theory or grillage analysis:
   - normal stress: 100% of the specified minimum yield point of the material;
   - shearing stress: 60% of the specified minimum yield point of the material.

2. for strength assessment with finite element analysis:
   - equivalent stress: 100% of the specified minimum yield point of the material.

For strength calculations by means of finite elements, the geometry is to be idealized as realistically as possible. The ratio of element length to width is not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.
5.6.3.3 Load considerations

5.6.3.3.1 The minimum design load applied to supporting hull structures for shipboard fittings is to be 1.15 times the minimum breaking strength of the mooring line according to the Tables 3.1.2-1 and 3.1.2-2 (see Notes).

Notes:
1. Side projected area including that of deck cargoes as given by the loading manual is to be taken into account for selection of towing lines and the loads applied to shipboard fittings and supporting hull structure.
2. The increase of the minimum breaking strength for synthetic ropes according to 4.2 needs not to be taken into account for the loads applied to shipboard fittings and supporting hull structure.

5.6.3.3.2 The minimum design load applied to supporting hull structures for winches is to be 1.25 times the intended maximum brake holding load, where the maximum brake holding load is to be assumed not less than 80% of the minimum breaking strength of the mooring line according to the Tables 3.1.2-1 and 3.1.2-2, see Notes. For supporting hull structures of capstans, 1.25 times the maximum hauling-in force is to be taken as the minimum design load.

5.6.3.3.3 When a safe working load SWL greater than that determined according to 5.6.3.6 is requested by the applicant, then the design load is to be increased in accordance with the appropriate SWL/design load relationship given by 5.6.3.3 and 5.6.3.6.

5.6.3.4 The design load is to be applied to fittings in all directions that may occur by taking into account the arrangement shown on the towing and mooring arrangements plan. Where the mooring line takes a turn at a fitting the total design load applied to the fitting is equal to the resultant of the design loads acting on the line, refer to the Fig. 5.6.2.3. However, in no case does the design load applied to the fitting need to be greater than twice the design load on the line.

5.6.3.4 Shipboard fittings

Shipboard fittings may be selected from an industry standard accepted by the Register and at least based on the minimum breaking strength of the mooring line according to the Tables 3.1.2-1 and 3.1.2-2 (see Notes in 5.6.3.3.1).

Mooring bitts (double bollards) are to be chosen for the mooring line attached in figure-of-eight fashion if the industry standard distinguishes between different methods to attach the line, i.e. figure-of-eight or eye splice attachment.

When the shipboard fitting is not selected from an accepted industry standard, the strength of the fitting and of its attachment to the ship is to be in accordance with 5.6.3.3 and 5.6.3.5. Mooring bitts (double bollards) are required to resist the loads caused by the mooring line attached in figure-of-eight fashion, see Note. For strength assessment beam theory or finite element analysis using net scantlings is to be applied, as appropriate. Corrosion additions are to be as defined in 5.6.5. A wear down allowance is to be included as defined in 5.6.6. At the discretion of the Register, load tests may be accepted as alternative to strength assessment by calculations.

Note:
With the line attached to a mooring bitt in the usual way (figure-of-eight fashion), either of the two posts of the mooring bitt can be subjected to a force twice as large as that acting on the mooring line. Disregarding this effect, depending on the applied industry standard and fitting size, overload may occur.

5.6.3.5 Supporting hull structure

5.6.3.5.1 Arrangement

Arrangement of the reinforced members (carrying) beneath shipboard fittings is to consider any variation of direction (horizontally and vertically) of the mooring forces (which is to be not less than the design load as per 5.6.3.3) ac-
The arrangement of reinforced members beneath shipboard fittings, winches and capstans is to consider any variation of direction (horizontally and vertically) of the mooring forces acting upon the shipboard fittings, see Fig. 5.6.2.5.1 for a sample arrangement. Proper alignment of fitting and supporting hull structure is to be ensured.

5.6.3.5.2 Acting point of mooring force

The design load applied to supporting hull structure is to be in accordance with 5.6.3.3.

The acting point of the mooring force on shipboard fittings is to be taken at the attachment point of a mooring line or at a change in its direction.

For bollards and bitts the attachment point of the mooring line is to be taken not less than 4/5 of the tube height above the base, see a) in Fig. 5.6.3.5.2. However, if fins are fitted to the bollard tubes to keep the mooring line as low as possible, the attachment point of the mooring line may be taken at the location of the fins, see b) in Fig. 5.6.3.5.2.

Figure 5.6.3.5.2

5.6.3.5.3 Allowable stresses

Allowable stresses under the design load conditions as specified in 5.6.3.3 are as follows:

1. for strength assessment with beam theory or grillage analysis:
   - normal stress: 100% of the specified minimum yield point of the material;
   - shearing stress: 60% of the specified minimum yield point of the material.

Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress. No stress concentration factors being taken into account.

2. for strength assessment with finite element analysis:
   - equivalent stress: 100% of the specified minimum yield point of the material.

For strength calculations by means of finite elements, the geometry is to be idealized as realistically as possible. The ratio of element length to width is not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

5.6.3.6 Safe working load (SWL)

5.6.3.6.1 The Safe Working Load (SWL) is the load limit for mooring purpose.

5.6.3.6.2 Unless a greater SWL is requested by the applicant according to 5.6.3.3, the SWL is not to exceed the minimum breaking strength of the Tables 3.1.2-1 and 3.1.2-2, see Notes in 5.6.3.3.

5.6.3.6.3 The SWL, in [t], of each shipboard fitting is to be marked (by weld bead or equivalent) on the deck fittings used for mooring. For fittings intended to be used for, both, mooring and towing, TOW, in [t], according to 5.6.2.6 is to be marked in addition to SWL.

5.6.3.6.4 The above requirements on SWL apply for the use with no more than one mooring line.

5.6.3.6.5 The towing and mooring arrangements plan mentioned in 5.6.4 is to define the method of use of mooring lines.

5.6.4 Towing and mooring arrangements plan

5.6.4.1 The SWL and TOW for the intended use for each shipboard fitting is to be noted in the towing and mooring arrangements plan available on board for the guidance of the Master.

It is to be noted that TOW is the load limit for towing purpose and SWL that for mooring purpose. If not otherwise chosen, for towing bitts it is to be noted that TOW is the load limit for a towing line attached with eye-spllice.

5.6.4.2 Information provided on the plan is to include in respect of each shipboard fitting:

1. location on the ship;
2. fitting type;
3. SWL/TOW;
4. purpose (mooring/harbour towing/other towing);  
5. manner of applying towing or mooring line load including limiting fleet angles.  

Item 3 with respect to items 4 and 5, is subject to approval by the Register.

Furthermore, information provided on the plan is to include:  
1. the arrangement of mooring lines showing number of lines (N),  
2. the minimum breaking strength of each mooring line (MBL),  
3. the acceptable environmental conditions as given in IACS Recommendation No. 10 "Anchoring, Mooring and Towing Equipment" for the recommended minimum breaking strength of mooring lines for ships with equipment number En > 2000:  
   - 30 second mean wind speed from any direction (vW or vW* according to IACS Recommendation No. 10).  
   - maximum current speed acting on bow or stern (±10°).

5.6.4.3 The information as given in 5.6.4.2 is to be incorporated into the pilot card in order to provide the pilot proper information on harbour and other towing operations.

5.6.5 Corrosion addition  
The corrosion addition, , in [mm], is not to be less than the following values:  
1. Ships covered by IACS Common Structural Rules for Bulk Carriers and Oil Tankers: total corrosion additions defined in these rules  
2. Other ships: 2.0 mm.  
   - for the supporting hull structure, according to the Register’s Rules for the surrounding structure (e.g. deck structures, bulwark structures).  
   - for pedestals and foundations on deck which are not part of a fitting according to an accepted industry standard, 2.0 mm.  
   - for shipboard fittings not selected from an accepted industry standard, 2.0 mm.

5.6.6 Wear allowance  
In addition to the corrosion addition given in 5.6.5 the wear allowance, , for shipboard fittings not selected from an accepted industry standard is not to be less than 1.0 mm, added to surfaces which are intended to regularly contact the line.

5.6.7 Survey after construction  
The condition of deck fittings, their pedestals or foundations, if any, and the hull structures in the vicinity of the fittings are to be examined in accordance with the Register’s Rules.

5.7 EQUIPMENT FOR MOORING AT SINGLE POINT MOORINGS  
5.7.1 Upon request from the owner, Register is prepared to certify that the vessel is specially fitted for compliance with Section 2.1, 4.2 and 6. of the “Standards for equipment employed in the mooring of ships at single point moorings” published by the Oil Companies International Marine Forum (OCIMF), 1978. See also IACS Rec. No.13.

5.7.2 The certificate may be issued if:  
   i) plans showing the equipment and the arrangement as well as necessary substructures are submitted for approval  
   ii) the chain stopper, Smit bracket, or other device for securing the chafing chain to the ship and the structure to which it is attached are capable of withstanding a load not less than the breaking strength of the chain corresponding to the size of the ship as given in Section 6 of the standards stipulated in 5.1 above and calculations to demonstrate this capability are submitted  
   iii) the chain bearing surface of the bow fairleads described in 6.1 of the standard stipulated in 5.1 above have a diameter at least seven times that of the associated chain  
   iv) the installation on board the ship is surveyed by a Register’s surveyor.

5.8 EMERGENCY TOWING PROCEDURES ON SHIPS  
5.8.1 This paragraph applies to:  
   .1 all passenger ships, not later than 1 January 2010;  
   .2 cargo ships constructed on or after 1 January 2010; and  
   .3 cargo ships constructed before 1 January 2010, not later than 1 January 2012.

5.8.2 Ships shall be provided with a ship-specific emergency towing procedure. Such a procedure shall be carried aboard the ship for use in emergency situations and shall be based on existing arrangements and equipment available on board the ship.

5.8.3 The procedure** shall include:  
   .1 drawings of fore and aft deck showing possible emergency towing arrangements;  
   .2 inventory of equipment on board that can be used for emergency towing;  
   .3 means and methods of communication; and  
   .4 sample procedures to facilitate the preparation for and conducting of emergency towing operations.

** Refer to the Guidelines for owners/operators on preparing emergency towing procedures (MSC.1/Circ.1255).
6 SIGNAL MASTS

6.1 GENERAL PROVISIONS

6.1.1 The requirements given in the present section refer only to the signal masts, i.e. the masts which are intended for carrying the signal means: navigation lights, day signals, antennae, etc.

6.1.2 Arrangement, height and equipment of the signal masts shall comply with the requirements of the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs).

6.1.3 The vibration calculation is recommended to be carried out.

6.2 STAYED MASTS

6.2.1 The outside diameter and the plate thickness at the heel of the masts made of steel having yield point from 215 up to 255 N/mm² and stayed by two shrouds on each side of the ship, are not to be less than:

\[ d = 22 \, l, \text{[mm]}, \]
\[ t = 0,2 \, l + 3, \text{[mm]}, \]

where:

- \( d \) - outside diameter of the mast at the heel, in [mm],
- \( t \) - plate thickness at the heel, in [mm],
- \( l \) - mast length, in [m], from the heel to the shroud eyeplates.

The diameter of the mast may be gradually decreased upwards to a value of 0,75 \( d \) at the shroud eyeplates, while the thickness of the mast plates is maintained constant throughout the length \( l \). The mast length from the shroud eyeplates to the top is not to exceed one third of \( l \).

The mast is to be stayed by the shrouds as follows:

1. horizontal distance (\( a \)) from the deck (or bulwark) stay eyeplate to the transverse plane through the mast stay eyeplate is not to be less than:
   \[ a = 0,15 \, h, \text{in [m]}, \]

where:

- \( h \) - vertical distance, in [m], from the mast stay eyeplate to the deck (or bulwark) stay eyeplate,

2. horizontal distance (\( b \)) from the deck (or bulwark) stay eyeplate to the longitudinal plane through the mast stay eyeplate is not to be less than:
   \[ b = 0,30 \, h, \text{in [m]}, \]

3. the value of \( a \) is not to exceed the value of \( b \).

6.2.2 The breaking strength of the whole ropes used for the mast shrouds as specified in 6.2.1 is not to be less than:

\[ F = 0,49 \, (l^2 + 10l + 25), \text{in [kN]} \]

The loose gear of shrouds (shackles, turnbuckles, etc.) is to be such that their safe working load is not to be less than 0,25 times the actual breaking strength of the ropes referred to above.

In all other respects the ropes for the mast shrouds shall meet the requirements of the Rules, Part 25 - Metallic materials, 8.

6.2.3 Where:
- the mast is made of high-tensile steel, light alloys, fibreglass or wood (1st grade wood must be used),
- the mast is stayed in some way other than that specified in 6.2.1,
- in addition to a yard arm, lights, and day signals, the mast is fitted with other equipment of considerable weight, such as radar reflectors with platforms for their servicing, "crow's nests", etc.

proceed as specified in 6.4.

6.2.4 The wire of the shrouds must have a standard quality zinc coating.

6.3 UNSTAYED MASTS

6.3.1 The outer diameter, \( d \), and thickness of the plates at the base of the masts, which are to be made of steel with a yield point between 215 and 255 N/mm² inclusive, is not to be less than:

\[ d = \frac{22}{\sqrt{\frac{l^2 + 1 + \frac{515 \times 10^4}{l^2 \times (0,6741l + a + 13)^2}}}{100 \times (0,6741l + a + 13)^2}}, \text{[mm]} \]

\[ t = \frac{l}{70}, \text{[mm]}, \]

where:

- \( l \) - length of the mast from bottom to top, in [m],
- \( a \) - vertical distance from the base of the mast to the centre of gravity of the ship, in [m].

The outer diameter of a mast may decrease so that at 0,75 \( l \) from the base is 0,5 \( d \). The thickness of the mast plates is not to be less than 4 mm. The heel of the mast must be rigidly fixed to the deck from all directions.

6.3.2 Where:
- the mast is made of high-tensile steel, light alloys, fibreglass or wood (1st grade wood must be used),
- in addition to a yard arm, lights, and day signals, the mast is fitted with other equipment of considerable weight, such as radar reflectors with platforms for their servicing, etc.

proceed as specified in 6.4.
6.4 MASTS OF SPECIAL CONSTRUCTION

6.4.1 In the cases specified in 6.2.3 and 6.3.2 as well as where bipod, tripod and other similar masts are installed, detailed strength calculations of these masts are to be carried out. These calculations are to be submitted for the approval.

6.4.2 The calculations are to be performed on the assumption that each part of the mast is affected by a horizontal force:

\[ F_i = \left( m_i + 4\pi^2 \left( 2 r + r \sin\theta + m_i g \sin\theta + p A_i \cos\theta \right) \right) \cdot 10^{-3}, \quad [\text{kN}] \]

where:

- \( m_i \) = mass of part (i), in [kg],
- \( z_i \) = elevation of the centre of gravity of part (i) above that of the ship, in [m],
- \( A_i \) = projected lateral area of part (i), in [m²],
- \( T \) = rolling or pitching period, in sec.,
- \( \theta \) = amplitude of roll or pitch, maximum, in radians,
- \( r \) = wave half height, in [m],
- \( p \) = specified wind pressure, in [N/m²]

\[ p = 1960 \text{ N/m}^2. \]

The calculations are to be carried out both for rolling and pitching of the ship; \( r \) being taken as equal to \( L/40 \), where \( L \) is the ship's length, in [m], and \( \theta \) in radians, as corresponding angle of 40° at roll and of 5° at pitch.

6.4.3 Under load specified in 6.4.2 the stresses in parts of the mast are not to exceed 0.7 times the yield stress of the material if made of metal and are not to exceed 12 N/mm² if made of wood.

The safety factor of the standing rope under the same load is not to be less than 3.
7 OPENINGS IN HULL, SUPERSTRUCTURES AND DECKHOUSES AND THEIR CLOSING APPLIANCES

7.1 GENERAL PROVISIONS

7.1.1 The requirements of the present section apply to ships of unrestricted service as well as to ships of restricted areas of navigation 2 and 3. The requirements for ships of restricted areas of navigation 4, 5, 6, 7 and 8 may be relaxed, the extent of relaxation is to be specially considered by the Register in each case depending upon the type of ship, navigation area, strength, freeboard and stability of ship.

For specific requirements relating to the windows and external doors of the passenger ships in domestic service class "D" operating exclusively in the area of navigation 6 and 7, in the period from April 1 to October 31, and carrying passengers on a daily trips or carrying not more than 36 cabin passengers, see requirements in Sections A.1 to A.8 of these Rules.

7.1.2 Departures from these requirements may be permitted for the ships to which a greater than minimum freeboard is assigned on condition that the Register is satisfied with safety conditions provided.

7.1.3 The arrangement of openings and their closing appliances in the hull, superstructures and deckhouses shall also comply with the requirements of the Rules, Part 17 - Fire protection, Part 12 - Electrical equipment, ICLL, 1966 and Part 24 - Non-metallic materials.

7.1.4 As far as deck openings are considered, the following two positions are distinguished in the present section:

.1 Position 1:
.1 upon exposed freeboard and raised quarter decks;
.2 upon exposed superstructure decks situated forward of a point located a quarter of the ship's length from the forward perpendicular;

.2 Position 2:
.1 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;
.2 upon exposed superstructure decks situated forward of a point located a quarter of the ship's length from the forward perpendicular and located at least two standard heights of superstructure above the freeboard deck.

7.1.5 The heights of coamings in ships of restricted area of navigation are to be approved by the Administration.

7.1.6 The height of coamings specified in the present section is measured from the upper surface of the steel deck plating or from the upper surface of the wood or other sheathing, if fitted.

7.1.7 In supply vessels the access to the spaces situated below the open cargo deck shall preferably be provided from the location inside the enclosed superstructure or deckhouse or from the location above the superstructure deck or deckhouse top.

7.1.8 For the ships indicated in 7.1.7 the arrangement of companion or other hatches on the open cargo deck leading to the spaces below this deck is subject to special consideration, taking account of the degree of protection of these hatches from possible damage during cargo handling operations as well as the volume of spaces flooded in case of damage to the hatch.

7.1.9 All external openings leading to compartments assumed intact in the damage stability calculation, which are below the final damage water line, are required to be watertight. The closing appliances of these openings are to be of sufficient strength and, except for cargo hatch covers, are to be fitted with indicators (open-closed) on the bridge.

7.1.10 Openings in the shell plating below the bulkhead deck are to be kept permanently closed while at sea. If any of these openings are accessible during the voyage, they are to be fitted with a device which prevents unauthorised opening.

7.1.11 Notwithstanding the requirements of 7.1.10, the Register may authorise that particular doors may be opened at the discretion of the master, if necessary for the operation of the ship and provided that the ship safety is not impaired.

7.1.12 Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of external openings are to be provided with a notice affixed to each appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not to be so marked.

7.1.13 The number of openings in the shell plating of the passenger ships is to be reduced to the minimum compatible with the design and proper working of the ship.

7.1.14 The number of scuppers, sanitary discharges and other similar openings in the shell plating is to be reduced to the minimum either by making each discharge serve for as many as possible of the sanitary and other pipes, or in any other satisfactory manner.

7.1.15 All inlets and discharges in the shell plating are to be fitted with efficient and accessible arrangements for preventing the accidental admission of water into the ship.

7.1.16 Subject to the requirements of the ICLL, 1996, and except as provided in 7.1.18, each separate discharge led through the shell plating from spaces below the bulkhead deck of passenger ships and the freeboard deck of cargo ships is to be provided with either one automatic non-return valve fitted with a positive means of closing it from above the bulkhead deck or with two automatic non-return valves without positive means of closing, provided that the inboard valve is situated above the deepest subdivision draught and is always accessi-
ble for examination under service conditions. Where a valve with positive means of closing is fitted, the operating position above the bulkhead deck is to always be readily accessible and means are to be provided for indicating whether the valve is open or closed.

7.1.17 The requirements of the ICCL, 1996, shall apply to discharges led through the shell plating from spaces above the bulkhead deck of passenger ships and the freeboard deck of cargo ships.

7.1.18 Machinery space, main and auxiliary sea inlets and discharges in connection with the operation of machinery are to be fitted with readily accessible valves between the pipes and the shell plating or between the pipes and fabricated boxes attached to the shell plating. In manned machinery spaces the valves may be controlled locally and are to be provided with indicators showing whether they are open or closed.

7.1.19 Moving parts penetrating the shell plating below the deepest subdivision draught are to be fitted with a watertight sealing arrangement acceptable to the Register. The inboard gland is to be located within a watertight space of such volume that, if flooded, the bulkhead deck is not to be submerged. The Register may require that if such compartment is flooded, essential or emergency power and lighting, internal communication, signals or other emergency devices must remain available in other parts of the ship.

7.1.20 All shell fittings and valves required by these requirements are to be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable. All pipes to which this regulation refers are to be of steel or other equivalent material to the satisfaction of the Register.

7.1.21 Gangway, cargo and fuelling ports fitted below the bulkhead deck of passenger ships and the freeboard deck of cargo ships are to be watertight and in no case be so fitted as to have their lowest point below the deepest subdivision draught.

7.1.22 The inboard opening of each ash-chute, rubbish-chute, etc., is to be fitted with an efficient cover.

7.1.23 If the inboard opening is situated below the bulkhead deck of passenger ships and the freeboard deck of cargo ships, the cover is to be watertight and, in addition, an automatic non-return valve is to be fitted in the chute in an easily accessible position above the deepest subdivision draught.

7.1.24 It is recommended that cargo ports or similar openings below the uppermost load specified in Regulation 21(2) of ICCL, 1996 may be accepted submerged provided the safety of the ship is in no way impaired. It is considered that the fitting of a second door of equivalent strength and watertightness is one acceptable arrangement. In that case leakage detection device should be provided in the compartment between the two doors. Further, drainage of this compartment to the bilges controlled by an easily accessible screw down valve, should be arranged. The outer door should preferably open outwards. See IACS Unified Interpretation LL.21.

7.2 SIDESCUTTLES AND WINDOWS

7.2.1 General

7.2.1.1 The requirements in 7.2.1 to 7.2.4 apply to sidescuttles and rectangular windows providing light and air, located in positions which are exposed to the action of sea and/or bad weather.

7.2.1.2 Sidescuttles are round or oval openings with an area not exceeding 0.16 m². Round or oval openings having area exceeding 0.16 m² are to be treated as windows.

7.2.1.3 Windows are rectangular openings generally, having a radius at each corner relative to window size in accordance with recognised national or international standards, and round or oval openings with an area exceeding 0.16 m².

7.2.1.4 The number of sidescuttles in the shell plating below the freeboard deck is to be reduced to a minimum compatible with the design and proper working of the ship.

Fishing vessels mooring alongside each other or other ships at sea are not to have sidescuttles under freeboard deck in the mooring zone, wherever possible. If in this zone side scuttles are fitted in the shell plating, they are to be so positioned that the possibility of their damage during mooring operations is excluded.

No sidescuttles are permitted within the boundaries of the ice belt of the shell plating specified in the Rules, Part 2 - Hull, 14, in icebreakers and ships with ice strengthening.

7.2.1.5 Sidescuttles and windows together with their glasses, deadlights and storm covers, if fitted, are to be of approved design and substantial construction in accordance with, or equivalent to, recognised national or international standards.

Non-metallic frames are not acceptable. The use of ordinary cast iron is not allowed for sidescuttles below the freeboard deck.

7.2.1.6 All sidescuttles the sills of which are below the bulkhead deck of passenger ships and the freeboard deck of cargo ships, as permitted by paragraph 7.2.2.1, are to be of such construction as will effectively prevent any person opening them without the consent of the master of the ship.

Sidescuttles and their deadlights which are not accessible during navigation are to be closed and secured before ship leaves the port.

7.2.1.7 Side scuttles to the following spaces shall be fitted with efficient hinged inside deadlights:

(a) spaces below freeboard deck
(b) spaces within the first tier of enclosed superstructures
(c) first tier deckhouses on the freeboard deck protecting openings leading below or considered buoyant in stability calculations.

The deadlights shall be capable of being effectively closed and secured watertight if fitted below freeboard deck and weathertight if fitted above.
Efficient hinged inside deadlights so arranged that they can be easily and effectively closed and secured watertight, are to be fitted to all sidescuttles except that abait one eighth of the ship's length from the forward perpendicular and above a line drawn parallel to the bulkhead deck at side and having its lowest point at a height of 3.7 m plus 2.5% of the breadth of the ship above the deepest subdivision draught, the deadlights may be portable in passenger accommodation other than that for steerage passengers, unless the deadlights are required by the ICL, 1996, to be permanently attached in their proper positions. Such portable deadlights are to be stowed adjacent to the sidescuttles they serve.

7.2.2 Position and opening arrangement

7.2.2.1 No sidescuttle is to be fitted in such position that its sill is below a line drawn parallel to the bulkhead deck at side and having its lowest point 0.025-B above the summer load waterline (or timber summer load waterline if assigned), or 0.5 m, whichever is the greater.

If the length of the ship is less than 24 m, the specified distance may be reduced to 0.3 m for ships of navigation area 4 and 5 and to 0.15 m for ships of navigation area 6, 7 and 8.

7.2.2.2 No sidescuttles is to be fitted in any spaces which are appropriated exclusively for carriage of cargo or coal.

Sidescuttles may, however, be fitted in spaces appropriated alternatively for carriage of cargo or passengers, but they are to be of such construction as will effectively prevent any person opening them or their deadlights without the consent of the master.

If cargo is carried in such spaces, the sidescuttles and their deadlights are to be closed watertight and locked before the cargo is shipped.

7.2.2.3 Side scuttles shall be of the non-opening type in ships subject to damage stability regulations, if calculations indicate that they would become immersed by any intermediate stage of flooding or the final equilibrium waterplane in any required damage case.

7.2.2.4 In ships having several decks above the bulkhead deck, such as passengers ships, the arrangement of sidescuttles and rectangular windows is to be specially considered by the Register in each case. Special consideration is to be given to the ship side up to the upper deck and the front bulkhead of the superstructure.

7.2.2.5 Automatic ventilating sidescuttles are not to be fitted in the shell plating below the bulkhead deck without the special sanction of the Register.

7.2.2.6 Windows are not to be fitted below the freeboard deck, in first tier end bulkheads or sides of enclosed superstructures and in first tier deckhouses considered as being buoyant in the stability calculations or protecting openings leading below.

In the front bulkhead of a superstructure situated on the upper deck, in case of substantially increased freeboard, rectangular windows with permanently fitted storm covers are acceptable.

7.2.2.7 Side scuttles and windows at the side shell in the second tier, protecting direct access below or considered buoyant in the stability calculations, shall be provided with efficient hinged inside deadlights capable of being effectively closed and secured watertight.

7.2.2.8 Side scuttles and windows set inboard from the side shell in the second tier, protecting direct access below to spaces listed in 7.2.1.7, shall be provided with either efficient hinged inside deadlights or, where they are accessible, permanently attached external storm covers of approved design and of substantial construction and capable of being effectively closed and secured watertight.

7.2.2.9 Cabin bulkheads and doors in the second tier separating side scuttles and windows from a direct access leading below may be accepted in place of deadlights or storm covers fitted to the side scuttles and windows.

7.2.2.10 Deckhouses situated on a raised quarter deck or on the deck of a superstructure of less than standard height or on the deck of a deckhouse of less than standard height, may be regarded as being in the second tier as far as the provision of deadlights is concerned, provided the height of the raised quarter deck, superstructure or deckhouse is equal to, or greater than, the standard quarter deck height.

7.2.2.11 Fixed or opening skylights shall have glass thickness appropriate to their size and position as required for side scuttles and windows. Skylight glasses in any position shall be protected from mechanical damage and where fitted in positions 1 or 2, shall be provided with robust deadlights or storm covers permanently attached. See also IASC Unified Interpretation LL62.

7.2.3 Glasses

7.2.3.1 In general, toughened glasses with frames of special type are to be used in compliance with, or equivalent to, recognised national or international standards, see the Rules, Part 24 - Non-metallic materials, 3.7.

The use of clear plate glasses is to be specially considered by the Register in each case.

7.2.3.2 The thickness of toughened glasses in sidescull- tles is not to be less than that obtained from Table 7.2.3.2-1.

### Table 7.2.3.2-1

<table>
<thead>
<tr>
<th>Clear light diameter of sidescuttle [mm]</th>
<th>Type A Heavy series Thickness [mm]</th>
<th>Type B Medium series Thickness [mm]</th>
<th>Type C Light series Thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>10</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>250</td>
<td>12</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>300</td>
<td>15</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>350</td>
<td>15</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>400</td>
<td>19</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>450</td>
<td>Not applicable</td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>
Type A, B or C sidescuttles are to be adopted according to the requirements of Table 7.2.3.2-2, where:
- zone 1 is the zone comprised between a line, parallel to the sheer profile, with its lowest point at a distance above the summer load waterline equal to 0.025 $B$ or 0.5 m, whichever is the greater, and a line parallel to the previous one located 1.4 m above it;
- zone 2 is the zone located above zone 1 and bounded at the top by the freeboard deck;
- zone 4 is the second tier of superstructures or deckhouses;
- zone 5 is the third and higher tiers of superstructures or deckhouses;
- exposed zones are the boundaries of superstructures or deckhouses set in from the ship's side at a distance less than or equal to 0.04 $B$;
- unexposed zones are the boundaries of superstructures or deckhouses set in from the ship's side at a distance greater than 0.04 $B$.

7.2.3.3 Ships of navigation area 4 and 5, having length less than 24 m, may be fitted with sidescuttles type B and type C instead of those type A and type B required in Table 7.2.3.2-2.

Ships of navigation area 6 and 7 may be fitted with sidescuttles type B and type C instead of those type A and type B required in Table 7.2.3.2-2.

In ships of navigation area 8 all fitted sidescuttles may be type C.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Aft of 0.875 $L$ from the aft end</th>
<th>Forward of 0.875 $L$ from the aft end</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Type C</td>
<td>Type B</td>
</tr>
<tr>
<td>4</td>
<td>Protecting openings giving direct access to spaces below the freeboard deck: Type B</td>
<td>Type B</td>
</tr>
<tr>
<td></td>
<td>Not protecting openings giving direct access to spaces below the freeboard deck: Type C</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Exposed zones</td>
<td>Type B</td>
</tr>
<tr>
<td></td>
<td>Unexposed zones</td>
<td>Type B</td>
</tr>
<tr>
<td></td>
<td>Protecting openings giving direct access to spaces below the freeboard deck: Type B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not protecting openings giving direct access to spaces below the freeboard deck: Type C</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Type B</td>
<td>Type A</td>
</tr>
<tr>
<td>1</td>
<td>Type A</td>
<td>Type A</td>
</tr>
</tbody>
</table>

7.2.4 Deadlights arrangement

7.2.4.1 Sidescuttles in the following positions are to be fitted with efficient, hinged inside deadlights so arranged that they can be easily and effectively closed and secured watertight:
- in the shell plating below freeboard deck;
- in front bulkheads of enclosed superstructures and deckhouses of the first tier;
- in front bulkheads of enclosed superstructures and deckhouses of the second tier within 0.25 $L$ from the forward perpendicular;
- in the first tier of enclosed superstructures and deckhouses on freeboard deck protecting openings leading below or considered buoyant in stability calculations.
7.4.1.1 Bow doors and inner doors

7.4.1.1.1 General

The requirements of this head of the Rules apply to the arrangement, strength and securing of bow doors and inner doors leading to a complete or long forward enclosed superstructure, or to a long non-enclosed superstructure, where fitted to attain minimum bow height equivalence.

The requirements apply to all ro-ro passenger ships and ro-ro cargo ships engaged on international voyages and also to ro-ro passenger ships and ro-ro cargo ships engaged only in domestic (non-international) voyages, except where specifically indicated otherwise herein.

The requirements are not applicable to high speed, light displacement craft as defined in the IMO Code of Safety for High Speed Craft.

Two types of bow door are provided for:

**Visor doors** opened by rotating upwards and outwards about a horizontal axis through two or more hinges located near the top of the door and connected to the primary structure of the door by longitudinally arranged lifting arms,

**Side-opening doors** either by rotating outwards about a vertical axis through two or more hinges located near the outboard edges or by horizontal translation by means of linking arms arranged with pivoted attachments to the door and the ship.

Other types of bow doors are to be specially considered by the Register.

7.4.1.1.2 Bow doors are to be situated above the freeboard deck. A watertight recess in the freeboard deck located forward of the collision bulkhead and above the deepest waterline fitted for arrangement of ramps or other related mechanical devices may be regarded as a part of the freeboard deck for the purpose of this requirement.

7.4.1.1.3 Inner doors are to be fitted. The inner door is to be part of the collision bulkhead. The inner door need not be fitted directly above the bulkhead below, provided that it is located within the limits specified for the position of the collision bulkhead, refer to Regulation II-1/12 of the SOLAS Convention. A vehicle ramp may be arranged for this purpose, provided its position complies with Regulation II-1/12 of the SOLAS Convention. If this is not possible a separate inner weathertight door are to be installed, as far as practicable within the limits specified for the position of the collision bulkhead.

7.4.1.1.4 Bow doors are to be so fitted as to ensure tightness consistent with operational conditions and to give effective protection to inner doors. Inner doors forming of the collision bulkhead are to be weathertight over the full height of the cargo space and arranged with fixed sealing supports on the aft side of the doors.

7.4.1.1.5 Bow doors and inner doors are to be so arranged so as to preclude the possibility of the bow door causing structural damage to the inner door or to the collision bulkhead in the case of damage to or detachment of the bow door. If this is not possible, a separate inner weathertight door is to be installed, as indicated in 7.4.1.1.3.

7.4.1.1.6 For the purpose of satisfaction of the requirements for inner doors, vehicles are to be effectively lashed and secured against movement in stowed position.

7.4.1.1.7 Definitions

- **Securing device**: a device used to keep the door closed by preventing it from rotating about its hinges.
- **Supporting device**: a device used to transmit external or internal loads from the door to a securing device and from the securing device to the ship's structure, or a device other than a securing device, such as a hinge, stopper or other fixed device, transmits loads from the door to the ship's structure.
- **Locking device**: a device that locks a securing device in the closed position.
- **Ro-ro passenger ship**: a passenger ship with ro-ro spaces or special category spaces.
- **Ro-ro spaces**: are spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the ship, in which...
7.4.1.3 Design loads

Pe and supporting devices of bow doors is not to be less than:

\[ \text{design forces} = p \times e \]

where:

- \( p \) = design pressure, kN/m²
- \( e \) = design projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser.

7.4.1.2 Strength criteria

7.4.1.2.1 Scantlings of the primary member, securing and supporting devices of bow doors and inner doors are to be determined to withstand the design loads defined in 7.4.1.3, using the following permissible stresses:

- shear stress: \( \tau = \frac{80}{k} \) [N/mm²]
- bending stress: \( \sigma = \frac{120}{k} \) [N/mm²]
- equivalent stress:
  \[ \sigma_e = \sqrt{\sigma^2 + 3\tau^2} = \frac{150}{k} \] [N/mm²]

where \( k \) is the material factor as given in the Rules, Part 2 - Hull, 1.4, but is not to be taken less than 0.72.

7.4.1.2.2 The buckling strength of primary members is to be verified as being adequate.

7.4.1.2.3 For steel to steel bearings in securing and supporting devices, the nominal bearing pressure calculated by dividing the design force by the projected bearing area is not to exceed 0.8 \( \times R_{d0} \), where \( R_{d0} \) is the yield stress of the bearing material. For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer’s specification.

7.4.1.2.4 The arrangement of securing and supporting devices is to be such that threaded bolts do not carry support forces. The maximum tension in way of threads of bolts not carrying support forces is not to exceed 125/k [N/mm²].

7.4.1.3 Design loads

7.4.1.3.1 The design external pressure, in [kN/m²], to be considered for the scantlings of primary members, securing and supporting devices of bow doors is not to be less than:

\[ p_e = 2.75 \times \lambda \times C_H \times (0.22 + 0.15 \times \tan \alpha)(0.4 \times v \times \sin \beta + 0.6 \times \sqrt{L})^2 \]

where:

- \( \lambda = 0.5 \) for sailing area 5, 6, 7 and 8.
- \( C_H = 0.0125 L, \) for \( L < 80 \) m
- \( = 1.00, \) for \( L \geq 80 \) m
- \( \alpha = \) flare angle at the point to be considered, defined as the angle between a vertical line and the tangent to the side shell plating, measured in a vertical plane normal to the horizontal tangent to the shell plating (see Figure 7.4.1.3.2);
- \( \beta = \) entry angle at the point to be considered, defined as the angle between a longitudinal line parallel to the centreline and the tangent to the shell plating in a horizontal plane (see Figure 7.4.1.3.2).

\[ F_x = p_e \times A_x \]
\[ F_y = p_e \times A_y \]
\[ F_z = p_e \times A_z \]

where:

- \( A_x \) = area, in [m²], of the transverse vertical projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser.
- \( A_y \) = area, in [m], of the longitudinal vertical projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser.
- \( A_z \) = area, in [m²], of the horizontal projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser.
of the door may be measured to the upper deck or to the top of the door, whichever is lesser.

\[ h = \text{height, in } [m], \text{ of the door between the levels of the bottom of the door and the upper deck or between the bottom of the door and the top of the door, whichever is the lesser;} \]

\[ l = \text{length, in } [m], \text{ of the door at a height } h/2 \text{ above the bottom of the door;} \]

\[ w = \text{breadth, in } [m], \text{ of the door at a height } h/2 \text{ above the bottom of the door;} \]

\[ p_e = \text{external pressure, in } [kN/m^2], \text{ as given in 7.4.1.3.1 with angles } \alpha \text{ and } \beta \text{ defined as follows:} \]

\[ \alpha = \text{flare angle measure at the point on the bow door, } l/2 \text{ aft of the stem line on the plane } h/2 \text{ above the bottom of the door, as shown in Figure 7.4.1.3.2;} \]

\[ \beta = \text{entry angle measured at the same point as } \alpha. \]

\[ M_y = F_x \cdot a + 10 \cdot W \cdot c + F_z \cdot b \]

where:

\[ W = \text{mass of the visor door, in } [t]; \]

\[ a = \text{vertical distance, in } [m], \text{ from visor pivot to the centroid of the transverse vertical projected area of the visor door, as shown in Figure 7.4.1.3.3;} \]

\[ b = \text{horizontal distance, in } [m], \text{ from visor pivot to the centroid of the horizontal projected area of the visor door, as shown in Figure 7.4.1.3.3;} \]

\[ c = \text{horizontal distance, in } [m], \text{ from visor pivot to the centre of gravity of visor mass, as shown in Figure 7.4.1.3.3.} \]

For bow doors, including bulwark, of unusual form or proportions, e.g. ships with a rounded nose and large stem angles, the areas and angles used for determination of the design values of external forces may require to be specially considered.

7.4.1.3.3 For visor doors the closing moment \( M_y \) under external loads, in [kNm], is to be taken as:

7.4.1.4 Scantlings of bow and inner doors

7.4.1.4.1 The strength of bow doors is to be commensurate with that of the surrounding structure.

7.4.1.4.2 Bow doors are to be adequately stiffened and means are to be provided to prevent lateral or vertical movement of the doors when closed. For visor doors adequate strength for the opening and closing operations is to be provided in the connections of the lifting arms to the door structure and to the ship structure.

7.4.1.4.3 The thickness of the bow door plating is not to be less than required for the side shell plating, using bow door stiffener spacing, but in no case less than the minimum required thickness of fore end shell plating.

7.4.1.4.4 The section modulus of horizontal or vertical stiffeners of bow doors is not to be less than that required for fore end framing. Consideration is to be given, where necessary, to differences in fixity between ship's frames and bow doors stiffeners.

7.4.1.4.5 The stiffener webs of bow doors are to have a net sectional area, in [cm²], not less than:
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7.4.1.4.6 The bow door secondary stiffeners are to be supported by primary members constituting the main stiffening of the door.

The primary members of the bow door and the hull structure in way are to have sufficient stiffness to ensure integrity of the boundary support of the door.

Scantlings of the primary members of the bow and inner doors are generally to be supported by direct strength calculations in association with the external pressure given in 7.4.1.3.1 and 7.4.1.3.5, respectively, and permissible stress given in 7.4.1.2.1. Normally, formula for simple beam theory may be applied to determine the bending stress. Members are to be considered to have simply supported end connections.

7.4.1.4.7 Where inner doors also serve as a vehicle ramp, the scantlings are not to be less than those required for vehicle decks.

7.4.1.4.8 The distribution of the forces acting on the securing and supporting devices of inner doors is generally to be supported by direct calculations taking into account the flexibility of the structure and the actual position and stiffness of the supports.

7.4.1.5 Securing and supporting of bow doors

7.4.1.5.1 Bow doors are to be fitted with adequate means of securing and supporting so as to be commensurate with the strength and stiffness of the surrounding structure. The hull supporting structure in way of the bow doors is to be suitable for the same design loads and design stress as the securing and supporting devices. Where packing is required, the packing material is to be of a comparatively soft type, and the supporting forces are to be carried by the steel structure only. Maximum design clearance between securing and supporting devices is not generally to exceed 3 mm.

A means are to be provided for mechanically fixing the door in the open position.

7.4.1.5.2 Only the active supporting and securing devices having an effective stiffness in the relevant direction are to be included and considered to calculate the reaction forces acting on the devices. Small and/or flexible devices such as cleats intended to provide load compression of the packing material are not generally to be included in the calculations called for in 7.4.1.5.8. The number of securing and supporting devices is generally to be the minimum practical whilst taking into account the requirements for redundant provision given in 7.4.1.5.9 and 7.4.1.5.10 and the available space for adequate support in the hull structure.

7.4.1.5.3 For opening outwards visor doors, the pivot arrangement is generally to be such that the visor is self closing under external loads, that is My > 0. Moreover, the closing moment My as given in 7.4.1.3.3 is not to be less than:

\[ M_{o} = 10 \cdot W \cdot d + 5 \cdot A_e \cdot a \]

where:

- \( W \) = weight of the door
- \( d \) = distance between the center of gravity and the hinge points
- \( A_e \) = projected area
- \( a \) = distance from the center of gravity to the pivot point

7.4.1.5.4 Securing and supporting devices are to be adequately designed so that they can withstand the reaction forces within the permissible stresses given in 7.4.1.3.1.

7.4.1.5.5 For visor doors the reaction forces applied on the effective securing and supporting devices assuming the door as a rigid body are determined for the following combination of external loads acting simultaneously together with the self weight of the door:

\[ M_{o} = 10 \cdot W \cdot c + 0.1 \cdot \sqrt{a^2 + b^2} \cdot (F_x^2 + F_y^2) \]

7.4.1.5.6 For side-opening doors the reaction forces applied on the effective securing and supporting devices assuming the door as a rigid body are determined for the following combination of external loads acting simultaneously together with the self weight of the door:

\[ M_{o} = 10 \cdot W \cdot c + 0.1 \cdot \sqrt{a^2 + b^2} \cdot (F_x^2 + F_y^2) \]

where:

- \( W \) = weight of the door
- \( c \) = distance between the center of gravity and the hinge points
- \( a \) = distance from the center of gravity to the pivot point
- \( F_x \) and \( F_y \) are determined as indicated in 7.4.1.3.2 and applied at the centroid of projected areas.

7.4.1.5.7 The support forces as determined according to 7.4.1.5.5 a) and b) shall generally give rise to a zero moment about the transverse axis through the centroid of the area \( A_e \). For visor doors, longitudinal reaction forces of pin and/or wedge supports at the door base contributing to this moment are not to be of the forward direction.

7.4.1.5.8 The distribution of the reaction forces acting on the securing and supporting devices may require to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position and stiffness of the supports.

7.4.1.5.9 The arrangement of securing and supporting devices in way of these securing devices is to be designed with redundancy so that in the event of failure of any single securing or supporting device the remaining devices are capable to withstand the reaction forces without exceeding by more than 20 percent the permissible stresses as given in 7.4.1.2.1.

7.4.1.5.10 For visor doors, two securing devices are to be provided at the lower part of the door, each capable of providing the full reaction force required to prevent opening of the door within the permissible stresses given in 7.4.1.2.1. The opening moment \( M_{o} \), in [kNm], to be balanced by this reaction force, is not to be taken less than:

\[ M_{o} = 10 \cdot W \cdot c + 5 \cdot A_e \cdot a \]
7.4.1.5.11 For visor doors, the securing and supporting devices excluding the hinges are to be capable of resisting the vertical design force ($F_v = 10 \cdot W$), in [kN], within the permissible stresses given in 7.4.1.2.1.

7.4.1.5.12 All load transmitting elements in the design load path, from door through securing and supporting devices into the ship structure, including welded connections, are to be to the same strength standard as required for the securing and supporting devices. These elements include pins, supporting brackets and back-up brackets.

7.4.1.5.13 For side-opening doors, thrust bearing has to be provided in way of girder ends at the closing of the two leaves to prevent one leaf to shift towards the other one under effect of unsymmetrical pressure (see example of Figure 7.4.1.5.13). Each part of the thrust bearing has to be kept secured on the other part by means of securing devices. Any other arrangement serving the same purpose may be proposed.

![Thrust bearing](image)

**Figure 7.4.1.5.13** Thrust bearing

7.4.1.6 Securing and locking arrangement

7.4.1.6.1 Securing devices are to be simple to operate and easily accessible. Securing devices are to be equipped with mechanical locking arrangement (self locking or separate arrangement), or be of the gravity type. The opening and closing systems as well as securing and locking devices are to be interlocked in such a way that can only operate in the proper sequence.

7.4.1.6.2 Bow doors and inner doors giving access to vehicle decks are to be provided with an arrangement for remote control, from a position above the freeboard deck, of:

- the closing and opening of the doors, and
- associated securing and locking devices for every door.

Indication of the open/closed position of every securing and locking device is to be provided at the remote control stations. The operating panels for operation of doors are to be inaccessible to unauthorised persons. A notice plate, giving instructions to the effect that all securing devices are to be closed and locked before leaving harbour, is to be placed at each operating panel and is to be supplemented by warning indicator lights.

7.4.1.6.3 Where hydraulic devices are applied, the system is to be mechanically lockable in closed position. This means that, in the event of loss of the hydraulic fluid, the securing devices remain locked.

The hydraulic system for securing and locking devices is to be isolated from other hydraulic circuits, when in closed position.

7.4.1.6.4 Separate indicator lights and audible alarms are to be provided on the navigation bridge and on the operating panel to show that the bow door and inner door are closed and that their securing and locking devices are properly positioned.

The indication panel is to be provided with a lamp test function. It is not to be possible to turn off the indicator light.

7.4.1.6.5 The indicator system is to be designed on the fail safe principal and is to show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system for operating and closing doors is to be independent of the power supply for operating and closing the door and is to be provided with a back-up power supply from the emergency source of power or other secure power supply. The sensor of indicator system is to be protected from water, ice formation, and mechanical damages.

Note: The indicator system is considered designed on the fail - safe principal when:

1) The indication panel is provided with:
   - a power failure alarm
   - an earth failure alarm
   - a lamp test
   - separate indication for door closed, door locked, door not closed and door not locked.

2) Limit switches electrically closed when the door is closed (when more limit switches are provided they may be connected in series).

3) Limit switches electrically closed when securing arrangements are in place (when more limit switches are provided they may be connected in series).

4) Two electrical circuits (also in one multicore cable), one for the indication of door closed / not closed and the other for door locked / not locked.

5) In case of dislocation of limit switches, indication to show : not closed / not locked / securing arrangement not in place - as appropriate.

7.4.1.6.6 The indication panel on the navigation bridge is to be equipped with a mode selection function "harbour/sea voyage", so arranged that audible alarm is given on the navigation bridge if the vessel leaves harbour with the bow door or inner door not closed or with any of the securing devices not in the correct position.

7.4.1.6.7 A water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the inner door.

See Note in item 7.4.1.6.5.
7.4.1.6.8 Between the bow door and the inner door a television surveillance system is to be fitted with a monitor on the navigation bridge and in the engine control room. The system must monitor the position of doors and a sufficient number of their securing devices. Special consideration is to be given for lighting and contrasting colour of objects under surveillance.

See Note in item 7.4.1.6.5.

7.4.1.6.9 A drainage system is to be arranged in the area between bow door and ramp, as well as in the area between the ramp and inner door where fitted. The system is to be equipped with an audible alarm function to the navigation bridge for water level in these areas exceeding 0.5 [m] above the car deck level.

See Note in item 7.4.1.6.5.

7.4.1.6.10 For ro-ro passenger ships on international voyages, the special category spaces and ro-ro spaces are to be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions or unauthorised access by passengers thereto, can be detected whilst the ship is underway.

Note: It is recommended that recorded inspections of the door supporting and securing devices be carried out by the ship's staff at monthly intervals or following incidents that could result in damage, including heavy weather or contact in the region of the shell doors.

Any damages recorded during inspections of the door supporting and securing devices, carried out by the ship's staff, are to be reported to the Register.

7.4.1.7 Operating and maintenance manual

7.4.1.7.1 An operating and maintenance manual for the bow door and inner door is to be provided on board and is to contain necessary information on:

- main particulars and design drawings;
- special safety precautions
- details of vessel
- equipment and design loading (for ramps)
- key plan of equipment (doors and ramps)
- manufacturer's recommended testing for equipment
- description of equipment for bow doors
- inner bow doors
- bow ramp/doors
- side doors
- stern doors
- central power pack
- bridge panel
- engine control room panel
- service conditions
- limiting heel and trim of ship for loading/unloading
- limiting heel and trim for door operations
doors/ramps operating instructions
doors/ramps emergency operating instructions
- maintenance
- schedule and extent of maintenance
- trouble shooting and acceptable clearances
- manufacturer's maintenance procedures
- register of inspections and repairs, including inspection of locking, securing and supporting devices, and repairs and renewals.

This manual is to be submitted to the Register for approval that the above mentioned items are contained in the OMM and that the maintenance part includes the necessary information with regard to inspections, trouble-shooting and acceptance/rejection criteria.

7.4.2 Side shell doors and stern doors

7.4.2.1 General

7.4.2.1.1 These requirements are for the arrangement, strength and securing of side shell doors, after the collision bulkhead, and stern doors leading to enclosed spaces.

The requirements apply to all ro-ro passenger ships and ro-ro cargo ships engaged on international voyages and also to ro-ro passenger ships and ro-ro cargo ships engaged only in domestic (non-international) voyages, except where specifically indicated otherwise herein.

The requirements are not applicable to high speed, light displacement craft as defined in the IMO Code of Safety for High Speed Craft.

7.4.2.1.2 Arrangement of doors

7.4.2.1.2.1 Stern doors for passenger vessels are to be situated above the freeboard deck. Stern doors for Ro-Ro cargo ships and side shell doors may be either below or above the freeboard deck.

7.4.2.1.2.2 Side shell doors and stern doors are to be so fitted as to ensure tightness and structural integrity commensurate with their location and the surrounding structure.

7.4.2.1.2.3 Where the sill of any side shell door is below the uppermost load line, the arrangement is to be specially considered.

7.4.2.1.2.4 Doors should preferably open outwards.

7.4.2.1.3 Definitions

7.4.2.1.3.1 For definitions see item 7.4.1.1.7.

7.4.2.2 Strength criteria

7.4.2.2.1 Primary structure and securing and supporting devices

7.4.2.2.1.1 Scantlings of the primary members, securing and supporting devices of side shell doors and stern doors are to be determined to withstand the design loads defined in 7.4.2.3, using the following permissible stresses:

\[ \tau = \frac{80}{k} \text{ [N/mm}^2\text{]} \]

\[ \sigma = \frac{120}{k} \text{ [N/mm}^2\text{]} \]
7.4.2.2.1.2 The buckling strength of primary members is to be verified as being adequate.

7.4.2.2.1.3 For steel to steel bearings in securing and supporting devices, the nominal bearing pressure calculated by dividing the design force by the projected bearing area is not to exceed 0.8, where the yield stress of the bearing material. For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer's specification.

7.4.2.2.1.4 The arrangement of securing and supporting devices is to be such that threaded bolts do not carry support forces. The maximum tension in way of threads bolts not carrying support forces is not to exceed 125/k [N/mm²], with k defined in 7.4.2.2.1.1.

7.4.2.2.1.5 The buckling strength of primary members is to be verified as being adequate.

7.4.2.2.1.6 For steel to steel bearings in securing and supporting devices, the nominal bearing pressure calculated by dividing the design force by the projected bearing area is not to exceed 0.8, where the yield stress of the bearing material. For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer's specification.

7.4.2.3 Design loads

7.4.2.3.1 The design forces, in [kN], considered for the scantlings of primary members, securing and supporting devices of side shell doors and stern doors are to be not less than:

7.4.2.3.1.1 Design forces for securing or supporting devices of doors opening inwards:
   
   \[ F_e = A p_e + F_p \]

   external force: \( F_e = A p_e + F_p \)
   \( F_e \) = internal force: \( F_i = F_p + 10 \, W \)

7.4.2.3.1.2 Design forces for securing or supporting devices of doors opening outwards:

   \[ F_e = A p_e \]
   \( F_e \) = external force: \( F_e = A p_e \)
   \( F_i = F_p + 10 \, W + F_p \)

7.4.2.3.1.3 Design forces for primary structural members:

   \[ F_e = A p_e \]
   \( F_e \) = external force: \( F_e = A p_e \)
   \( F_i = F_p + 10 \, W \)

   whichever is the greater,

   where:

   \( A \) = area, in \( [\text{m}^2] \), of the door opening,
   \( W \) = mass of the door, in \( [\text{t}] \),
   \( F_p \) = total packing force, in \( [\text{kN}] \), packing line pressure is normally not to be taken less than 5 N/mm,
   \( F_o \) = the greater of \( F_e \) and 5A, in \( [\text{kN}] \),
   \( F_a \) = accidental force, in \( [\text{kN}] \), due to loose of cargo etc., to be uniformly distributed over the area \( A \) and not to be taken less than 300 kN. For small doors such as bunker doors and pilot doors, the value of \( F_a \) may be appropriately reduced.

7.4.2.4 Scantlings of side shell doors and stern doors

7.4.2.4.1 General

7.4.2.4.1.1 The strength of side shell doors and stern doors is to be commensurate with that of the surrounding structure.

7.4.2.4.1.2 Side shell doors and stern doors are to be adequately stiffened and means are to be provided to prevent any lateral or vertical movement of the doors when closed. Adequate strength is to be provided in the connections of the lifting/manoeuvring arms and hinges to the door structure and to the ship's structure.

7.4.2.4.1.3 Where doors also serve as vehicle ramps, the design of the hinges should take into account the ship angle of trim and heel, which may result in uneven loading on the hinges.
7.4.2.4.1.4 Shell door openings are to have well-rounded corners and adequate compensation is to be arranged with web frames at sides and stringers or equivalent above and below.

7.4.2.4.2 Plating and secondary stiffeners

7.4.2.4.2.1 The thickness of the door plating is to be not less than the required thickness for the side shell plating, using the door stiffener spacing, but in no case less than the minimum required thickness of shell plating.

Where doors serve as vehicle ramps, the plating thickness is to be not less than required for vehicle decks.

7.4.2.4.2.2 The section modulus of horizontal or vertical stiffeners is not to be less than that required for side framing. Consideration is to be given, where necessary, to differences in fixity between ship's frames and door stiffeners.

Where doors serve as vehicle ramps, the stiffener scantlings are not to be less than required for vehicle decks.

7.4.2.4.3 Primary structure

7.4.2.4.3.1 The secondary stiffeners are to be supported by primary members constituting the main stiffening of the door.

7.4.2.4.3.2 The primary members and the hull structure in way are to have sufficient stiffness to ensure structural integrity of the boundary of the door.

7.4.2.4.3.3 Scantlings of the primary members are generally to be supported by direct strength calculations in association with the design forces given in 7.4.2.3 and permissible stresses given in 7.4.2.2.1.1.

Normally, formulae for simple beam theory may be applied to determine the bending stresses. Members are to be considered to have simply supported end connections.

7.4.2.5 Securing and supporting of doors

7.4.2.5.1 General

7.4.2.5.1.1 Side shell doors and stern doors are to be fitted with adequate means of securing and supporting so as to be commensurate with the strength and stiffness of the surrounding structure. The hull supporting structure in way of the doors is to be suitable for the same design loads and design stresses as the securing and supporting devices.

Where packing is required, the packing material is to be of a comparatively soft type, and the supporting forces are to be carried by the steel structure only. Other types of packing may be considered.

Maximum design clearance between securing and supporting devices is not generally to exceed 3 mm.

A means is to be provided for mechanically fixing the door in the open position.

7.4.2.5.1.2 Only the active supporting and securing devices having an effective stiffness in the relevant direction are to be included and considered to calculate the reaction forces acting on the devices. Small and/or flexible devices such as cleats intended to provide local compression of the packing material are not generally to be included in the calculations called for in 7.4.2.5.2.2. The number of securing and supporting devices are generally to be the minimum practical whilst taking into account the requirement for redundant provision given in 7.4.2.5.2.3 and the available space for adequate support in the hull structure.

7.4.2.5.2 Scantlings

7.4.2.5.2.1 Securing and supporting devices are to be adequately designed so that they can withstand the reaction forces within the permissible stresses given in 7.4.2.2.1.1.

7.4.2.5.2.2 The distribution of the reaction forces acting on the securing devices and supporting devices may require to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position of the supports.

7.4.2.5.2.3 The arrangement of securing devices and supporting devices in way of these securing devices is to be designed with redundancy so that in the event of failure of any single securing or supporting device the remaining devices are capable to withstand the reaction forces without exceeding by more than 20 per cent the permissible stresses as given in 7.4.2.2.1.1.

7.4.2.5.2.4 All load transmitting elements in the design load path, from the door through securing and supporting devices into the ship's structure, including welded connections, are to be to the same strength standard as required for the securing and supporting devices. These elements include pins, support brackets and back-up brackets.

7.4.2.6 Securing and locking arrangement

7.4.2.6.1 Systems for operation

7.4.2.6.1.1 Securing devices are to be simple to operate and easily accessible. Securing devices are to be equipped with mechanical locking arrangement (self locking or separate arrangement), or are to be of the gravity type. The opening and closing systems as well as securing and locking devices are to be interlocked in such a way that they can only operate in the proper sequence.

7.4.2.6.1.2 Doors which are located partly or totally below the freeboard deck with a clear opening area greater than 6 m² are to be provided with an arrangement for remote control, from a position above the freeboard deck, of:

- the closing and opening of the doors
- associated securing and locking devices.

For doors which are required to be equipped with a remote control arrangement, indication of the open/closed position of the door and the securing and locking device is to be provided at the remote control stations. The operating panels for operation of doors are to be inaccessible to unauthorised persons. A notice plate, giving instructions to the effect that all securing devices are to be closed and locked before leaving harbour, is to be placed at each operating panel and is to be supplemented by warning indicator lights.

7.4.2.6.1.3 Where hydraulic securing devices are applied, the system is to be mechanically lockable in closed position. This means that, in the event of loss of the hydraulic fluid, the securing devices remain locked.

The hydraulic system for securing and locking devices is to be isolated from other hydraulic circuits, when closed position.
7.4.2.6.2 Systems for indication/monitoring

7.4.2.6.2.1 The following requirements apply to doors in the boundary of special category spaces or ro-ro spaces, see the Rules, Part 17 - Fire protection, 2.2, through which such spaces may be flooded.

For cargo ships, where no part of the door is below the uppermost waterline and the area of the door opening is not greater than 6 m², then the requirements of this section need not be applied.

7.4.2.6.2.2 Separate indicator lights and audible alarms are to be provided on the navigation bridge and on each operating panel to indicate that the doors are closed and that their securing and locking devices are properly positioned.

The indication panel is to be provided with a lamp test function. It is not to be possible to turn off the indicator light.

7.4.2.6.2.3 The indicator system is to be designed on the fail safe principle and is to show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system is to be independent of the power supply for operating and closing the doors and is to be provided with a backup power supply from the emergency source of power or secure power supply.

See 7.4.1.6.5 for fail safe principal design.

The sensors of the indicator system are to be protected from water, ice formation and mechanical damages.

7.4.2.6.2.4 The indication panel on the navigation bridge is to be equipped with a mode selection function “harbour/sea voyage”, so arranged that audible alarm is given on the navigation bridge if the vessel leaves harbour with any side shell or stern door not closed or with any of the securing devices not in the correct position.

7.4.2.6.2.5 For passenger ships, a water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of any leakage through the doors.

For cargo ships, a water leakage detection system with audible alarm is to be arranged to provide an indication to the navigation bridge.

7.4.2.6.2.6 For ro-ro passenger ships, on international voyages, the special category spaces and ro-ro spaces are to be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorised access by passengers thereto, can be detected whilst the ship is underway.

7.4.2.7 Operating and maintenance manual

7.4.2.7.1 An operating and maintenance manual for the side shell and stern doors is to be provided on board and contain necessary information (see 7.4.1.7.1).

This manual has to be submitted for approval to the Register that the above mentioned items are contained in the OMM and that the maintenance part includes the necessary information with regard to inspections, trouble-shooting and acceptance / rejection criteria.

Note:

It is recommended that recorded inspections of the door supporting and securing devices be carried out by the ship's staff at monthly intervals or following incidents that could result in damage, including heavy weather or contact in the region of side shell and stern doors. Any damage recorded during such inspections is to be reported to the Register.

7.4.2.7.2 Documented operating procedures for closing and securing side shell and stern doors are to be kept on board and posted at the appropriate places.

7.5 SUPERSTRUCTURES AND DECKHOUSES

7.5.1 Construction, openings and closing appliances

7.5.1.1 Openings in the freeboard deck other than those defined in 7.3, 7.6 to 7.11 are to be protected by the enclosed superstructure or enclosed deckhouse.

The similar openings in the deck of enclosed superstructure or enclosed deckhouse are to be protected by enclosed deckhouse of the second tier.

7.5.1.2 Superstructures and deckhouses are considered enclosed if:

- their construction complies with the Rules, Part 2 - Hull, 13.
- all access openings comply with the requirements of 7.5.2 and 7.7;
- all other openings in their outside contour comply with requirements of 7.2 to 7.4 and 7.7 to 7.10.

7.5.2 Doors in enclosed superstructures and enclosed deckhouses

7.5.2.1 All access openings in the end bulkheads of enclosed superstructures and outside bulkheads of enclosed deckhouses are to be fitted with doors.

7.5.2.2 The height of the sills to access openings specified in 7.5.2.1 is to be at least 380 mm. However, the bridge or poop is to be regarded as enclosed unless access is provided for the crew to machinery and other working spaces inside these superstructures from any place in the uppermost continuous open deck or above it by alternative means which are available at all times when bulkhead openings are closed, the height of the sills of the openings in the bulkheads of such bridge or poop is to be at least 600 mm in position 1 and at least 380 mm in position 2.

7.5.2.3 The doors are to be permanently and strongly attached to the bulkhead and fitted with clamping devices or other equivalent means for expeditiously opening, closing and securing them weathertight; such devices are to be so arranged that they can be operated from both sides of the bulkhead.

The doors are to be opening outside, opening of doors inside the superstructure or deckhouse space is to be specially considered by the Register in each case.
7.5.2.4 The doors are to be weathertight when secured. The tightness is to be ensured by a rubber or other suitable gasket.

7.5.2.5 The doors are to be made of steel or other material approved by the Register.

The strength of the door is to be of equivalent strength to the unpierced bulkhead.

7.6 MACHINERY CASINGS

7.6.1 Machinery space openings in positions 1 and 2 are to be efficiently enclosed by casings of ample strength raised above the decks as far as is reasonable and practicable, and terminated themselves by a deck, or covers if a skylight is in question. The construction of the casings shall meet the Rules, Part 2 - Hull, 13.

7.6.2 Casings are to be made weathertight.

7.6.3 Casings are to be made of steel or other materials approved by Register.

7.6.4 The access openings in the casings are to be fitted with permanently attached doors which shall comply with the requirements of 7.5.2.3-7.5.2.5. The height of the sills is to be at least 600 mm in position 1 and at least 380 mm in position 2.

7.6.5 In Type "A" ships and also in Type "B" ships which are permitted to have the tabular freeboard less than that prescribed by ICLL, 1966, the engine and boiler casings are to be protected by enclosed poop or bridge of at least standard height, or by a deckhouse of equal height and equivalent strength. However, engine and boiler casings may be exposed if there are no openings giving direct access from the freeboard deck to the machinery space. A door complying with requirements of 7.5.2.3 to 7.5.2.5 may, however, be permitted in the machinery casing provided that it leads to a space or passageway which is as strongly constructed as the casing and is separated form the stairway to the engine and boiler room by a second similar door. The opening for the outside door is to be provided with a sill at least 600 mm in height, and that for the inside door with a sill of at least 230 mm in height.

7.6.6 In supply vessels the doors in the casings giving access to the engine or boiler rooms are to be located, where possible, inside the enclosed superstructure or deckhouse.

The door in the casing for access to the engine or boiler room may be fitted directly on the open cargo provided that, in addition to the first outside door, the second inside door is fitted; in this case, the outside and inside doors shall satisfy the requirements of 7.5.2.3 to 7.5.2.5, the height of the outside door sill is to be at least 600 mm, and of the inside door sill, at least 230 mm.

7.7 COMPANION HATCHES, SKYLIGHTS AND VENTILATING TRUNKS

7.7.1 Deck openings in positions 1 and 2 intended for stairways to the ship's spaces located below as well as light and air openings to these spaces are to be protected by strong companion hatches, skylights and ventilating trunks.

Where the openings intended for stairways to the ship's spaces located below are protected by superstructures or deckhouse instead of companion hatches, these superstructures or deckhouse shall comply with the requirements of 7.5.

7.7.2 The height of coamings of companion hatches, skylights and ventilating trunks is to be at least 600 mm in position 1 and at least 450 mm in position 2.

The construction of coamings shall comply with requirements of the Rules, Part 2 - Hull, 2.6.

7.7.3 All companion hatches, skylights and ventilating trunks are to be provided with covers made of steel or some other approved material and permanently attached to the coamings.

Where the covers are made of steel, the thickness of their plating is to be equal to at least 0,01 times the spacing of the stiffeners but no less than 6 mm. The minimum specified thickness of 6 mm may be reduced if the cover was formed by pressing, as shown in Figure 7.7.3 and in Table 7.7.3-1.

![Figure 7.7.3](image)

**Table 7.7.3-1**

<table>
<thead>
<tr>
<th>Casing Dimensions</th>
<th>Cover Material</th>
<th>Height of Press $h$, [mm]</th>
<th>Minimum Thickness $s$, [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>450 x 600</td>
<td>steel</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>600 x 600</td>
<td>steel</td>
<td>28</td>
<td>4</td>
</tr>
<tr>
<td>700 x 700</td>
<td>light alloy</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>800 x 800</td>
<td>steel</td>
<td>55</td>
<td>4</td>
</tr>
<tr>
<td>800 x 1200</td>
<td>light alloy</td>
<td>55</td>
<td>5</td>
</tr>
<tr>
<td>1000 x 1400</td>
<td>steel</td>
<td>90</td>
<td>5</td>
</tr>
</tbody>
</table>

On small vessels with a deck plating less than 6 mm in thickness, the thickness of the cover may be equal to the thickness of the deck, but not less than 4 mm.

7.7.4 Covers of companion hatches, skylights and ventilating trunks are to have securing devices workable at least from outside of the hatch. However, where the hatches are used as emergency exits in addition to their primary application, the securing devices are to be capable of being operated from each side of the cover.
When secured, the covers are to be weathertight. The tightness is to be provided by a rubber or other suitable gasket.

7.7.5 The glass for windows in the covers of skylights is to be hardened and at least 6 mm thick if the inner diameter is 150 mm and below, and at least 12 mm with the inner diameter of 450 mm.

For intermediate inner diameters, the thickness of glass is to be determined by liner interpolation. However, where wire-reinforced glass is used, its thickness may be 5 mm, and the requirement relating to its hardening is not to be applicable.

Glass is to be efficiently attached to the covers by means of a frame and have on its contour a weathertight gasket of rubber or other equivalent material.

Windows in the covers of skylights fitted in machinery spaces shall comply with the requirements of the Rules, Part 17 - Fire protection, 2.1.

7.7.6 Each window or group of adjacent windows is to be provided with portable shields of the same material as the cover being at least 3 mm in thickness and capable of being efficiently fastened outside the cover by means of ear-nuts; such portable shields are to be stowed adjacent to the skylights.

7.8 VENTILATORS

7.8.1 Ventilators to spaces below freeboard deck or deck of enclosed superstructures and deckhouses are to be fitted with coamings efficiently connected to the deck. The coamings of ventilators are to be at least 900 mm in height in position 1 and at least 760 mm in position 2.

The thickness of the coaming plates is to be 7.5 mm where the clear opening sectional area of the ventilator coamings is 300 cm² or less, and 10 mm where the clear opening sectional area exceeds 1600 cm². Intermediate values are to be determined by direct interpolation. A thickness of 6 mm is generally to be sufficient within not permanently closed superstructures.

7.8.2 Ventilators in position 1 the coamings of which extend to more than 4500 mm above the deck and in position 2 the coamings of which extend to more than 2300 mm above the deck need not be fitted with closing appliances. In all other cases, each ventilator is to be fitted with a strong cover made of steel or other material approved by the Register.

In ships of less than 100 m in length, the covers are to be permanently attached; in ships of 100 mm in length and over they may be conveniently stowed near the ventilators to which they are to be fitted.

7.8.3 When secured, the covers of ventilators are to be weathertight. The tightness is to be provided by a rubber or other suitable gasket.

7.8.4 In supply vessels, in order to minimise the possibility of flooding of the spaces situated below, the ventilators are to be positioned in the protected locations where the probability of their damage by cargo is excluded during cargo handling operations. Particular attention is to be given to the arrangement of ventilators of the engine and boiler rooms for which the location is preferable above the deck level of the first tier of superstructures or deckhouses.

7.8.5 The ventilation of machinery spaces shall be according to the principles laid down in SOLAS Regulation II-1/35 and supplied through suitably protected openings arranged in such a way that they can be used in all weather conditions, taking into account Reg.17(3) and Reg.19 of the 1966 Load Line Convention as amended by the Protocol of 1988.

The machinery spaces are those defined in SOLAS Regulation II-1/3.16.

7.9 MANHOLES

7.9.1 Covers of manholes are to be made of steel or other approved material.

Thickness of the covers is not to be less than that of the plating on which they are fitted. In some cases it may be permitted to decrease the thickness of the covers provided the thickness of plating is greater than 12 mm.

7.9.2 The covers of manholes are to be efficiently attached to the coaming or doubling ring by means of bolts or pins with nuts.

7.9.3 When secured, the covers are to be tight under inner pressure of water or other liquids, for which the tanks are intended, up to the top of the air pipe. The tightness is to be provided by a rubber or other suitable gasket. The gasket is to be resistant to the liquid cargoes referred to above.

7.10 HATCHWAYS OF DRY CARGO HOLDS

7.10.1 General

7.10.1.1 The deck openings through which cargoes or ship's stores are loaded and unloaded are to be protected by strong hatchways. If these hatchways are situated in positions 1 and 2 (section 7.1.4), the hatchway covers are to be weathertight. The tightness is to be provided by one of the following two methods:

1. closed by portable covers and secured weathertight by tarpaulins and battening devices;
2. by weathertight covers made of steel or other equivalent material fitted with rubber or other suitable gaskets and clamping devices.

7.10.1.2 The strength requirements are applicable to hatch covers and hatch coamings of stiffened plate construction and its closing arrangements.

7.10.1.3 These requirements are applicable to hatch covers and coamings made of steel. In case of alternative materials and innovative designs the approval is subject to special consideration of the Register.

7.10.1.4 These requirements don't apply to portable covers secured weathertight by tarpaulins and battening devices, or pontoon covers, as defined in ICLL Regulation 15.
7.10.1.5 Hatchways on freeboard and superstructure decks are to have coamings, the minimum height of which above the deck is to be as follows:
- in position 1: 600 mm
- in position 2: 450 mm

7.10.1.6 The height of coamings of the hatchways specified in 7.10.1.2 may be decreased in relation to that prescribed by 7.10.1.5 or the coamings may be omitted entirely where the efficiency of the cover tightness and securing means will satisfy the Register.

7.10.1.7 Where an increased freeboard is assigned, the height of hatchway coamings according to 7.10.1.5 on the actual freeboard deck may be as required for a superstructure deck, provided the summer freeboard is such that the resulting draught will not be greater than that corresponding to the minimum freeboard calculated from an assumed freeboard deck situated at a distance equal to a standard superstructure height below the actual freeboard deck.

7.10.1.8 Coamings are not to be required for hatchways below the freeboard deck or within weathertight closed superstructure unless they are required for the strength purposes.

7.10.1.9 Coamings which are 600 mm or more in height are to be stiffened by a horizontal stiffener. Where the unsupported height of a coaming exceeds 1.2 m additional stiffeners are to be arranged. Additional stiffeners may be dispensed with if this is justified by the ship's service and if sufficient strength is verified (e.g. in case of container ships).

7.10.1.10 For hatchway coamings which are designed on the basis of strength calculations as well as for hatch girders, cantilevers and pillars, see Part 2, Section 9.

For structural members welded to coamings and for cutouts in the top of coaming sufficient fatigue strength according to Part 2, Section 16 is to be verified.

7.10.1.11 Hatchway coamings are to be adequately supported by stays.

7.10.1.12 Hatch coamings and supporting structures are to be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions.

Coaming stays are to be supported by appropriate substructures.

Under deck structures are to be designed under consideration of permissible stresses according to 7.10.3.1.

7.10.1.13 Adequate safety against buckling according to Section 4, 4.6 is to be proved for longitudinal coamings which are part of the longitudinal hull structure.

7.10.1.14 The connection of the coamings to the deck at the hatchway corners is to be carried out with special care. For bulk carriers, see also Part 2, Section 17, 17.2.8.

7.10.1.15 For rounding of hatchway corners, see also Part 2, Section 6, 6.1.3.

7.10.1.16 For application of the corrosion margin required by Regulation 16 (5)(d) of the ICLL, 1996 (Res. MSC. 143(77), see 7.10.7, 7.10.8.6 and IACS Unified Interpretation LL70.

7.10.2 Evaluation of scantlings of hatch covers and hatch coamings and clashing arrangements of cargo holds of ships

7.10.2.1 Application

The requirements of the Section 7.10.2 to Section 7.10.7 apply to all ships except bulk carriers, self-unloading bulk carriers, ore carriers and combination carriers, as defined in the Rules, Part 1 – General Requirements, Chapter 1 – General Information, 4.2.5.5, and are for all cargo hatch covers and coamings on exposed decks.

These requirements are in addition to the requirements of the ICLL.

For evaluation of scantling of hatch covers and hatch coamings of cargo holds of bulk carriers, ore carriers and combination carriers, see 7.10.8.

7.10.2.2 Definition

ICLL Where ICLL is referred to in the text, this is to be taken as the International Convention on Load Lines, 1966 as amended by the 1988 protocol, as amended in 2003.

7.10.2.2.1 Hatch cover types

7.10.2.2.1.1 Single skin cover

A hatch cover made of steel or equivalent material that is designed to comply with ICLL Regulation 16. The cover has continuous top and side plating, but is open underneath with the stiffening structure exposed. The cover is weathertight and fitted with gaskets and clamping devices unless such fittings are specifically excluded.

7.10.2.2.1.2 Double skin cover

A hatch cover as above but with continuous bottom plating such that all the stiffening structure and internals are protected from the environment.

7.10.2.2.1.3 Pontoon type cover

A special type of portable cover, secured weathertight by tarpaulins and battening devices. Such covers are to be designed in accordance with ICLL Regulation 15 and are not covered by these requirements.

Clarification note:

Modern hatch cover designs of lift-away-covers are in many cases called pontoon covers. This definition does not fit to the definition above. Modern lift-away hatch cover designs should belong to one of the two categories single skin covers or double skin cover.

7.10.2.2.2 Positions

The hatchways are classified according to their position as follows:

Position 1 Upon exposed freeboard and raised quarter-decks, and upon exposed superstructure decks situated forward of a point located a quarter of ship’s length from forward perpendicular.
Position 2  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 the superstructure above the freeboard deck.
Upon exposed superstructure decks situated forward of a point located a quarter of the ship’s length from the forward perpendicular and located at least two standard height of the superstructure above the freeboard deck.

7.10.2.3 Material
Hatch covers and coamings are to be made of material in accordance with the definitions of the Rules, Part 2 – Hull, 1.4.2. A material class I is to be applied for top plate, bottom plate and primary supporting members.

7.10.2.4 General requirements
Primary supporting members and secondary stiffeners of hatch covers are to be continuous over the breadth and length of hatch covers, as far as practical. When this is impractical, snipped end connections are not to be used and appropriate arrangements are to be adopted to provide sufficient load carrying capacity.

The spacing of primary supporting members parallel to the direction of secondary stiffeners is not to exceed 1/3 of the span of primary supporting members. When strength calculation is carried out by FE analysis using plane strain or shell elements, this requirement can be waived.
Secondary stiffeners of hatch coamings are to be continuous over the breadth and length of hatch coamings.

7.10.2.5 Net scantling approach
Unless otherwise quoted, the thicknesses \( t \) of the following sections are net thicknesses.
The net thicknesses are the member thicknesses necessary to obtain the minimum net scantlings required by 7.10.3 and 7.10.5.
The required gross thicknesses are obtained by adding corrosion additions, \( t_s \) given in Table 7.10.7.1 in 7.10.7.1.
Strength calculations using beam theory, grillage analysis or FEM are to be performed with net scantlings.

7.10.2.6 Hatch cover and coaming load model
Structural assessment of hatch covers and hatch coamings is to be carried out using the design loads, defined in this chapter.

Definitions
\[ L = \text{length of ship, in [m], as defined in 1.2.2.1} \]
\[ L_{LL} = \text{length of ship, in [m], as defined in ICLL Regulation 3} \]
\[ x = \text{longitudinal co-ordinate of mid point of assessed structural member measured from aft end of length } L \text{ or } L_{LL}, \text{ as applicable} \]
\[ D_{\text{min}} = \text{the least moulded depth, in [m], as defined in ICLL Regulation 3} \]

\[ h_N = \text{standard superstructure height, in [m]} \]
\[ = 1.05 + 0.01L_{LL}, 1.8 \leq h_N \leq 2.3 \]

7.10.2.6.1 Vertical weather design load
The pressure \( p_h \), in [kN/m²], on the hatch cover panels is given by ICLL. This may be taken from Table 7.10.2.6.1. The vertical weather design load needs not to be combined with cargo loads according to 7.10.2.6.3 and 7.10.2.6.4.
In Fig.7.10.2.6.1-1 the positions 1 and 2 are illustrated for an example ship.
Where an increased freeboard is assigned, the design load for hatch covers according to Tab. 7.10.2.6.1 on the actual freeboard deck may be as required for a superstructure deck, provided the summer freeboard is such that the resulting draught will not be greater than that corresponding to the minimum freeboard calculated from an assumed freeboard deck situated at a distance at least equal to the standard superstructure height \( h_N \) below the actual freeboard deck, see Fig.7.10.2.6.1-2.
Table 7.10.2.6.1  Design load $p_H$ of weather deck hatches

<table>
<thead>
<tr>
<th>Position</th>
<th>Design load $p_H$ [kN/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\frac{x}{L_{ll}} \leq 0.75$</td>
</tr>
<tr>
<td>for $24 \leq L_{ll} \leq 100$ m</td>
<td>on freeboard deck</td>
</tr>
<tr>
<td></td>
<td>upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck</td>
</tr>
<tr>
<td>for $L_{ll} &gt; 100$ m</td>
<td>on freeboard deck for type B ships according to ICC</td>
</tr>
<tr>
<td></td>
<td>on freeboard deck for ships with less freeboard than type B according to ICC</td>
</tr>
<tr>
<td></td>
<td>$L_{f} = L_{ll}$ but not more than 340 m</td>
</tr>
<tr>
<td></td>
<td>upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck</td>
</tr>
<tr>
<td>for $24 \leq L_{ll} \leq 100$ m</td>
<td>$\frac{9.81}{76} (1.1 \cdot L_{ll} + 87.6)$</td>
</tr>
<tr>
<td>for $L_{ll} &gt; 100$ m</td>
<td>$9.81 \cdot 2.1$</td>
</tr>
<tr>
<td></td>
<td>upon exposed superstructure decks located at least one superstructure standard height above the lowest Position 2 deck</td>
</tr>
</tbody>
</table>
* reduced load upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck

** reduced load upon exposed superstructure decks of vessels with $L_{LL} > 100$ m located at least one superstructure standard height above the lowest Position 2 deck

**Figure 7.10.2.6.1-1** Positions 1 and 2

* reduced load upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck

** reduced load upon exposed superstructure decks of vessels with $L_{LL} > 100$ m located at least one superstructure standard height above the lowest Position 2 deck

**Figure 7.10.2.6.1-2** Positions 1 and 2 for an increased freeboard
7.10.2.6.2 Horizontal weather design load

The horizontal weather design load, in [kN/m²], for determining the scantlings of outer edge girders (skirt plates) of weather deck hatch covers and of hatch coamings is:

\[ p_A = a \cdot \left( b \cdot c L \cdot f - z \right) \]

\[ f = \frac{L}{25} + 4.1, \quad \text{for } L < 90 \text{ m} \]
\[ = 10.75 \cdot \left( \frac{300 - L}{100} \right)^{1/3}, \quad \text{for } 90 \text{ m} \leq L < 300 \text{ m} \]
\[ = 10.75, \quad \text{for } 300 \text{ m} \leq L < 350 \text{ m} \]
\[ = 10.75 \cdot \left( \frac{L - 350}{150} \right)^{1/3}, \quad \text{for } 350 \text{ m} \leq L \leq 500 \text{ m} \]

\[ c_L = \sqrt{\frac{L}{90}}, \quad \text{for } L < 90 \text{ m} \]
\[ = 1, \quad \text{for } L \geq 90 \text{ m} \]

\[ a = 20 + \frac{L}{12}, \quad \text{for unprotected front coamings and hatch cover skirt plates} \]

\[ a = 10 + \frac{L}{12}, \quad \text{for unprotected front coamings and hatch cover skirt plates, where the distance from the actual freeboard deck to the summer load line exceeds the minimum non-corrected tabular freeboard according to } I C L L \text{ by at least one standard superstructure height } h_N \]

\[ a = 5 + \frac{L}{15}, \quad \text{for side and protected front coamings and hatch cover skirt plates} \]

\[ a = 7 + \frac{L}{100} - \frac{8 \cdot x'}{L}, \quad \text{for aft ends of coamings and hatch cover skirt plates abaft amidships} \]

\[ a = 5 + \frac{L}{100} - 4 \cdot \frac{x'}{L}, \quad \text{for aft ends of coamings and hatch cover skirt plates forward of amidships} \]

\[ L_1 = L, \quad \text{need not be taken greater than } 300 \text{ m} \]

\[ b = 1,0 + \left( \frac{x'}{L} - 0,45 \right)^{1/2}, \quad \text{for } \frac{x'}{L} < 0,45 \]

\[ = 1,0 + 1,5 \cdot \left( \frac{x'}{L} - 0,45 \right)^{1/2}, \quad \text{for } \frac{x'}{L} \geq 0,45 \]

\[ 0,6 \leq C_g \leq 0,8, \text{when determining scantlings of aft ends of coamings and hatch cover skirt plates forward of amidships, } C_g \text{ need not be taken less than } 0,8. \]

\[ x' = \text{distance, in [m], between the transverse coaming or hatch cover skirt plate considered and aft end of the length } L. \] When determining side coamings or side hatch cover skirt plates, the side is to be subdivided into parts of approximately equal length, not exceeding 0,15-L each, and \( x' \) is to be taken as the distance between aft end of the length \( L \) and the centre of each part considered.

\[ z = \text{vertical distance, in [m], from the summer load line to the midpoint of stiffener span, or to the middle of the plate field} \]

\[ c = 0,3 + 0,7 \cdot \left( \frac{L}{B'} \right) \]

\[ b' = \text{breadth of coaming in m at the position considered} \]

\[ B' = \text{actual maximum breadth of ship, in [m], on the exposed weather deck at the position considered.} \]

\[ b'/B' \text{ is not to be taken less than } 0,25. \]

The design load \( p_A \) is not to be taken less than the minimum values given in Table 7.10.2.6.2.

| \( L \) | \( P_{A_{\text{min}}} \), in [kN/m²], for |
|---|---|---|
| | unprotected fronts | elsewhere |
| \leq 50 | 30 | 15 |
| > 50 | \( 25 + \frac{L}{10} \) | \( 12,5 + \frac{L}{20} \) |
| < 250 | 50 | 25 |

Note:

The horizontal weather design load need not be included in the direct strength calculation of the hatch cover, unless it is utilized for the design of substructures of horizontal support according to 7.10.6.2.3.

7.10.2.6.3 Cargo loads

7.10.2.6.3.1 Distributed loads

The load on hatch covers due to distributed cargo loads \( p_L \), in [kN/m²], resulting from heave and pitch (i.e. ship in upright condition) is to be determined according to the following formula:

\[ p_L = p_C \left( 1 + a_v \right) \]

where:

\[ p_C = \text{uniform cargo load, in [kN/m²]}, \]
\[ a_v = \text{vertical acceleration addition as follows:} \]
\[ a_v = F \cdot m \]
\[ F = 0,11 \cdot \frac{v_h}{\sqrt{L}} \]
\[ m = m_0 - 5 \left( m_0 - 1 \right) \cdot \frac{x}{L}, \quad \text{for } 0 \leq \frac{x}{L} \leq 0,2 \]
\[ = 1,0, \quad \text{for } 0,2 \leq \frac{x}{L} \leq 0,7 \]
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\[
= 1 + \frac{m_0 + 1}{0.3}\left[\frac{x}{L} - 0.7\right]
\]

for \(0.7 < \frac{x}{L} \leq 1.0\).

\(m_0 = 1.5 + F\),

\(v_0 = \) maximum speed at summer load line draught, \(v_0\) is not to be taken less than \(\sqrt{L}\), in [knots].

7.10.2.6.3.2 Point loads

The load \(P\), in [kN], due to a concentrated force \(P_s\), in [kN], except for container load resulting from heave and pitch (i.e. ship in upright condition) is to be determined as follows:

\[
P = P_s(1 + a_v).
\]

7.10.2.6.4 Container loads

7.10.2.6.4.1 The loads defined in 7.10.2.6.4.2 and 7.10.2.6.4.4 are to be applied where containers are stowed on the hatch cover.

7.10.2.6.4.2 The load \(P\), in [kN], applied at each corner of a container stack, and resulting from heave and pitch (i.e. ship in upright condition) is to be determined as follows:

\[
P = 9.81\frac{M}{4}(1 + a_v)
\]

where:

\(a_v = \) acceleration addition according to 7.10.2.6.3.1

\(M = \) maximum designed mass of container stack, in [t].

7.10.2.6.4.3 The loads, in [kN], applied at each corner of a container stack, and resulting from heave, pitch, and the ship’s rolling motion (i.e. ship in heel condition) are to be determined as follows, see also Fig 7.10.2.4.

\[
A = 9.81\frac{M}{2}(1 + a_v)\left(0.45 - 0.42\frac{h_m}{b}\right)
\]

\[
B = 9.81\frac{M}{2}(1 + a_v)\left(0.45 + 0.42\frac{h_m}{b}\right)
\]

\(B = 2.4 \cdot M\)

where:

\(a_v = \) acceleration addition according to 7.10.2.6.3.1,

\(M = \) maximum designed mass of container stack, in [t],

\(h_m = \) designed height of centre of gravity of stack above hatch cover top, in [m], may be calculated as weighted mean value of the stack, where the centre of gravity of each tier is assumed to be located at the centre of each container,

\[
e = \sum_{i=1}^{n}(z_i \cdot W_i)/M
\]

\(z_i = \) distance from hatch cover top to the centre of \(i\)th container, in [m],

\(W_i = \) weight of \(i\)th container, in [t],

\(b = \) distance between midpoints of foot points, in [m].

\(A, B = \) support forces in z-direction at the forward and aft stack corners,

\(B = \) support force in y-direction at the forward and aft stack corners.

When strength of the hatch cover structure is assessed by grillage analysis according to 7.10.3.5, \(h_m\) and \(z_i\) need to be taken above the hatch cover supports. Forces \(B\) does not need to be considered in this case.

Values of \(A\) and \(B\) applied for the assessment of hatch cover strength are to be shown in the drawings of the hatch covers.

Note:

It is recommended that container loads as calculated above are considered as limit for foot point loads of container stacks in the calculations of cargo securing (container lashing).

![Figure 7.10.2.6.4 Forces due to container loads](image)

7.10.2.6.4.4 Load cases with partial loading

The load cases defined in 7.10.2.6.4.2 and 7.10.2.6.4.3 are also to be considered for partial non homogeneous loading which may occur in practice, e.g. where specified container stack places are empty. For each hatch cover, the heel directions, as shown in Table 7.10.2.6.4.4, are to be considered.

The load case partial loading of container hatch covers can be evaluated using a simplified approach, where the hatch cover is loaded without the outermost stacks that are located completely on the hatch cover. If there are additional stacks that are supported partially by the hatch cover and partially by container stanchions then the loads from these stacks are also to be neglected, refer to Table 7.10.2.6.4.4 Partial loading of container hatch covers.

In addition, the case where only the stack places supported partially by the hatch cover and partially by container stanchions are left empty is to be assessed in order to consider the maximum loads in the vertical hatch cover supports.

It may be necessary to also consider partial load cases where more or different container stack places are left empty. Therefore, the Register may require that additional partial load cases be considered.
Table 7.10.2.6.4.4 Partial loading of container hatch covers

<table>
<thead>
<tr>
<th>Heel direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatch covers supported by the longitudinal hatch coaming with all container stacks located completely on the hatch cover</td>
</tr>
<tr>
<td>Hatch covers supported by the longitudinal hatch coaming with the outermost container stack supported partially by the hatch cover and partially by container stanchions</td>
</tr>
<tr>
<td>Hatch covers not supported by the longitudinal hatch coaming (center hatch covers)</td>
</tr>
</tbody>
</table>

7.10.2.6.4.5 Mixed stowage of 20' and 40' containers on hatch cover

In the case of mixed stowage (20'+40' container combined stack), the foot point forces at the fore and aft end of the hatch cover are not to be higher than resulting from the design stack weight for 40'containers, and the foot point forces at the middle of the cover are not to be higher than resulting from the design stack weight for 20'containers.

7.10.2.6.5 Loads due to elastic deformations of the ship's hull

Hatch covers, which in addition to the loads according to 7.10.2.6.1 to 7.10.2.6.4 are loaded in the ship's transverse direction by forces due to elastic deformations of the ship's hull, are to be designed such that the sum of stresses does not exceed the permissible values given in 7.10.3.1.1.
7.10.3 Hatch cover strength criteria

7.10.3.1 Permissible stresses and deflections

7.10.3.1.1 Stresses

The equivalent stress $\sigma_v$ in steel hatch cover structures related to the net thickness shall not exceed $0.8 \times R_{eff}$, where $R_{eff}$ is the minimum yield stress, in [N/mm²], of the material. For design loads according to 7.10.2.6.2 to 7.10.2.6.5, the equivalent stress $\sigma_v$ related to the net thickness shall not exceed $0.9 \times R_{eff}$ when the stresses are assessed by means of FEM.

For steels with a minimum yield stress of more than 355 N/mm², the value of $R_{eff}$ to be applied throughout this requirement is subject to the Register but is not to be more than the minimum yield stress of the material.

For grillage analysis, the equivalent stress may be taken as follows:

$$\sigma_v = \sqrt{\sigma^2 + 3\tau^2}, \text{ in [N/mm}^2\text{]}.$$

where:

- $\sigma$ = normal stress, in [N/mm²].
- $\tau$ = shear stress, in [N/mm²].

For FEM calculations, the equivalent stress may be taken as follows:

$$\sigma_v = \sqrt{\sigma_x^2 + \sigma_y^2 + 3\tau^2}, \text{ in [N/mm}^2\text{]}$$

where:

- $\sigma_x$ = normal stress, in [N/mm²], in $x$-direction.
- $\sigma_y$ = normal stress, in [N/mm²], in $y$-direction.
- $\tau$ = shear stress, in [N/mm²], in the $x$-$y$ plane.

Indices $x$ and $y$ are coordinates of a two-dimensional Cartesian system in the plane of the considered structural element.

In case of FEM calculations using shell or plane strain elements, the stresses are to be read from the centre of the individual element. It is to be observed that, in particular, at flanges of unsymmetrical girders, the evaluation of stress from element centre may lead to non-conservative results. Thus, a sufficiently fine mesh is to be applied in these cases or, the stress at the element edges shall not exceed the allowable stress. Where shell elements are used, the stresses are to be evaluated at the mid plane of the element.

Stress concentrations are to be assessed to the satisfaction of the Register.

7.10.3.1.2 Deflection

The vertical deflection of primary supporting members due to the vertical weather design load according to 7.10.2.6.1 is to be not more than $0.0056 \times l$, where $l$ is the greatest span of primary supporting members.

Note:

Where hatch covers are arranged for carrying containers and mixed stowage is allowed, i.e., a 40'-container stowed on top of two 20'-containers, particular attention should be paid to the deflections of hatch covers. Further the possible contact of deflected hatch covers with in hold cargo has to be observed.

7.10.3.2 Local net plate thickness

The local net plate thickness $t$, in [mm], of the hatch cover top plating is not to be less than:

$$t = F_p \cdot 15.8 \cdot \frac{p}{0.95 \times R_{eff}}$$

and to be not less than 1% of the spacing of the stiffener or 6 mm if that be greater.

$F_p$ = factor for combined membrane and bending response,

= 1.5 in general,

= $1.9 \cdot \frac{\sigma_s}{\sigma_y}\geq 0.8$ for the attached plate flange of primary supporting members.

where:

- $s$ = stiffener spacing, in [m].
- $p$ = pressure $p_H$ and $p_L$, in [kN/m²], as defined in 7.10.2.6.
- $\sigma$ = maximum normal stress, in [N/mm²], of hatch cover top plating, determined according to Fig. 7.10.3.2.

$\sigma_a = 0.8 \times R_{eff}$, in [N/mm²].

For flange plates under compression sufficient buckling strength according to 7.10.3.6.5 is to be demonstrated.

![Figure 7.10.3.2 Determination of normal stress of the hatch cover plating](image)

7.10.3.2.1 Local net plate thickness of hatch covers for wheel loading

The local net plate thickness of hatch covers for wheel loading have to be derived from the Rules, Part 2 – Hull, Section 6.

7.10.3.2.2 Lower plating of double skin hatch covers and box girders

The thickness to fulfill the strength requirements is to be obtained from the calculation according to 7.10.3.5.
7.10.3.3 Net scantling of secondary stiffeners

The net section modulus $W$ and net shear area $A_s$ of uniformly loaded hatch cover stiffeners constraint at both ends must not be less than:

$$W = \frac{104 \cdot p_{sl} \cdot l^2}{R_{st}}, \text{ in } [\text{cm}^3], \text{ for design load according to 7.10.2.6.1;}$$

$$W = \frac{93 \cdot p_{sl} \cdot l^2}{R_{st}}, \text{ in } [\text{cm}^3], \text{ for design load according to 7.10.2.6.3.1;}$$

$$A_s = \frac{10.8 \cdot p_{sl}}{R_{st}}, \text{ in } [\text{cm}^2], \text{ for design load according to 7.10.2.6.1;}$$

$$A_s = \frac{9.6 \cdot p_{sl}}{R_{st}}, \text{ in } [\text{cm}^2], \text{ for design load according to 7.10.2.6.3.1;}$$

where:

$W$ = net section modulus, [cm$^3$];

$A_s$ = net shear area, [cm$^2$];

$p_{sl}$ = pressure $p_{sl}$ and $p_{sl}$, in [kN/m$^2$], as defined in 7.10.2.

For secondary stiffeners of lower plating of double skin hatch covers, requirements mentioned above are not applied due to the absence of lateral loads.

The net thickness, in mm, of the stiffener (except U-beams/trapeze stiffeners) web is to be taken not less than 4 mm.

The net thickness of the lower plating is to be taken not less than 5 mm. When project cargo, e.g., timber, pipes or steel coils need not to be considered as project cargo.

When the lower plating is not considered as a strength member of the hatch cover, the thickness of the lower plating should be determined according to the *Rules, Part 2 – Hull*.

### 7.10.3.4 Net scantling of primary supporting members

#### 7.10.3.4.1 Primary supporting members

Scantlings of primary supporting members are obtained from calculations according to 7.10.3.5 under consideration of permissible stresses according to 7.10.3.1.1.

For all components of primary supporting members sufficient safety against buckling must be verified according to 7.10.3.6. For biaxial compressed flange plates this is to be verified within the effective widths according to 7.10.3.6.3.2.

The net thickness, in [mm], of webs of primary supporting members shall not be less than:

$$t = 6.5 \cdot s, \text{ in } [\text{mm}],$$

where:

$s$ = stiffener spacing, in [m].

#### 7.10.3.4.2 Edge girders (Skirt plates)

Scantlings of edge girders are obtained from the calculations according to 7.10.3.5 under consideration of permissible stresses according to 7.10.3.1.1.

The net thickness, in [mm], of the outer edge girders exposed to wash of sea shall not be less than the largest of the following values:

$$t = \frac{15.8 \cdot s \cdot \sqrt{\frac{p_{sl}}{0.95 \cdot R_{st}}}}{t_{min} = 5 \text{ mm}},$$

where:

$s$ = stiffener spacing, in [m].
\( P_A \) = horizontal pressure as defined in 7.10.2.6.2.
The stiffness of edge girders is to be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia, in \( \text{cm}^4 \), of edge girders is not to be less than:
\[
I = 6 \cdot q \cdot s_{SD}^4
\]
where:
\( q \) = packing line pressure, in \( \text{N/mm} \), minimum 5 \( \text{N/mm} \),
\( s_{SD} \) = spacing, in \( \text{m} \), of securing devices.

### 7.10.3.5 Strength calculations

Strength calculation for hatch covers may be carried out by either grillage analysis or FEM. Double skin hatch covers or hatch covers with box girders are to be assessed using FEM, refer to 7.10.3.5.2.

#### 7.10.3.5.1 Effective cross-sectional properties for calculation by beam theory or grillage analysis

Cross-sectional properties are to be determined considering the effective breadth. Cross sectional areas of secondary stiffeners parallel to the primary supporting member under consideration within the effective breadth can be included, refer Fig. 7.10.3.6.

The effective breadth of plating \( e_m \) of primary supporting members is to be determined according to Table 7.10.3.5.1, considering the type of loading. Special calculations may be required for determining the effective breadth of one-sided or non-symmetrical flanges.

The effective cross sectional area of plates is not to be less than the cross sectional area of the face plate.

For flange plates under compression with secondary stiffeners perpendicular to the web of the primary supporting member, the effective width is to be determined according to 7.10.3.6.3.2.

<table>
<thead>
<tr>
<th>( l/e )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>( \bar{0}8 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e_{m1}/e )</td>
<td>0</td>
<td>0.36</td>
<td>0.64</td>
<td>0.82</td>
<td>0.91</td>
<td>0.96</td>
<td>0.98</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>( e_{m2}/e )</td>
<td>0</td>
<td>0.20</td>
<td>0.37</td>
<td>0.52</td>
<td>0.65</td>
<td>0.75</td>
<td>0.84</td>
<td>0.89</td>
<td>0.90</td>
</tr>
</tbody>
</table>

\( e_{m1} \) is to be applied where primary supporting members are loaded by uniformly distributed loads or else by not less than 6 equally spaced single loads

\( e_{m2} \) is to be applied where primary supporting members are loaded by 3 or less single loads

Intermediate values may be obtained by direct interpolation.

\( l \) = length of zero-points of bending moment curve:

\( l = l_0 \) for simply supported primary supporting members

\( l = 0.6 \cdot l_0 \) for primary supporting members with both ends constraint,

where \( l_0 \) is the unsupported length of the primary supporting member

\( e \) = width of plating supported, measured from centre to centre of the adjacent unsupported fields

#### 7.10.3.5.2 General requirements for FEM calculations

For strength calculations of hatch covers by means of finite elements, the cover geometry shall be idealized as realistically as possible. Element size must be appropriate to account for effective breadth. In no case element width shall 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 shall not exceed 4.

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

#### 7.10.3.6 Buckling strength of hatch cover structures

For hatch cover structures sufficient buckling strength is to be demonstrated.

The buckling strength assessment of coaming parts is to be done according to the Rules, Part 2 – Hull, 4.6.

**Definitions**

\( a \) = length of the longer side of a single plate field, in \( \text{mm} \), \( (x) \)-direction, see Fig. 7.10.3.6,

\( b \) = breadth of the shorter side of a single plate field, in \( \text{mm} \), \( (y) \)-direction, see Fig. 7.10.3.6,

\( \alpha \) = aspect ratio of single plate field, 

\( = a/b \)

\( n \) = number of single plate field breadths within the partial or total plate field,
Compressive and shear stresses are to be taken positive, tension stresses are to be taken negative.

**Table 7.10.3.6** Correction factor $F_i$

<table>
<thead>
<tr>
<th>Stiffeners sniped at both ends</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guidance values$^1$ where both ends are effectively connected to adjacent structures</td>
<td>1.05 for flat bars, 1.10 for bulb sections, 1.20 for angle and tee-sections, 1.30 for u-type sections$^2$ and girders of high rigidity</td>
</tr>
</tbody>
</table>

An average value of $F_i$ is to be used for plate panels having different edge stiffeners.

$^1$ Exact values may be determined by direct calculations.

$^2$ Higher value may be taken if it is verified by a buckling strength check of the partial plate field using non-linear FEA and deemed appropriate by the Register but not greater than 2.0.

$$
\sigma_k = \text{reference stress, in [N/mm²], taken equal to } \left(0.9 : E \left( \frac{t}{b} \right)^2 \right)
$$

$$
\psi = \text{edge stress ratio taken equal to } \frac{\sigma_k}{\sigma_k}
$$

Where: $\sigma_k = \text{maximum compressive stress}$, $\sigma_k = \text{minimum compressive stress or tension stress}$.

$S = \text{safety factor (based on net scantling approach), taken equal to: }$

- 1.25 for hatch covers when subjected to the vertical weather design load according to 7.10.2.1,
- 1.10 for hatch covers when subjected to loads according to 7.10.2.2 to 7.10.2.5.

$\lambda = \text{reference degree of slenderness, taken equal to: }$

$$
\lambda = \sqrt{\frac{R_{ult}}{K \cdot \sigma_e}}
$$

$K = \text{buckling factor according to Table 7.10.3.6.1-2.}$

**Table 7.10.3.6.1** Coefficients $\epsilon_1, \epsilon_2, \epsilon_3$ and factor $B$

<table>
<thead>
<tr>
<th>Exponents $\epsilon_1 - \epsilon_3$ and factor $B$</th>
<th>Plate panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\epsilon_1$</td>
<td>$1 + \kappa_k^4$</td>
</tr>
<tr>
<td>$\epsilon_2$</td>
<td>$1 + \kappa_k^4$</td>
</tr>
<tr>
<td>$\epsilon_3$</td>
<td>$1 + \kappa_k \cdot \kappa_k^2$</td>
</tr>
<tr>
<td>$B$</td>
<td>$\sigma_k$ and $\sigma_k$ positive (compression stress) $\left(\kappa_k \cdot \kappa_k^2\right)^6$</td>
</tr>
<tr>
<td>$\sigma_k$, $\sigma_k$ negative (tension stress)</td>
<td>1</td>
</tr>
</tbody>
</table>
### Table 7.10.3.6.1-2  Buckling and reduction factors for plane elementary plate panels

<table>
<thead>
<tr>
<th>Buckling-Load Case</th>
<th>Edge stress ratio $\psi$</th>
<th>Asp. ratio $\alpha = a/b$</th>
<th>Buckling factor $K$</th>
<th>Reduction factor $\kappa$</th>
</tr>
</thead>
</table>
| 1                  | $1 \geq \psi \geq 0$     | $\alpha \geq 1$          | $K = \frac{8.4}{\psi + 1.1}$ | $\kappa_x = 1$ for $\lambda \leq \lambda_c$  
$\kappa_x = \frac{1}{\lambda} - \frac{0.22}{\lambda^2}$ for $\lambda > \lambda_c$ |
|                    | $0 > \psi > -1$          | $\psi \leq -1$           | $K = 7.63 - \psi (6.26 - 10\psi)$ | $c = (1.25 - 0.12\psi) \leq 1.25$  
$\lambda_c = \frac{c}{2} \left(1 + \sqrt{1 - \frac{0.88}{c}}\right)$ |
| 2                  | $1 \geq \psi \geq 0$     | $\alpha \geq 1$          | $K = F_1 \left[1 + \frac{1}{\alpha^2}\right]^2 \cdot \frac{2.1}{\psi + 1.1}$ | $\kappa_y = \frac{1}{\lambda} - \frac{R + F^2 (H - R)}{\lambda^2}$  
$c = (1.25 - 0.12\psi) \leq 1.25$  
$R = \frac{1 - \frac{\lambda}{\lambda_c}}{c}$ for $\lambda < \lambda_c$  
$R = 0.22$ for $\lambda \geq \lambda_c$  
$\lambda_c = \frac{c}{2} \left(1 + \sqrt{1 - \frac{0.88}{c}}\right)$ |
|                    | $1 \leq \alpha \leq 1.5$ | $0 > \psi > -1$           | $K = F_1 \left[1 + \frac{1}{\alpha^2}\right]^2 \cdot \frac{2.1(1 + \psi)}{1.1}$  
$- \frac{\psi}{\alpha^2}(13.9 - 10\psi)$ | $\kappa_y = \frac{1}{\lambda} - \frac{R + F^2 (H - R)}{\lambda^2}$  
$c = (1.25 - 0.12\psi) \leq 1.25$  
$R = \frac{1 - \frac{\lambda}{\lambda_c}}{c}$ for $\lambda < \lambda_c$  
$R = 0.22$ for $\lambda \geq \lambda_c$  
$\lambda_c = \frac{c}{2} \left(1 + \sqrt{1 - \frac{0.88}{c}}\right)$ |
|                    | $\alpha > 1.5$           | $\alpha > 1.5$           | $K = F_1 \left[1 + \frac{1}{\alpha^2}\right]^2 \cdot \frac{2.1(1 + \psi)}{1.1}$  
$- \frac{\psi}{\alpha^2}(5.87 + 1.87\alpha^2)$  
$+ \frac{8.6}{\alpha^2} - 10\psi$ | $F = \left(\frac{K}{0.91 - 1}\right) \cdot c_1 \geq 0$  
$\lambda_p^2 = \lambda^2 - 0.5$ for $1 \leq \lambda_p^2 \leq 3$  
$c_1 = \left(1 - \frac{F_1}{\alpha}\right) \geq 0$ |
|                    | $1 \leq \alpha \leq 3(1 - \psi)$ | $\psi \leq -1$           | $K = F_1 \left[1 - \frac{\psi}{\alpha}\right]^2 \cdot 5.975$ | $H = \lambda - \frac{2\lambda}{c(T + \sqrt{T^2 - 4})} \geq R$  
$T = \lambda + \frac{14}{15\lambda} \cdot \frac{1}{3}$ |
|                    | $\alpha > \frac{3(1 - \psi)}{4}$ | $\alpha > \frac{3(1 - \psi)}{4}$ | $K = F_1 \left[1 - \frac{\psi}{\alpha}\right]^2 \cdot 3.9675$  
$+ 0.5375 \left(\frac{1 - \psi}{\alpha}\right)^4$  
$+ 1.87$ | $H = \lambda - \frac{2\lambda}{c(T + \sqrt{T^2 - 4})} \geq R$  
$T = \lambda + \frac{14}{15\lambda} \cdot \frac{1}{3}$ |

Explanations for boundary conditions

- - - - - plate edge free

bbb bb plate edge simply supported
### 7.10.3.6.2 Webs and flanges of primary supporting members

For non-stiffened webs and flanges of primary supporting members sufficient buckling strength as for the hatch cover top and lower plating is to be demonstrated according to 7.10.3.6.1.

### 7.10.3.6.3 Proof of partial and total fields of hatch covers

#### 7.10.3.6.3.1 Longitudinal and transverse secondary stiffeners

It is to be demonstrated that the continuous longitudinal and transverse stiffeners of partial and total plate fields comply with the conditions set out in 7.10.3.6.3.3 through 7.10.3.6.3.4.

For u-type stiffeners, the proof of torsional buckling strength according to 7.10.3.6.3.4 can be omitted.

Single-side welding is not permitted to use for secondary stiffeners except for u-stiffeners.

#### 7.10.3.6.3.2 Effective width of top and lower hatch cover plating

For demonstration of buckling strength according to 7.10.3.6.3.3 through 7.10.3.6.3.4 the effective width of plating may be determined by the following formulae:

\[
b_m = \kappa_L b, \quad \text{for longitudinal stiffeners}
\]

\[
a_m = \kappa_T a, \quad \text{for transverse stiffeners}
\]

See also Fig. 7.10.3.6.

The effective width of plating is not to be taken greater than the value obtained from 7.10.3.5.1.

The effective width \(e_m\) of stiffened flange plates of primary supporting members may be determined as follows:

![Diagram](image)

**Figure 7.10.3.6.3.2-1** Stiffening parallel to web of primary supporting member

\[
b < e_m
\]

\[
e_m' = n \cdot \frac{4.534}{\alpha^2}
\]
\[
\begin{align*}
n &= \text{integer number of stiffener spacings } b \\
&= \text{int} \left( \frac{e_m}{b} \right)
\end{align*}
\]

\[
\begin{align*}
\sigma_{\text{a}} &= \text{uniformly distributed compressive stress, in [N/mm}\,^2]\text{, in the direction of the stiffener axis,} \\
\sigma_{\text{a}} &= \sigma_\alpha, \text{ for longitudinal stiffeners,} \\
\sigma_{\text{a}} &= \sigma_\beta, \text{ for transverse stiffeners,} \\
\sigma_0 &= \text{bending stress, in [N/mm}\,^2]\text{, in the stiffener} \\
&= M_0 + M_1 \\
&= Z_{\alpha,1} \cdot 10^5 \\
M_0 &= \text{bending moment, in [Nmm], due to the deformation } w \text{ of stiffener, taken equal to:} \\
M_0 &= F_{K_1} \left( \frac{P - p}{c_f - p} \right), \text{ with } \left( c_f - p \right) > 0 \\
M_1 &= \text{bending moment, in [Nmm], due to the lateral load } p \text{ equal to:} \\
M_1 &= \frac{p \cdot b \cdot a^2}{24 \cdot 10^3}, \text{ for longitudinal stiffeners,} \\
M_1 &= \frac{p \cdot b (a - b)^2}{c_s \cdot 8 \cdot 10^3}, \text{ for transverse stiffeners.}
\end{align*}
\]

\[
\begin{align*}
n &= \text{to be taken equal to 1 for ordinary transverse stiffeners.} \\
p &= \text{lateral load, in [kN/m}\,^2]\text{.} \\
F_{K_1} &= \text{ideal buckling force, in [N], of the stiffener} \\
F_{K_{\text{th}}} &= \frac{\pi^2}{a^2} \cdot E \cdot I_x \cdot 10^4, \text{ for longitudinal stiffeners,} \\
F_{K_{\text{th}}} &= \frac{\pi^2}{(a - b)^2} \cdot E \cdot I_y \cdot 10^4, \text{ for transv. stiffeners,} \\
I_x, I_y &= \text{net moments of inertia, in [cm}\,^4]\text{, of the longitudinal or transverse stiffener including effective width of attached plating according to 7.10.3.6.3.2. } I_x \text{ and } I_y \text{ are to comply with the following criteria:}
\end{align*}
\]
\[ I_x \geq \frac{b \cdot t^3}{12 \cdot 10^4} \]
\[ I_y \geq \frac{a \cdot t^3}{12 \cdot 10^4} \]

\( p_s \) = nominal lateral load, in [N/mm²], of the stiffener due to \( \sigma_x, \sigma_y \) and \( t \)

\[ p_{yx} = \frac{t}{b} \left( 2 \cdot c_x \cdot \sigma_x + \sigma_y \cdot \sqrt{10^5} \right) \]

for longitudinal stiffeners

\[ p_{yy} = \frac{t}{a} \left( 2 \cdot c_y \cdot \sigma_y + \sigma_x \cdot \sqrt{10^5} \right) \]

for transverse stiffeners

\[ \sigma_{sl} = \sigma_x \cdot \left( 1 + \frac{A_s}{b \cdot t} \right) \]

\( c_x, c_y \) = factor taking into account the stresses perpendicular to the stiffener's axis and distributed variable along the stiffener's length

\[ = 0.5 \cdot \left( 1 + \psi \right) \quad \text{for} \quad 0 \leq \psi \leq 1 \]

\[ = \frac{0.5}{1 - \psi} \quad \text{for} \quad \psi < 0 \]

\( A_s, A_y \) = net sectional area, in [mm²], of the longitudinal or transverse stiffener, respectively, without attached plating

\[ \tau_1 = \tau = \frac{1}{R_{nt} \cdot E \cdot \left( \frac{m_1}{a \cdot b} + \frac{m_2}{b \cdot a} \right)} \geq 0 \]

for longitudinal stiffeners:

\[ \frac{a}{b} \geq 2.0 \quad : \quad m_1 = 1.47 \quad m_2 = 0.49 \]

\[ \frac{a}{b} < 2.0 \quad : \quad m_1 = 1.96 \quad m_2 = 0.37 \]

for transverse stiffeners:

\[ \frac{a}{n \cdot b} \geq 0.5 \quad : \quad m_1 = 0.37 \quad m_2 = \frac{1.96}{n^2} \]

\[ \frac{a}{n \cdot b} < 0.5 \quad : \quad m_1 = 0.49 \quad m_2 = \frac{1.47}{n^2} \]

\( w \) = deformation of stiffener, in [mm], at midpoint of stiffener span due to lateral load \( p \)

In case of uniformly distributed load the following values for \( w_1 \) may be used:

\[ w_1 = \frac{p \cdot b \cdot a^4}{384 \cdot 10^5 \cdot E \cdot I_x} \]

for longitudinal stiffeners,

\[ w_1 = \frac{5 \cdot a \cdot p \cdot (n \cdot b)^4}{384 \cdot 10^5 \cdot E \cdot I_y \cdot c_s^2} \]

for transverse stiffeners.

\( c_s \) = elastic support provided by the stiffener, in [N/mm²]

\[
\begin{align*}
{c_{fs}} & = F_{Ks} \cdot \frac{\pi^2}{(n \cdot b)^2} \left( 1 + c_{ps} \right) \\
{c_{ps}} & = \frac{1}{0.91 \cdot \left( \frac{12 \cdot 10^4 \cdot I_y}{t^5 \cdot b} - 1 \right)} \\
{c_{sa}} & = \left[ \frac{a}{2b} + \frac{2b}{a} \right]^2, \quad \text{for} \quad a \geq 2b \\
{c_{sa}} & = \left[ 1 + \left( \frac{a}{2b} \right)^2 \right]^2, \quad \text{for} \quad a < 2b \\
{c_{ya}} & = \frac{1}{0.91 \cdot \left( \frac{12 \cdot 10^4 \cdot I_x}{t^5 \cdot a} - 1 \right)} \\
{c_{ya}} & = \left[ \frac{n \cdot b}{2a} + \frac{2a}{n \cdot b} \right]^2, \quad \text{for} \quad n \cdot b \geq 2a \\
{c_{ya}} & = \left[ 1 + \left( \frac{n \cdot b}{2a} \right)^2 \right]^2, \quad \text{for} \quad n \cdot b < 2a \\
{c_s} & = \text{factor accounting for the boundary conditions of the transverse stiffener} \\
& = 1.0, \quad \text{for simply supported stiffeners,} \\
& = 2.0, \quad \text{for partially constraint stiffeners.} \\
W_{sf} & = \text{net section modulus of stiffener (long. or transverse), in [cm], including effective width of plating according to 7.10.3.6.3.2.} \\
\end{align*}
\]

If no lateral load \( p \) is acting the bending stress \( \sigma_0 \) is to be calculated at the midpoint of the stiffener span for that
fibre which results in the largest stress value. If a lateral load \( p \) is acting, the stress calculation is to be carried out for both fibres of the stiffener’s cross sectional area (if necessary for the biaxial stress field at the plating side).

### 7.10.3.6.3.4 Torsional buckling of secondary stiffeners

#### 7.10.3.6.3.4.1 Longitudinal secondary stiffeners

The longitudinal ordinary stiffeners are to comply with the following criteria:

\[
\frac{\sigma_s \cdot S}{K_T \cdot R_{off}} \leq 1.0
\]

\( K_T = \) coefficient taken equal to:

\( K_T = 1.0 \) , for \( \lambda_T \leq 0.2 \)

\( K_T = \frac{1}{\Phi + \sqrt{\Phi^2 - \lambda_T^2}} \) , for \( \lambda_T > 0.2 \)

\( \Phi = 0.5 [1 + 0.21(\lambda_T - 0.2) + \lambda_T^2] \)

\( \lambda_T = \) reference degree of slenderness taken equal to:

\[ \lambda_T = \sqrt{\frac{\sigma_s}{\sigma_{krit}}} \]

\( \sigma_{krit} = \frac{E}{f_p} \left( \frac{\pi^2 \cdot I_w}{a^4} \cdot e + 0.385 \cdot T_f \right) \), in [N/mm²].

For \( I_p, I_T, I_\omega \) see Figure 7.10.3.6.3.4.1 and Table 7.10.3.6.3.4.1.

---

**Table 7.10.3.6.3.4.1 Moments of inertia**

<table>
<thead>
<tr>
<th>Section</th>
<th>( I_p )</th>
<th>( I_T )</th>
<th>( I_\omega )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat bar</td>
<td>( \frac{h_w^3 \cdot t_w}{3 \cdot 10^4} )</td>
<td>( \frac{h_w \cdot t_w^3}{3 \cdot 10^4} \left( 1 - 0.63 \frac{t_w}{h_w} \right) )</td>
<td>( \frac{h_w^3 \cdot t_w}{3 \cdot 10^5} )</td>
</tr>
<tr>
<td>Sections with bulb or flange</td>
<td>( \left( \frac{A_w \cdot h_w^2}{3} + A_f \cdot e_f^2 \right) ) ( \cdot 10^{-4} )</td>
<td>( \frac{h_w \cdot t_w^3}{3 \cdot 10^4} \left( 1 - 0.63 \frac{t_w}{h_w} \right) + \frac{b_f \cdot t_f^3}{3 \cdot 10^4} \left( 1 - 0.63 \frac{t_f}{b_f} \right) )</td>
<td>( \frac{h_w^3 \cdot t_w}{3 \cdot 10^5} ) for bulb and angle sections: ( \frac{A_f \cdot e_f^2 \cdot b_f^2}{12 \cdot 10^6} \left( \frac{A_f + 2.6 A_w}{A_f + A_w} \right) ) for tee-sections: ( \frac{b_f^2 \cdot t_f \cdot e_f^2}{12 \cdot 10^4} )</td>
</tr>
</tbody>
</table>
7.10.3.6.3.4.2 Transverse secondary stiffeners

For transverse secondary stiffeners loaded by compressive stresses and which are not supported by longitudinal stiffeners, sufficient torsional buckling strength is to be demonstrated analogously in accordance with 7.10.3.6.3.4.1.

7.10.4 Details of hatch covers

7.10.4.1 Container foundations on hatch covers

Container foundations are to be designed to the satisfaction of the Register. The substructures of container foundations are to be designed for cargo and container loads according to 7.10.2.6, applying the permissible stresses according to 7.10.3.1.1.

7.10.4.2 Weather tightness

Further to the following requirements IACS Rec. 14 is applicable to hatch covers.

7.10.4.2.1 Packing material (General)

The packing material is to be suitable for all expected service conditions of the ship and is to be compatible with the cargoes to be transported. The packing material is to be selected with regard to dimensions and elasticity in such a way that expected deformations can be carried. Forces are to be carried by the steel structure only.

The packings are to be compressed so as to give the necessary tightness effect for all expected operating conditions. Special consideration shall be given to the packing arrangement in ships with large relative movements between hatch covers and coamings or between hatch cover sections.

7.10.4.2.2 Dispensation of weather tight gaskets

For hatch covers of cargo holds solely for the transport of containers, upon request by the owners and subject to compliance with the following conditions the fitting of weather tight gaskets according to 7.10.4.2.1 may be dispensed with:

- The hatchway coamings shall be not less than 600 mm in height.
- The exposed deck on which the hatch covers are located is situated above a depth \( H(x) \geq d_{fb} + f_s + h \), in [m],

\[ d_{fb} = \text{draught, in [m], corresponding to the assigned summer load line}, \]
\[ f_s = \text{minimum required freeboard, in [m], determined in accordance with ICLL Reg. 28 as modified by further regulations as applicable} \]
\[ h = 4,6 \text{ m for } \frac{x}{L_{ICL}} \leq 0,75 \]
\[ = 6,9 \text{ m for } \frac{x}{L_{ICL}} > 0,75 \]

- Labyrinths, gutter bars or equivalents are to be fitted proximate to the edges of each panel in way of the coamings. The clear profile of these openings is to be kept as small as possible.

Where a hatch is covered by several hatch cover panels the clear opening of the gap in between the panels shall be not wider than 50 mm.

- The labyrinths and gaps between hatch cover panels shall be considered as unprotected openings with respect to the requirements of intact and damage stability calculations.
- With regard to drainage of cargo holds and the necessary fire-fighting system reference is made to the sections of the Rules, Part 8 – Piping and Part 17: Fire protection.
- Bilge alarms should be provided in each hold fitted with non-weathertight covers.
- Furthermore, Chapter 3 of IMO MSC/Circ. 1087 is to be referred to concerning the stowage and segregation of containers containing dangerous goods.

7.10.4.2.3 Drainage arrangements

Cross-joints of multi-panel covers are to be provided with efficient drainage arrangements.

7.10.5 Hatch coaming strength criteria

7.10.5.1 Local net plate thickness of coamings

The net thickness of weather deck hatch coamings shall not be less than the larger of the following values:

\[ t = 14,2 \cdot s \cdot \frac{p_s}{0,95 \cdot R_{st}}, \text{ in [mm]}, \]

\[ t_{min} = 6 + \frac{L_t}{100}, \text{ in [mm]}, \]

where:

\[ s = \text{stiffener spacing} , \text{ in [m]}, \]
\[ L_t = L, \text{ need not be taken greater than 300 m.} \]

Longitudinal strength aspects are to be observed.

7.10.5.2 Net scantling of secondary stiffeners of coamings

The stiffeners must be continuous at the coaming stays. For stiffeners with both ends constraint the elastic net section modulus \( W \), in [cm³], and net shear area \( A_s \) in [cm²], calculated on the basis of net thickness, must not be less than:

\[ W = \frac{83}{R_{st}} \cdot s \cdot l^2 \cdot p_s \]

\[ A_s = \frac{10 \cdot s \cdot l \cdot p_s}{R_{st}} \]

where:

\[ l = \text{secondary stiffener span, in [m], to be taken as the spacing of coaming stays,} \]
\[ s = \text{stiffener spacing, in [m]} \]

For sniped stiffeners of coaming at hatch corners section modulus and shear area at the fixed support have to be increased by 35 %. The gross thickness of the coaming plate at the sniped stiffener end shall not be less than
Horizontal stiffeners on hatch coamings, which are part of the longitudinal hull structure, are to be designed according to the Rules, Part 2 - Hull.

### 7.10.5.3 Coaming stays

Coaming stays are to be designed for the loads transmitted through them and permissible stresses according to 7.10.3.1.1.

#### 7.10.5.3.1 Coaming stay section modulus and web thickness

At the connection with deck, the net section modulus $W$, in $[cm^3]$, and the gross thickness $t_w$, in $[mm]$, of the coaming stays designed as beams with flange (examples 1 and 2 are shown in Fig. 7.10.5.3.1) are to be taken not less than:

$$W = \frac{526}{R_{di}} \cdot e \cdot h_s^2 \cdot p_s \cdot A_s \cdot eH$$

$$t_w = \frac{2 \cdot e \cdot h_s \cdot p_s \cdot A_s \cdot eH}{h_w}$$

where:

- $e$ = spacing of coaming stays, in $[m]$
- $h_s$ = height of coaming stays in $[m]$
- $h_w$ = web height of coaming stay at its lower end, in $[m]$
- $t_s$ = corrosion addition, in $[mm]$, according to 7.10.7.

For other designs of coaming stays, such as those shown in Fig. 7.10.5.3.1, examples 3 and 4, the stresses are to be determined through a grillage analysis or FEM. The calculated stresses are to comply with the permissible stresses according to 7.10.3.1.1.

Coaming stays are to be supported by appropriate substructures. Face plates may only be included in the calculation if an appropriate substructure is provided and welding provides an adequate joint.

webs are to be connected to the deck by fillet welds on both sides with a throat thickness of $a=0.44+t_s$. The size of welding for toes of webs at the lower end of coaming stays should be according to the Rules, Part 2 - Hull, Section 15.

### 7.10.5.3.2 Coaming stays under friction load

For coaming stays, which transfer friction forces at hatch cover supports, fatigue strength is to be considered according to Rules, Part 2 - Hull, refer to 7.10.6.2.2.

### 7.10.5.4 Further requirements for hatch coamings

#### 7.10.5.4.1 Longitudinal strength

Hatch coamings which are part of the longitudinal hull structure are to be designed according to the requirements for longitudinal strength of the Rules, Part 2 - Hull, Section 4.

For structural members welded to coamings and for cutouts in the top of coamings sufficient fatigue strength is to be verified according to Section 16.

Longitudinal hatch coamings with a length exceeding $0.1 \cdot L$ m are to be provided with tapered brackets or equivalent transitions and a corresponding substructure at both ends. At the end of the brackets they are to be connected to the deck by full penetration welds of minimum 300 mm in length.

#### 7.10.5.4.2 Local details

If the design of local details is not regulated in 7.10.5, local details are to comply with the Rules, Part 2 - Hull for the purpose of transferring the loads on the hatch covers to the hatch coamings and, through them, to the deck structures below. Hatch coamings and supporting structures are to be adequately stiffened to accommodate the loading.
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from hatch covers, in longitudinal, transverse and vertical directions.

Structures under deck are to be checked against the load transmitted by the stays.

Unless otherwise stated, weld connections and materials are to be dimensioned and selected in accordance with the Rules, Part 2 – Hull.

7.10.5.4.3 Stays

On ships carrying cargo on deck, such as timber, coal or coke, the stays are to be spaced not more than 1.5 m apart.

7.10.5.4.4 Extend of coaming plates

Coaming plates are to extend to the lower edge of the deck beams; or hatch side girders are to be fitted that extend to the lower edge of the deck beams. Extended coaming plates and hatch side girders are to be flanged or fitted with face bars or half-round bars. Fig. 7.10.5.4.4 gives an example.

7.10.5.4.5 Drainage arrangement at the coaming

If drain channels are provided inside the line of gasket by means of a gutter bar or vertical extension of the hatch side and end coaming, drain openings are to be provided at appropriate positions of the drain channels.

Drain openings in hatch coamings are to be arranged with sufficient distance to areas of stress concentration (e.g. hatch corners, transitions to crane posts).

Drain openings are to be arranged at the ends of drain channels and are to be provided with non-return valves to prevent ingress of water from outside. It is unacceptable to connect fire hoses to the drain openings for this purpose.

If a continuous outer steel contact between cover and ship structure is arranged, drainage from the space between the steel contact and the gasket is also to be provided for.

7.10.6 Closing arrangements

7.10.6.1 Securing devices

7.10.6.1.1 General

Securing devices between cover and coaming and at cross-joints are to be installed to provide weathertightness. Sufficient packing line pressure is to be maintained.

Securing devices must be appropriate to bridge displacements between cover and coaming due to hull deformations.

Securing devices are to be of reliable construction and effectively attached to the hatchway coamings, decks or covers. Individual securing devices on each cover are to have approximately the same stiffness characteristics.

Sufficient number of securing devices is to be provided at each side of the hatch cover considering the requirements of 7.10.3.4.2. This applies also to hatch covers consisting of several parts.

The materials of stoppers, securing devices and their weldings are to be to the Register satisfaction. Specifications of the materials are to be shown in the drawings of the hatch covers.

7.10.6.1.2 Rod cleats

Where rod cleats are fitted, resilient washers or cushions are to be incorporated.

7.10.6.1.3 Hydraulic cleats

Where hydraulic cleating is adopted, a positive means is to be provided so that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.

7.10.6.1.4 Cross-sectional area of the securing devices

The gross cross-sectional area, in \( \text{cm}^2 \), of the securing devices is not to be less than:

\[
A = 0.28 \cdot q \cdot s_{SD} \cdot k_i
\]

where:

\( q \) = packing line pressure, in \( \text{N/mm} \), minimum 5 \( \text{N/mm} \),

\( s_{SD} \) = spacing between securing devices in \( \text{m} \), not to be taken less than 2 m,

\( k_i = \left( \frac{235}{R_{yd}} \right)^2 \cdot R_{uv} \) is the minimum yield strength of the material, in \( \text{N/mm}^2 \), but is not to be taken greater than 0.7 \( \cdot R_m \), where \( R_m \) is the tensile strength of the material, in \( \text{N/mm}^2 \).

\( e = 0.75 \) for \( R_{yd} > 235 \, \text{N/mm}^2 \)

\( = 1.00 \) for \( R_{yd} \leq 235 \, \text{N/mm}^2 \).

Rods or bolts are to have a gross diameter not less than 19 mm for hatchways exceeding 5 \( \text{m}^2 \) in area.

Securing devices of special design in which significant bending or shear stresses occur may be designed as anti-lifting devices according to 7.10.6.1.5. As load the pack-
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ing line pressure \( q \) multiplied by the spacing between securing devices \( s_{SD} \) is to be applied.

7.10.6.1.5 Anti lifting devices

The securing devices of hatch covers, on which cargo is to be lashed, are to be designed for the lifting forces resulting from loads according to 7.10.2.6.4, refer Figure 7.10.6.1.5. Unsymmetrical loadings, which may occur in practice, are to be considered. Under these loadings the equivalent stress in the securing devices is not to exceed:

\[
\sigma_{f} = \frac{150}{K_{f}} \text{in \[ N/mm^2 \]}
\]

Note:
The partial load cases given in Table 7.10.2.6.4.4 may not cover all unsymmetrical loadings, critical for hatch cover lifting.

Section 5.6 of IACS Rec. 14 should be referred to for the omission of anti lifting devices.

![Lifting forces at a hatch cover](image)

Figure 7.10.6.1.5 Lifting forces at a hatch cover

7.10.6.2 Hatch cover supports, stoppers and supporting structures

7.10.6.2.1 Horizontal mass forces

For the design of hatch cover supports the horizontal mass forces \( F_{h} = m \cdot a \) are to be calculated with the following accelerations:

\[
a_{x} = 0.2 \cdot g \text{ in longitudinal direction},
\]

\[
a_{y} = 0.5 \cdot g \text{ in transverse direction},
\]

\[
m = \text{sum of mass of cargo lashed on the hatch cover and mass of hatch cover}.
\]

The accelerations in longitudinal direction and in transverse direction do not need to be considered as acting simultaneously.

7.10.6.2.2 Hatch cover supports

For the transmission of the support forces resulting from the load cases specified in 7.10.2.6 and of the horizontal mass forces specified in 7.10.6.2.1, supports are to be provided which are to be designed such that the nominal surface pressures in general do not exceed the following values:

\[
p_{\text{max}} = d \cdot p_{n} \text{ in \[ N/mm^2 \]}
\]

\[
d = 3.75 \cdot 0.015 \cdot L
\]

\[
d_{\text{max}} = 3.0
\]

\[
d_{\text{min}} = 1.0 \text{ in general}
\]

\[
d = 2.0 \text{ for partial loading conditions, see 7.10.2.6.4.1}
\]

\[
p_{n} = \text{see Table 7.10.7.2}
\]

For metallic supporting surfaces not subjected to relative displacements the nominal surface pressure applies:

\[
p_{n, \text{max}} = 3 \cdot p_{n}, \text{ in \[ N/mm^2 \]}
\]

Note:
When the maker of vertical hatch cover support material can provide proof that the material is sufficient for the increased surface pressure, not only statically but under dynamic conditions including relative motion for adequate number of cycles, permissible nominal surface pressure may be relaxed at the discretion of the Register. However, realistic long term distribution of spectra for vertical loads and relative horizontal motion should be assumed and agreed with the Register.

Drawings of the supports must be submitted. In the drawings of supports the permitted maximum pressure given by the material manufacturer must be specified.

![Permissible nominal surface pressure](image)

Tab. 7.10.6.2.2 Permissible nominal surface pressure \( p_{n} \)

<table>
<thead>
<tr>
<th>Support material</th>
<th>Vertical force</th>
<th>Horizontal force (on stoppers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull structural steel</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Hardened steel</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Lower friction materials</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

Where large relative displacements of the supporting surfaces are to be expected, the use of material having low wear and frictional properties is recommended.

The substructures of the supports must be of such a design, that a uniform pressure distribution is achieved.

Irrespective of the arrangement of stoppers, the supports must be able to transmit the following force \( P_{h} \) in the longitudinal and transverse direction:

\[
P_{h} = \mu \cdot \frac{P_{V}}{d}
\]

where:

\[
P_{V} = \text{vertical supporting force}
\]

\[
\mu = \text{frictional coefficient}
\]

\[
\mu = 0.5 \text{ in general.}
\]

For non-metallic, low-friction support materials on steel, the friction coefficient may be reduced but not to be less than 0.35 and to the satisfaction of the Rules, Part 24 – Non-Metalic Materials.

Supports as well as the adjacent structures and substructures are to be designed such that the permissible stresses according to 7.10.3.1.1 are not exceeded.

For substructures and adjacent structures of supports subjected to horizontal forces \( P_{h} \), a fatigue strength is to be considered according to the Rules, Part 2 – Hull, Section 16.
7.10.6.2.3 Hatch cover stoppers

Hatch covers shall be sufficiently secured against horizontal shifting. Stoppers are to be provided for hatch covers on which cargo is carried.

The greater of the loads resulting from 7.10.2.6.2 and 7.10.6.2.1 is to be applied for the dimensioning of the stoppers and their substructures.

The permissible stress in stoppers and their substructures, in the cover, and of the coamings is to be determined according to 7.10.3.1.1. In addition, the provisions in 7.10.6.2.2 are to be observed.

7.10.7 Corrosion addition and steel renewal

7.10.7.1 Corrosion addition for hatch covers and hatch coamings

The scantling requirements of the above sections imply the following general corrosion additions \( t_s \).

### Table 7.10.7.1 Corrosion additions \( t_s \) for hatch covers and hatch coamings

<table>
<thead>
<tr>
<th>Application</th>
<th>Structure</th>
<th>( t_s ) [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather deck hatches of container ships, car carriers, paper carriers, passenger vessels</td>
<td>Hatch covers</td>
<td>1.0</td>
</tr>
<tr>
<td>Weather deck hatches of all other ship types covered by these requirements</td>
<td>Weather exposed plating and bottom plating of double skin hatch covers</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Internal structure of double skin hatch covers and closed box girders</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Hatch coamings not part of the longitudinal hull structure</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Hatch coamings part of the longitudinal hull structure</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Coaming stays and stiffeners</td>
<td>1.5</td>
</tr>
</tbody>
</table>

7.10.7.2 Steel renewal

Steel renewal is required where the gauged thickness is less than \( t_{net} + 0.5 \) mm for:

- Single skin hatch covers,
- The plating of double skin hatch covers, and
- Coaming structures the corrosion additions \( t_s \) of which are provided in Table 7.10.7.1.

Where the gauged thickness is within the range \( t_{net} + 0.5 \) mm and \( t_{net} + 1.0 \) mm, coating (applied in accordance with the coating manufacturer’s requirements) or annual gauging may be adopted as an alternative to steel renewal. Coating is to be maintained in GOOD condition, as defined in the Rules, Part 1 – General Requirements, Ch.5.

For the internal structure of double skin hatch covers, thickness gauging is required when hatch cover top or bottom plating renewal is to be carried out or when this is deemed necessary, at the discretion of the Register’s surveyor, on the basis of the plating corrosion or deformation condition. In these cases, steel renewal for the internal structures is required where the gauged thickness is less than \( t_{net} \).

For corrosion addition \( t_s = 1.0 \) mm the thickness for steel renewal is \( t_{net} \) and the thickness for coating or annual gauging is when gauged thickness is between \( t_{net} \) and \( t_{net} + 0.5 \) mm.

For coaming structures, the corrosion additions \( t_s \) of which are not provided in Table 7.10.7.1, steel renewal and coating or annual gauging are to be in accordance with the Register’s requirements.

7.10.8 Hatch covers and hatch coamings of cargo holds of bulk carriers, ore carriers and combination carriers

7.10.8.1 Application and definitions

These requirements apply to all bulk carriers, ore carriers and combination carriers, as defined in the Rules, Part 1 – General requirements, Chapter 1 – General information, 4.2 and are for all cargo hatch covers and hatch forward and side coamings on exposed decks in position 1 (see Section 7.1.4). Other loadings are also to be considered, if necessary, according to the requirements of the Rules.

The strength requirements are applicable to hatch covers and hatch coamings of stiffened plate construction. The secondary stiffeners and primary supporting members of the hatch covers are to be continuous over the breadth and length of the hatch covers, as far as practical. When this is impractical, sniped end connections are not to be used and appropriate arrangements are to be adopted to ensure sufficient load carrying capacity.

The spacing of primary supporting members parallel to the direction of secondary stiffeners is not to exceed 1/3 of the span of primary supporting members.

The secondary stiffeners of the hatch coamings are to be continuous over the breadth and length of the hatch coamings.

These requirements are in addition to the requirements of the ICLL, 1966.

The net minimum scantlings of hatch covers are to fulfill the strength criteria given in:

- Section 7.10.8.3.3, for plating,
- Section 7.10.8.3.4, for secondary stiffeners,
- Section 7.10.8.3.5, for primary supporting members,
- the critical buckling stress check in Section 7.10.8.3.6 and the rigidity criteria given in Section 7.10.8.3.7, adopting the load model given in Section 7.10.8.2.
The net minimum scantlings of hatch coamings are to fulfill the strength criteria given in:
- Section 7.10.8.4.2, for plating,
- Section 7.10.8.4.3, for secondary stiffeners,
- Section 7.10.8.4.4, for coaming stays,
adopting the load model given in Section 7.10.8.4.1.

The net thicknesses, \( t_{\text{net}} \), are the member thicknesses necessary to obtain the minimum net scantlings required by Section 7.10.8.3 and Section 7.10.8.4.

The required gross thicknesses are obtained by adding the corrosion additions, \( t_c \), given in Section 7.10.8.6, to \( t_{\text{net}} \).

Material for the hatch covers and coamings is to be steel according to the requirements for ship’s hull.

These requirements do not apply to CSR Bulk Carriers.

### 7.10.8.2 Hatch cover load model

The pressure \( p \), in \([\text{kN/m}^2]\), on the hatch covers panels is given by:

For ships of 100 m in length and above:

\[
p = 34.3 + \frac{P_{FP}}{0.25} - 34.3 \left( 0.25 - \frac{x}{L} \right) \geq 34.3, \quad \text{for hatch ways located at the freeboard deck}
\]

\( P_{FP} = \text{pressure at the forward perpendicular} \)

\( a = 0.0726, \text{for type B freeboard ships} \)

\( 0.356, \text{for ships with reduced freeboard} \)

\( L = \text{freeboard length, in [m], as defined in the ICLL, 1966, to be taken not greater than 340 m} \)

\( x = \text{distance, in [m], of the mid length of the hatch cover under examination from the forward end of } L. \)

Where a position 1 hatchway is located at least one superstructure standard height higher than the freeboard deck, the pressure \( p \) may be 34.3 \( \text{kN/m}^2 \).

For ships less than 100 m in length:

\[
p = 34.3 + \frac{Lp_{FP}}{L} - 34.3 \left( 0.25 - \frac{x}{L} \right) \geq 34.3, \quad \text{for hatch ways located at the freeboard deck}
\]

\( p_{FP} = \text{pressure at the forward perpendicular} \)

\( t = \text{net thickness of considered attached plate, in [mm]} \)

\( b_{\text{ef}} = \text{effective breadth, in [m], of attached plate flange on each side of girder web} \)

\( b_p = \text{half distance, in [m], between the considered primary supporting member and the adjacent one} \)

\( \ell = \text{span, in [m], of primary supporting members} \)

### 7.10.8.3 Hatch cover strength criteria

#### 7.10.8.3.1 Allowable stress checks

The normal and shear stresses \( \sigma \) and \( \tau \) in the hatch cover structures are not to exceed the allowable values, \( \sigma_0 \) and \( \tau_0 \), in \([\text{N/mm}^2]\), given by:

\[
\sigma_0 = 0.8 R_{ef},
\tau_0 = 0.46 R_{ef},
\]

\( R_{ef} = \text{being the minimum upper yield stress, in [N/mm}^2\), of the material.\)

The normal stress in compression of the attached flange of primary supporting members is not to exceed 0.8 times the critical buckling stress of the structure according to the buckling check as given in Section 7.10.8.3.6.

The stresses in hatch covers that are designed as a grillage of longitudinal and transverse primary supporting members are to be determined by a grillage or a FEM analysis.

When a beam or a grillage analysis is used, the secondary stiffeners are not to be included in the attached flange area of the primary members.

When calculating the stresses \( \sigma \) and \( \tau \), the net scantlings are to be used.

#### 7.10.8.3.2 Effective cross-sectional area of panel flanges for primary supporting members

The effective flange area \( A_f \), in \([\text{cm}^2]\), of the attached plating, to be considered for the yielding and buckling checks of primary supporting members, when calculated by means of a beam or grillage model, is obtained as the sum of the effective flange areas of each side of the girder web as appropriate:

\[
A_f = \sum_{n_f} (10 b_{\text{ef}} t)
\]

where:

\( n_f = 2 \) if attached plate flange extends on both sides of girder web

\( 1 \) if attached plate flange extends on one side of girder web only

\( t = \text{net thickness of considered attached plate, in [mm]} \)

\( b_{\text{ef}} = \text{effective breadth, in [m], of attached plate flange on each side of girder web} \)

\( b_p = \text{half distance, in [m], between the considered primary supporting member and the adjacent one} \)

\( \ell = \text{span, in [m], of primary supporting members} \)

#### 7.10.8.3.3 Local net plate thickness

The local net plate thickness \( t \), in [mm], of the hatch cover top plating is not to be less than:

\[
t = F_p \times 15.8 \sqrt{\frac{p}{0.95 R_{ef}}} + 0.195 L + 14.9,
\]

but to be not less than 1% of the spacing of the stiffener or 6 mm if that is greater.

where:

\( F_p = \text{factor for combined membrane and bending response} \)

\( = 1.50 \text{ in general} \)

\( 1.90 \sigma / \sigma_0 \text{ for } \sigma / \sigma_0 \geq 0.8, \text{ for the attached plate flange of primary supporting members} \)

\( s = \text{stiffener spacing, in [m]} \)

\( p = \text{pressure, in [kN/m}^2\), as defined in Section 7.10.8.2 \)

\( \sigma = \text{as defined in Section 7.10.8.3.5} \)

\( \sigma_0 = \text{as defined in Section 7.10.8.3.1} \).
7.10.8.3.4 Net scantlings of secondary stiffeners

The required minimum section modulus, \( Z \), in [cm\(^3\)], of secondary stiffeners of the hatch cover top plate, based on stiffener net member thickness, are given by:

\[
Z = \frac{1000 \, \ell^2 \, s \, p}{12 \, \sigma_a}
\]

where:

- \( \ell \) = secondary stiffener span, in [m], to be taken as the spacing, in [m], of primary supporting members or the distance between a primary supporting member and the edge support, as applicable. When brackets are fitted at both ends of all secondary stiffener spans, the secondary stiffener span may be reduced by an amount equal to 2/3 of the minimum brackets arm length, but not greater than 10% of the gross span, for each bracket.
- \( s \) = secondary stiffener spacing, in [m]
- \( p \) = pressure, in [kN/m\(^2\)], as defined in Section 7.10.8.2
- \( \sigma_a \) = as defined in Section 7.10.8.3.1.

The net section modulus of the secondary stiffeners is to be determined based on an attached plate width assumed equal to the stiffener spacing.

7.10.8.3.5 Net scantlings of primary supporting members

The section modulus and web thickness of primary supporting members, based on member net thickness, are to be such that the normal stress \( \sigma \) and the shear stress \( \tau \) in the web, do not exceed the allowable values for primary supporting members, based on stiffener net member thickness, are given by:

\[
\sigma_a = \frac{C_1 \, \sigma_{YSS}}{2} = \frac{C_2 \, \sigma_{YSS}}{2}
\]

where:

- \( C_1 \) = when stiffeners are parallel to the direction of secondary stiffeners, induced by the bending of primary supporting members or the distance between a primary supporting member and the edge support, as applicable. When brackets are fitted at both ends of all secondary stiffener spans, the secondary stiffener span may be reduced by an amount equal to 2/3 of the minimum brackets arm length, but not greater than 10% of the gross span, for each bracket.
- \( C_2 \) = as defined in Section 7.10.8.3.1.

The breadth of the primary supporting member flange is to be not less than 40% of their depth for laterally unsupported spans greater than 3.0 m. Tripping brackets attached to the flange may be considered as a lateral support for primary supporting members.

The flange outstand is not to exceed 15 times the flange thickness.

7.10.8.3.6 Critical buckling stress check

7.10.8.3.6.1 Hatch cover plating

The compressive stress \( \sigma \) in the hatch cover plate panels, induced by the bending of primary supporting members parallel to the direction of secondary stiffeners, is not to exceed 0.8 times the critical buckling stress \( \sigma_{c1} \), to be evaluated as defined below:

\[
\sigma_{c1} = \sigma_{c1} \quad \text{when} \quad \sigma_{c1} \leq C_{1ss} \frac{R_{all}}{2}
\]

\[
\sigma_{c1} = R_{all} \left[ 1 - \frac{R_{all}}{C_{1ss}} \right] \quad \text{when} \quad \sigma_{c1} > C_{1ss} \frac{R_{all}}{2}
\]

where:

- \( R_{all} \) = minimum upper yield stress, in [N/mm\(^2\)], of the material
- \( \sigma_{c1} = 3.6 \, E \left( \frac{t}{1000 \, s} \right)^2 \)
- \( E = \) modulus of elasticity, in [N/mm\(^2\)]
- \( \sigma_{YSS} = 1.05 \) when plating is stiffened by flat bar
- \( \sigma_{YSS} = 1.0 \) when plating is stiffened by secondary stiffeners of bulb type
- \( \sigma_{YSS} = 1.1 \) when plating is stiffened by secondary stiffeners of angle or T type
- \( \sigma_{YSS} = 1.21 \) when plating is stiffened by primary supporting members

The compressive stress \( \sigma \) in the top flange of the hatch cover plate panels, when calculated by means of FEM shell element model, is to be in accordance with the Rules as deemed equivalent to the above criteria.

7.10.8.3.6.2 Hatch cover secondary stiffeners

The compressive stress \( \sigma \) in the top flange of secondary stiffeners, induced by the bending of primary supporting members parallel to the direction of secondary stiffeners, is not to exceed 0.8 times the critical buckling stress \( \sigma_{c2} \), to be evaluated as defined below:

\[
\sigma_{c2} = \sigma_{c2} \quad \text{when} \quad \sigma_{c2} \leq R_{all} \frac{C_{2ss}}{2}
\]

\[
\sigma_{c2} = R_{all} \left[ 1 - \frac{R_{all}}{C_{2ss}} \right] \quad \text{when} \quad \sigma_{c2} > R_{all} \frac{C_{2ss}}{2}
\]

where:

- \( C_{2ss} \) = minimum between \( C_{2ss} \) when \( \sigma_{c2} \leq R_{all} \frac{C_{2ss}}{2} \) and \( C_{2ss} \) when \( \sigma_{c2} > R_{all} \frac{C_{2ss}}{2} \)
- \( \sigma_{YSS} = 1.05 \) for steel
- \( \sigma_{YSS} = 2.06 \times 10^4 \) for steel
- \( R_{all} = \) minimum upper yield stress, in [N/mm\(^2\)], of the material
- \( \sigma_{YSS} = \) ideal elastic buckling stress, in [N/mm\(^2\)], of the secondary stiffener
- \( \sigma_{c2} = 0.001 \, E \, l_s / (4 \, t_s^2) \)
- \( E = \) modulus of elasticity, in [N/mm\(^2\)]
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\( I_m \) = moment of inertia, in [cm^4], of the secondary stiffener, including a top flange equal to the spacing of secondary stiffeners

\( A \) = cross-sectional area, in [cm^2], of the secondary stiffener, including a top flange equal to the spacing of secondary stiffeners

\( l \) = span, in [m], of the secondary stiffener

\( \sigma_{e1} \) = \( \frac{\pi^2 E I_w}{10^6 I_p} \left( m^2 + \frac{K}{m^2} \right) + 0.385 E \frac{I_l}{I_p} \)

\( K \) = \( C \frac{E}{A} \cdot 10^6 \) for flange web panels

\( m \) = number of half waves, given by the following table:

<table>
<thead>
<tr>
<th>( 0 &lt; K &lt; 4 )</th>
<th>( 4 &lt; K &lt; 36 )</th>
<th>( 36 &lt; K &lt; 144 )</th>
<th>( (m-1)^2 )</th>
<th>( m_2 \leq m_2(m+1)^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>m</td>
<td></td>
</tr>
</tbody>
</table>

\( I_w \) = sectorial moment of inertia, in [cm^4], of the secondary stiffener about its connection with the plating

\( I_w = \frac{h_b^3 t_w^3}{3} \cdot 10^{-4} \) for flat bar secondary stiffeners

\( I_w = \frac{t_f h_b^3}{12(b_f + h_w)} \left[ I_f + \frac{b_f}{2} + 2b_f h_w + 4h_w^2 \right] \cdot 10^{-6} \) for angles and bulb secondary stiffeners

\( I_p \) = polar moment of inertia, in [cm^4], of the secondary stiffener about its connection with the plating

\( I_p = \frac{h_b^3 t_w^3}{3} \cdot 10^{-4} \) for flat bar secondary stiffeners

\( I_p = \frac{h_b^3 t_w^3}{3} + \frac{h_b^3 t_f^3}{12} \cdot 10^{-4} \) for flanged secondary stiffeners

\( I_t \) = St Venant's moment of inertia, in [cm^4], of the secondary stiffener without top flange

\( I_t = \frac{h_b^3 t_w^3}{3} \cdot 10^{-4} \) for flat bar secondary stiffeners

\( I_t = \frac{h_b^3 t_w^3}{3} + \frac{h_b^3 t_f^3}{12} \cdot 10^{-4} \) for flanged secondary stiffeners

\( h_b, t_f \) = width and net thickness, in [mm], of the secondary stiffener bottom flange, respectively

\( s \) = spacing, in [m], of secondary stiffeners

\( C \) = spring stiffness exerted by the hatch cover top plating

\( C = k_p E t_p^3 \left( 1 + \frac{1.33k_p h_w t_p^3}{1000s d} \right)^{-10^{-3}} \)

\( k_p = 1 - \eta_p \) to be taken not less than zero; for flanged secondary stiffeners, \( k_p \) need not be taken less than 0,1

\( \eta_p = \frac{\sigma}{\sigma_{e1}} \)

\( \sigma \) = as defined in Section 7.10.8.3.5

\( \sigma_{e1} \) = as defined in Section 7.10.8.3.6.1

\( t_p \) = net thickness, in [mm], of the hatch cover plate panel.

For flat bar secondary stiffeners and buckling stiffeners, the ratio \( \frac{h_b}{h} \) is to be not greater than 150/33, where:

\( h, t_f \) = height and net thickness of the stiffener, respectively

\( k = \frac{235}{E_1} \)

\( R_{eff} = \) minimum upper yield stress, in [N/mm^2], of the material.

7.10.8.3.6.3 Web panels of hatch cover primary supporting members

This check is to be carried out for the web panels of primary supporting members, formed by web stiffeners or by the crossing with other primary supporting members, the face plate (or the bottom cover plate) or the attached top cover plate.

The shear stress \( \tau \) in the hatch cover primary supporting members web panels is not to exceed 0,8 times the critical buckling stress \( \tau_c \), to be evaluated as defined below:

\( \tau_c = \tau_{el} \) when \( \tau_c \leq \tau_{el}/2 \)

\( \tau_c \) = \( \tau_{el} \cdot [1 - \n \cdot (4 \ n)] \) when \( \tau_c > \tau_{el}/2 \)

where:

\( R_{eff} \) = minimum upper yield stress, in [N/mm^2], of the material

\( \tau_{el} = \frac{R_{eff}}{\sqrt{5}} \)

\( \tau_c = 0.9 k_1 E t_{pr,n} (1000 d)^{-2} \)

\( E \) = modulus of elasticity, in [N/mm^2]

\( k_1 = 2.06 \times 10^7 \) for steel

\( t_{pr,n} \) = net thickness, in [mm], of primary supporting member

\( k_1 = 5.35 + 4.0 / (a/d)^2 \)

\( a \) = greater dimension, in [m], of web panel of primary supporting member

\( d \) = smaller dimension, in [m], of web panel of primary supporting member.
For primary supporting members parallel to the direction of secondary stiffeners, the actual dimensions of the panels are to be considered.

For primary supporting members perpendicular to the direction of secondary stiffeners or for hatch covers built without secondary stiffeners, a presumed square panel of dimension $d$ is to be taken for the determination of the stress $t_C$. In such a case, the average shear stress $t$ between the values calculated at the ends of this panel is to be considered.

7.10.8.3.7 Deflection limit and connections between hatch cover panels

Load bearing connections between the hatch cover panels are to be fitted with the purpose of restricting the relative vertical displacements.

The vertical deflection of primary supporting members is to be not more than $0.0056 \times l$, where $l$ is the greatest span of primary supporting members.

7.10.8.4 Hatch coamings and local details

7.10.8.4.1 Load model

The pressure $p_{coam}$ in [kN/m$^2$], on the No. 1 forward transverse hatch coaming is given by:

$$p_{coam} = \begin{cases} 220, & \text{when a forecastle is fitted in accordance with the Rules, Part 2 - Hull, 17.2.} \\ 290, & \text{in the other cases} \end{cases}$$

The pressure $p_{coam}$ in [kN/m$^2$], on the other coamings is given by:

$$p_{coam} = 220.$$

7.10.8.4.2 Local net plate thickness

The local net plate thickness $t$, in [mm], of the hatch coaming plating is given by:

$$t = 14.9 s \sqrt{\frac{p_{coam}}{\sigma_{a,coam}}} S_{coam}$$

where:

- $s$ = secondary stiffener spacing, in [m]
- $p_{coam}$ = pressure, in [kN/m$^2$], as defined in Section 7.10.8.4.1
- $S_{coam}$ = safety factor to be taken equal to 1.15
- $\sigma_{a,coam}$ = 0.95 $R_{el}$

The local net plate thickness is to be not less than 9.5 mm.

7.10.8.4.3 Net scantlings of longitudinal and transverse secondary stiffeners

The required section modulus $Z$, in [cm$^3$], of the longitudinal or transverse secondary stiffeners of the hatch coamings, based on net member thickness, is given by:

$$Z = \frac{1000 S_{coam} \ell^2 s p_{coam}}{m c_p \sigma_{a,coam}}$$

where:

- $m = 16$ in general
- $\ell = 12$ for the end spans of stiffeners snipped at the coaming corners
- $S_{coam} = $ safety factor to be taken equal to 1.15
- $\ell = $ span, in [m], of secondary stiffeners
- $s = $ spacing, in [m], of secondary stiffeners
- $p_{coam} = $ pressure, in [kN/m$^2$], as defined in 7.10.8.4.1
- $c_p = $ ratio of the plastic section modulus to the elastic section modulus of the secondary stiffeners with an attached plate breadth, in [mm], equal to 40 $t$, where $t$ is the plate net thickness
- $\sigma_{a,coam} = 0.95 R_{el}$

7.10.8.4.4 Net scantlings of coaming stays

The required minimum section modulus, $Z$, in [cm$^3$], and web thickness, $t_w$, in [mm], of coaming stays designed as beams with flange connected to the deck or snipped and fitted with a bracket (see Fig. 7.10.8.4.4-1 and 7.10.8.4.4-2) at their connection with the deck, based on member net thickness, are given by:

$$Z = \frac{1000 H_C^2 s p_{coam}}{2 \sigma_{a,coam} t_w}$$

$$t_w = \frac{1000 H_C^2 s p_{coam}}{h \tau_{a,coam}}$$

- $H_C = $ stay height, in [m]
- $s = $ stay spacing, in [m]
- $h = $ stay depth, in [mm], at the connection with the deck
- $p_{coam} = $ pressure, in [kN/m$^2$], as defined in 7.10.8.4.1
- $\sigma_{a,coam} = 0.95 R_{el}$
- $\tau_{a,coam} = 0.5 R_{el}$

For calculating the section modulus of coaming stays, their face plate area is to be taken into account only when it is welded with full penetration welds to the deck plating and adequate underdeck structure is fitted to support the stresses transmitted by it.

For other designs of coaming stays, such as, for examples, those shown in Fig. 7.10.8.4.4-3 and 7.10.8.4.4-4, the stress levels in 7.10.8.3.1 apply and are to be checked at the highest stressed locations.

7.10.8.4.5 Local details

The design of local details is to comply with the requirement of the Rules, Part 2 - Hull, 9.5 for the purpose of transferring the pressures on the hatch covers to the hatch coamings and, through them, to the deck structures below. Hatch coamings and supporting structures are to be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions.
Underdeck structures are to be checked against the load transmitted by the stays, adopting the same allowable stresses specified in Section 7.10.8.4.4.

Unless otherwise stated, weld connections and materials are to be dimensioned and selected in accordance with the Rules, Part 2 - Hull, Part 25 - Metallic materials and Part 26 - Welding.

Double continuous welding is to be adopted for the connections of stay webs with deck plating and the weld throat is to be not less than 0.44 \( t_W \), where \( t_W \) is the gross thickness of the stay web.

Toes of stay webs are to be connected to the deck plating with deep penetration double bevel welds extending over a distance not less than 15% of the stay width.

**7.10.8.5 Closing arrangements**

**7.10.8.5.1 Securing devices**

The strength of securing devices is to comply with the following requirements:

Panel hatch covers are to be secured by appropriate devices (bolts, wedges or similar) suitably spaced alongside the coamings and between cover elements.

Arrangement and spacing are to be determined with due attention to the effectiveness for weather-tightness, depending upon the type and the size of the hatch cover, as well as on the stiffness of the cover edges between the securing devices.

The net sectional area of each securing device is not to be less than:

\[
A = 1.4 \frac{a}{f} \quad [\text{cm}^2]
\]

where:

\( a \) = spacing, in [m], of securing devices, not being taken less than 2 m
\( f = \frac{(R_{\text{ult}} / 235)^e}{(R_{\text{ult}} / 235)^{\text{f}}}, \)
\( R_{\text{ult}} \) = specified minimum upper yield stress, in [N/mm²], of the steel used for fabrication, not to be taken greater than 70% of the ultimate tensile strength.
\( e = 0.75 \text{ for } R_{\text{ult}} > 235 \)
\( e = 1.0 \text{ for } R_{\text{ult}} \leq 235 \)

Rods or bolts are to have a net diameter not less than 19 mm for hatchways exceeding 5 m² in area.

Between cover and coaming and at cross-joints, a packing line pressure sufficient to obtain weathertightness is to be maintained by the securing devices.

For packing line pressures exceeding 5 N/mm², the cross section area is to be increased in direct proportion. The packing line pressure is to be specified.

The cover edge stiffness is to be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia, I, of edge elements is not to be less than:

\[
I = 6 p a^3 \quad [\text{cm}^4]
\]

\( p \) = packing line pressure in [N/mm²], minimum 5 N/mm².
\( a \) = spacing, in [m], of securing devices.

Securing devices are to be of reliable construction and securely attached to the hatchway coamings, decks or covers. Individual securing devices on each cover are to have approximately the same stiffness characteristics.

Where rod cleats are fitted, resilient washers or cushions are to be incorporated.

Where hydraulic cleating is adopted, a positive means is to be provided to ensure that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.

**7.10.8.5.2 Stoppers**

Hatch covers are to be effectively secured, by means of stoppers, against the transverse forces arising from a pressure of 175 kN/m².

With the exclusion of No.1 hatch cover, hatch covers are to be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 175 kN/m².

No. 1 hatch cover is to be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 230 kN/m². This pressure may be reduced to 175 kN/m² when a forecastle is fitted in accordance with the Rules, Part 2 - Hull, 17.2.

The equivalent stress:

i. in stoppers and their supporting structures, and

ii. calculated in the throat of the stopper welds

is not to exceed the allowable value of 0.8 \( \sigma_y \).

**7.10.8.5.3 Materials and welding**

Stoppers or securing devices are to be manufactured of materials, including welding electrodes, meeting relevant requirements of the Rules, Part 25 - Metallic materials and Part 26 - Welding.

**7.10.8.6 Corrosion addition and steel renewal**

**7.10.8.6.1 Hatch covers**

For all the structure (plating and secondary stiffeners) of single skin hatch covers, the corrosion addition \( t_c \) is to be 2.0 mm.

For pontoon hatch covers, the corrosion addition is to be:

- 2.0 mm, for the top and bottom plating
- 1.5 mm, for the internal structures.

For single skin hatch covers and for the plating of pontoon hatch covers, steel renewal is required where the gauged thickness is less than \( t_{\text{gau}} + 0.5 \text{ mm} \) and \( t_{\text{gau}} + 1.0 \text{ mm} \), coating (applied in accordance with the coating manufacturer's requirements) or annual gauging may be adopted as an alternative to steel renewal. Coating is to be maintained in GOOD condition, as defined in Rules, Part 1 – General requirements, Chapter 5 – Surveys of ships in service.

For the internal structure of pontoon hatch covers, thickness gauging is required when plating renewal is to be carried out or when this is deemed necessary, at the discretion of the Register’s Surveyor, on the basis of the plating corrosion or deformation condition. In these cases, steel renewal for the internal structures is required where the gauged thickness is less than \( t_{\text{gau}} \).
7.10.8.6.2 Hatch coamings

For the structure of hatch coamings and coaming stays, the corrosion addition $t_c$ is to be 1.5 mm.

Steel renewal is required where the gauged thickness is less than $t_{net} + 0.5$ mm. Where the gauged thickness is within the range $t_{net} + 0.5$ mm and $t_{net} + 1.0$ mm, coating (applied in accordance with the coating manufacturer's requirements) or annual gauging may be adopted as an alternative to steel renewal. Coating is to be maintained in GOOD condition, as defined in Rules, Part 1 – General requirements, Chapter 5 – Surveys of ships in service, Section 1.2.

![Fig. 7.10.8.4.4-1](image1)

![Fig. 7.10.8.4.4-2](image2)

Fig. 7.10.8.4.4-4

Fig. 7.10.8.4.4-3

7.10.9 Construction of portable hatchway covers specified in 7.10.1.1

7.10.9.1 These covers are to be so constructed as to prevent their accidental opening under the effect of sea and weather.

7.10.9.2 Portable beams are to be placed in sockets of the coamings and locked therein. Where portable beams are of sliding type, efficient devices are to be provided for locking them when the hatchway is either closed or open.

7.10.9.3 If the hatchway covers are jointed on the portable beam, a vertical flat bar of at least 60 mm in height is to be attached by welding to the upper flange of the beam.

7.10.9.4 The width of each bearing surface for hatchway covers is to be at least 65 mm.

7.10.9.5 Where the covers are made of wood, their finished thickness is to be at least 60 mm for a load intensity sustained by the cover equal to 17.16 kPa and less. If the load intensity exceeds this value, the above thickness is to be increased by 1.5 mm per 0.981 kPa of overload. In all cases, the portable beams of the hatchway provided with wooden covers are to be spaced not more than 1.5 m apart.

Independently of the provisions of 7.10.1 to 7.10.8, all covers made of steel are to have the thickness of their plating at least 0.01 times the spacing of stiffeners or 6 mm, whichever is the greater.

If the covers are made of light alloy, the minimum thickness of their top plating is to be specially considered by the Register in each case.

7.10.9.6 The hatchways in positions 1 and 2 are to be protected by at least two layers of tarpaulins.

Tarpaulins are to be tightly pressed against the hatchway coamings with the aid of battens and wedges, for which purpose the coamings, as well as horizontal stiffeners, if fitted, are to be provided with cleats of at least 65 mm wide and 10 mm thick; edges of the cleats are to be rounded so that the possibility of cutting the wedges is brought to the minimum. Cleats are to be spaced not more than 600 mm centre to centre; the cleats along each side or end are to not be more than 150 mm form hatch corners. The cleats are to be so mounted as to provide setting of wedges in them in the fore to
aft direction on the side coamings, and from the sides to centre line direction on the end coamings.

Wedges are to be not less than 200 mm in length and 50 mm in width with a taper of not more than 1:6, and a thickness not less than 13 mm at the thinnest point.

7.10.9.7 Steel bars or other equivalent means are to be provided in order to efficiently and independently secure each section of hatchway covers after the tarpaulins are battened down. Sections of hatchway covers of more than 1.5 m in length are to be secured by at least two such securing appliances.

7.10.10 Hatch beams and cover stiffeners of variable cross section (ICLL Regulation 15 and 16)

7.10.10.1 To avoid stresses and deflections exceeding those given in the above Regulations along construction elements of variable cross section, the required section modulus calculated as for construction elements of constant cross section is to be increased by a factor \( C_1 \) expressed by:

\[
C_1 = 1 + \frac{3.2\alpha - \gamma - 0.8}{7\gamma + 0.4},
\]

where:

\[
\alpha = \frac{I_1}{I}; \quad \gamma = \frac{W_1}{W};
\]

The value of factor \( C_1 \) obtained by the formula is not to be less than unity.

\( I_1, I, W_1 \) and \( W \) are indicated on the Figure 7.10.9.1.

7.10.10.2 The moment of inertia is likewise to be increased by the factor \( C_2 \) expressed by:

\[
C_2 = 1 + 8\alpha^3 \frac{1 - \beta}{0.2 + 3\sqrt[3]{\beta}};
\]

The value factor of \( C \) obtained by the formula is not to be less than unity.

\( I_1 \) and \( I \) are indicated on the Figure 7.10.9.1.

The use of the above formulae is limited to the determination of the strength of hatch beams and covers in which abrupt changes in the section of the face material do no occur along the length of the beam or cover.

7.11 Hatchways of cargo tanks in type "A" ships

7.11.1 Openings for hatchways of the cargo tanks on tankers are to be of round or oval form. Height of the coamings of cargo tank hatchways is not to be regulated by the Register. Construction of the coamings of cargo tank hatchways shall comply with the requirements of the Rules, Part 2 - Hull, 17.2.8.

7.11.2 Covers of hatchs and tank cleaning openings are to be made of steel, bronze or brass. Use of other materials is subject to special consideration by the Register in each case.

In ships carrying flammable liquids in bulk use of light alloys for covers of hatches and tank cleaning openings is not permitted.

7.11.3 Covers of the cargo tank hatchways are to be permanently attached and tight, when secured, under the inner pressure of liquid carried in tanks to a head of at least 2.5 m. Tightness is to be provided by a rubber or other suitable gasket being resistant to the liquids which are carried in the cargo tanks.

7.11.4 The plate of the cargo tank hatchway covers is to be at least 12 mm in thickness if it is of steel. The cover plate is to be reinforced by stiffeners made of flat bars not less than 80 x 12 mm in size, and spaced at every 600 mm of the cover length, or the cover is to be of spherical shape.

7.11.5 The hatchway cover is to be provided with a sighting port having an inner diameter of 150 mm and closed by a cover of similar construction.

7.11.6 Materials and designs of cargo tank hatchway covers in ships intended to carry flammable liquids are to be so selected as to preclude spark formation during opening and closing the covers.

7.12 Openings in watertight subdivision bulkheads and their closing appliances

7.12.1 General

7.12.1.1 Unless expressly provided otherwise, the present head covers the ships to which the requirements of the Rules, Part 5 - Subdivision apply. For other ships the requirements of this chapter apply only to bulkheads provided in accordance with the Rules, Part 2 – Hull, Section 10. For these ships the requirements may be relaxed, and the degree of relaxation is to be specially considered by the Register in each case.

7.12.2 Openings in watertight bulkheads below the bulkhead deck in passenger ships

7.12.2.1 The number of openings in watertight subdivision bulkheads is to be reduced to the minimum compatible with the design and proper working of the ship, satisfactory means are to be provided for closing these openings.

7.12.2.2 Where pipes, scuppers, electric cables, etc., are carried through watertight bulkheads, arrangements are to be
made to ensure the watertight integrity of the bulkheads and the requirements of the Rules, Part 8 - Piping, 1.6 and Part 12-Electrical equipment, 16.8 also is to be taken into consideration.

Valves not forming part of a piping system are to not be permitted in watertight bulkheads.

Lead or other heat sensitive materials are to not be used in systems which penetrate watertight bulkheads, where deterioration of such systems in the event of fire would impair the watertight integrity of the bulkheads.

7.12.2.3 No doors, manholes, or access openings are permitted in watertight transverse bulkheads dividing a cargo space from an adjoining cargo space, except as provided in 7.12.2.20 and in the Rules, Part 5 – Subdivision, 2.12.

7.12.2.4 Subject to requirement 7.12.2.22, not more than one door, apart from the doors to shaft tunnels, may be fitted in each watertight bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion. Where two or more shafts are fitted, the tunnels are to be connected by an intercommunicating passage. There shall be only one door between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors are to be of the sliding type and are to be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck is to be situated outside the spaces containing the machinery.

7.12.2.5 Watertight doors, except as provided in 7.12.2.20 or in the Rules, Part 5 – Subdivision, 2.12, are to be power-operated sliding doors complying with the requirements of 7.12.2.9 to 7.12.2.16 capable of being closed simultaneously from the central operating console at the navigation bridge in not more than 60 s with the ship in the upright position.

7.12.2.6 The means of operation whether by power or by hand of any power-operated sliding watertight door are to be capable of closing the door with the ship listed to 15° either way. Consideration is to also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door.

7.12.2.7 Watertight door controls, including hydraulic piping and electric cables, are to be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimise the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls is to be such that if the ship sustains damage within one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision draught, the operation of the watertight doors clear of the damaged portion of the ship is not impaired.

7.12.2.8 All power-operated sliding watertight doors are to be provided with means of indication which will show at all remote operating positions whether the doors are open or closed. Remote operating positions are only to be at the navigation bridge as required by paragraph 7.12.2.9.5 and at the location where hand operation above the bulkhead deck is required by paragraph 7.12.2.9.4.

7.12.2.9 Each power-operated sliding watertight door:

.1 is to have a vertical or horizontal motion;

.2 is to, subject to requirement 7.12.2.22, be normally limited to a maximum clear opening width of 1.2 m. The Register may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:

.1 special consideration is to be given to the strength of the door and its closing appliances in order to prevent leaks; and

.2 the door is to be located inboard the damage zone B/5;

.3 is to be fitted with the necessary equipment to open and close the door using electric power, hydraulic power, or any other form of power that is acceptable to the Register;

.4 is to be provided with an individual hand-operated mechanism. It is to be possible to open and close the door by hand at the door itself from either side, and in addition, close the door from an accessible position above the bulkhead deck with an all round crank motion or some other movement providing the same degree of safety acceptable to the Register. Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, is not to exceed 90 s with the ship in the upright position

.5 is to be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console at the navigation bridge;

.6 is to be provided with an audible alarm, distinct from any other alarm in the area, which will sound whenever the door is closed remotely by power and which shall sound for at least 5 s but no more than 10 s before the door begins to move and shall continue sounding until the door is completely closed. In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving. Additionally, in passenger areas and areas of high ambient noise the Register may require the audible alarm to be supplemented by an intermittent visual signal at the door; and

.7 is to have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position shall in no case be less than 20 s or more than 40 s with the ship in the upright position.
7.12.2.10 The electrical power required for power-operated sliding watertight doors is to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck. The associated control, indication and alarm circuits are to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by the transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power.

7.12.2.11 Power-operated sliding watertight doors are to have either:

1. a centralised hydraulic system with two independent power sources each consisting of a motor and pump capable of simultaneously closing all doors. In addition, there shall be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. The power operating system is to be designed to minimise the possibility of having a single failure in the hydraulic piping adversely affect the operation of more than one door. The hydraulic system is to be provided with a low-level alarm for hydraulic fluid reservoirs serving the power-operated system and a low gas pressure alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators. These alarms are to be audible and visual and are to be situated on the central operating console at the navigation bridge; or

2. an independent hydraulic system for each door with each power source consisting of a motor and pump capable of opening and closing the door. In addition, there shall be a hydraulic accumulator of sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. A low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators are to be provided at the central operating console on the navigation bridge. Loss of stored energy indication at each local operating position is also to be provided; or

3. an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source is to be capable of being automatically supplied by the transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°; see also the Rules, Part 12-Electrical equipment, 5.10.

For the systems specified in 7.12.2.11.1, 7.12.2.11.2 and 7.12.2.11.3, provision is to be made as follows: Power systems for power-operated watertight sliding doors are to be separate from any other power system. A single failure in the electric or hydraulic power-operated systems excluding the hydraulic actuator is not to prevent the hand operation of any door.

7.12.2.12 Control handles are to be provided at each side of the bulkhead at a minimum height of 1.6 m above the floor and are to be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidentally. The direction of movement of the handles in opening and closing the door is to be in the direction of door movement and is to be clearly indicated.

7.12.2.13 As far as practicable, electrical equipment and components for watertight doors are to be situated above the bulkhead deck and outside hazardous areas and spaces.

7.12.2.14 The enclosures of electrical components necessarily situated below the bulkhead deck shall provide suitable protection against the ingress of water. *

* Refer to the following IEC publication 529(1976):

.1 electrical motors, associated circuits and control components; protected to IPX 7 standard;

.2 door position indicators and associated circuit components; protected to IPX 8 standard; and

.3 door movement warning signals; protected to IPX 6 standard.

Other arrangements for the enclosures of electrical components may be fitted provided the Administration is satisfied that an equivalent protection is achieved. The water pressure IPX 8 shall be based on the pressure that may occur at the location of the component during flooding for a period of 36 h.

7.12.2.15 Electric power, control, indication and alarm circuits are to be protected against fault in such a way that a failure in one door circuit will not cause a failure in any other door circuit. Short circuits or other faults in the alarm or indicator circuits of a door are not to result in a loss of power operation of that door. Arrangements are to be such that leakage of water into the electrical equipment located below the bulkhead deck will not cause the door to open.

7.12.2.16 A single electrical failure in the power operating or control system of a power-operated sliding watertight door is not to result in a closed door opening. Availability of the power supply is to be continuously monitored at a point in the electrical circuit as near as practicable to each of the motors required by 7.12.2.11. Loss of any such power supply should
activate an audible and visual alarm at the central operating console at the navigation bridge.

7.12.2.17 The central operating console at the navigation bridge is to have a ‘master mode’ switch with two modes of control: a ‘local control’ mode which shall allow any door to be locally opened and locally closed after use without automatic closure, and a ‘floors closed’ mode which shall automatically close any door that is open. The ‘floors closed’ mode shall automatically close any door that is open. The ‘floors closed’ mode shall permit doors to be opened locally and shall automatically re-close the doors upon release of the local control mechanism. The ‘master mode’ switch is normally to be in the ‘local control’ mode. The ‘floors closed’ mode is only to be used in an emergency or for testing purposes. Special consideration is to be given to the reliability of the ‘master mode’ switch.

7.12.2.18 The central operating console at the navigation bridge is to be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light shall indicate a door is fully open and a green light shall indicate a door is fully closed. When the door is closed remotely the red light shall indicate the intermediate position by flashing. The indicating circuit is to be independent of the control circuit for each door.

7.12.2.19 It is not to be possible to remotely open any door from the central operating console.

7.12.2.20 If the Register is satisfied that such doors are essential, watertight doors of satisfactory construction may be fitted in watertight bulkheads dividing cargo between deck spaces. Such doors may be hinged, rolling or sliding doors but are not to be remotely controlled. They are to be fitted at the highest level and as far from the shell plating as practicable, but in no case are to be outward vertical edges be situated at a distance from the shell plating which is less than one fifth of the breadth of the ship, as defined in regulation 2, such distance being measured at right angles to the centreline at the level of the deepest subdivision draught.

7.12.2.21 Should any such doors be accessible during the voyage, they are to be fitted with a device which prevents unauthorised opening. When it is proposed to fit such doors, the number and arrangements shall receive the special consideration of the Register.

7.12.2.22 Portable plates on bulkheads are not to be permitted except in machinery spaces.

The Register may permit not more than one power-operated sliding watertight door in each watertight bulkhead larger than those specified in paragraph 7.12.2.9.2 to be substituted for these portable plates, provided these doors are intended to remain closed during navigation except in case of urgent necessity at the discretion of the master. These doors need not meet the requirements of paragraph 7.12.2.9.4 regarding complete closure by hand-operated gear in 90 s.

7.12.2.23 Where trunkways or tunnels for access from crew accommodation to the stokehold, for piping, or for any other purpose are carried through watertight bulkheads, they are to be watertight and in accordance with the requirements of the Rules, Part 2—Hull, 11.7. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, is to be through a trunk extending watertight to a height sufficient to permit access above the bulkhead deck. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels are not to extend through the first subdivision bulkhead abait the collision bulkhead.

7.12.2.24 Where it is proposed to fit tunnels piercing watertight bulkheads, these shall receive the special consideration of the Register.

7.12.2.25 Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings are to be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

7.12.2.26 Doors are to be made of steel. Use of other materials for doors is to be specially considered by the Register in each case.

7.12.2.27 Doors shall withstand the pressure of water head of a height measured from the lower edge of the doorway to the underside of the bulkhead deck plating at the centre line, but not less than 5 m of water column.

7.12.2.28 Stresses in the door frame and door plate under the pressure head specified in 7.12.2.27 are not to exceed 0.6 times the upper yield stress of their material.

7.12.2.29 When closed, doors are to be tight under the pressure of water head of the height specified in 7.12.2.27.

7.12.2.30 For doors in watertight bulkheads located in way of the internal watertight subdivision boundaries and the external watertight boundaries necessary to ensure compliance with the relevant subdivision and damage stability regulations IACS Unified Interpretation SC136 is to be applied.

This unified interpretation does not apply to doors located in external boundaries above equilibrium or intermediate waterplanes.

7.12.2.31 For the requirements relating to the accesses that lead to spaces below the bulkhead deck specified in SOLAS Regulation II-1/17-1, Integrity of the hull and superstructure, damage prevention and control on ro-ro passenger ships, see also IACS Unified Interpretation SC220.

7.12.3 Openings in watertight bulkheads and internal decks in cargo ships

7.12.3.1 The number of openings in watertight subdivisions is to be kept to a minimum compatible with the design and proper working of the ship. Where penetrations of watertight bulkheads and internal decks are necessary for access, piping, ventilation, electrical cables, etc., arrangements are to be made to maintain the watertight integrity. The Register may permit relaxation in the watertightness of openings above the freeboard deck, provided that it is demonstrated that any progressive flooding can be easily controlled and that the safety of the ship is not impaired.

7.12.3.2 Doors provided to ensure the watertight integrity of internal openings which are used while at sea are to be sliding watertight doors capable of being remotely closed from the bridge and are also to be operable locally from each side of the bulkhead. Indicators are to be provided at the control position showing whether the doors are open or closed, and an audible
alarm is to be provided at the door closure. The power, control and indicators are to be operable in the event of main power failure. Particular attention is to be paid to minimising the effect of control system failure. Each power-operated sliding watertight door is to be provided with an individual hand-operated mechanism. It is to be possible to open and close the door by hand at the door itself from both sides.

7.12.3.3 Access doors and access hatch covers normally closed at sea, intended to ensure the watertight integrity of internal openings, are to be provided with means of indication locally and on the bridge showing whether these doors or hatch covers are open or closed. A notice is to be affixed to each such door or hatch cover to the effect that it is not to be left open.

7.12.3.4 Watertight doors or ramps of satisfactory construction may be fitted to internally subdivide large cargo spaces, provided that the Register is satisfied that such doors or ramps are essential. These doors or ramps may be hinged, rolling or sliding doors or ramps, but are not to be remotely controlled. Should any of the doors or ramps be accessible during the voyage, they are to be fitted with a device which prevents unauthorised opening.

7.12.3.5 Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of internal openings are to be provided with a notice which is to be affixed to each such closing appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not be so marked.

7.12.3.6 In all tankers, where there is permanent access from a pipe tunnel to the cargo pump room, a watertight door is to be fitted. A watertight door, in addition to bridge operation, is to be capable of being manually closed from outside the cargo pump-room entrance.

7.12.3.7 For doors in watertight bulkheads located in way of the internal watertight subdivision boundaries and the external watertight boundaries necessary to ensure compliance with the relevant subdivision and damage stability regulations, see IACS Unified Interpretation SC156.

7.12.4 Manholes in watertight subdivision bulkheads

7.12.4.1 The requirements of 7.9 relating to the manholes located on the freeboard deck, raised quarter deck or the first tier of superstructures are generally applicable to the manholes fitted in the watertight subdivision bulkheads.

No manholes are permitted:

.1 in the collision bulkhead below the bulkhead deck for ships having subdivision distinguishing mark in the class notation, and below the freeboard deck for other ships;

.2 in watertight subdivision bulkheads separating a cargo space from an adjacent cargo space or a fuel oil tank.

7.12.5 Construction and initial tests of watertight doors, sidescuttles, etc.

7.12.5.1 In all ships:

.1 the design, materials and construction of all watertight doors, sidescuttles, gangway and cargo ports, valves, pipes, ash-chutes and rubbish-chutes referred to in these regulations are to be to the satisfaction of the Register;

.2 such valves, doors and mechanisms are to be suitably marked to ensure that they may be properly used to provide maximum safety; and

.3 the frames of vertical watertight doors are to have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

7.12.5.2 In passenger ships and cargo ships watertight doors are to be tested by water pressure to a head up to the bulkhead deck or freeboard deck respectively. Where testing of individual doors is not carried out because of possible damage to insulation or outfitting items, testing of individual doors may be replaced by a prototype pressure test of each type and size of door with a test pressure corresponding at least to the head required for the intended location. The prototype test is to be carried out before the door is fitted. The installation method and procedure for fitting the door on board shall correspond to that of the prototype test. When fitted on board, each door is to be checked for proper seating between the bulkhead, the frame and the door.

7.13 STRENGTH AND SECURING OF SMALL HATCHES ON THE EXPOSED FORE DECK

7.13.1 General

7.13.1.1 The strength of, and securing devices for, small hatches fitted on the exposed fore deck are to comply with the requirements of this Section.

7.13.1.2 Small hatches in the context of this Section are hatches designed for access to spaces below the deck and are capable to be closed weather-tight or watertight, as applicable. Their opening is normally 2.5 square meters or less.

7.13.1.3 Hatches designed for use of emergency escape are to comply with the requirements of this Section, excepting 7.13.4.1 (i) and (ii), 7.13.5.3 and 7.13.6.

7.13.1.4 Securing devices of hatches designed for emergency escape are to be of a quick-acting type (e.g., one action wheel handles are provided as central locking devices for latching/unlatching of hatch cover) operable from both sides of the hatch cover.

7.13.2 Application

7.13.2.1 These requirements are applicable to small hatches on the exposed deck over the forward 0.25L for:
All ship types of sea going service of length 80 m or more, where the height of the exposed deck in way of the hatch is less than 0.1L or 22 m above the summer load water-line, whichever is the lesser.

7.13.2.2 The ship length \( L \) is as defined in 1.2.2.1.

7.13.2.3 These requirements do not apply to CSR Bulk Carriers and Oil Tankers.

7.13.3 Strength

7.13.3.1 For small rectangular steel hatch covers, the plate thickness, stiffener arrangement and scantlings are to be in accordance with Table 7.13.3.1, and Figure 7.13.3.1-1. Stiffeners, where fitted, are to be aligned with the metal-to-metal contact points, required in 7.13.5.1, see Figure 7.13.3.1-1. Primary stiffeners are to be continuous. All stiffeners are to be welded to the inner edge stiffener, see Figure 7.13.3.1-2.

7.13.3.2 The upper edge of the hatchway coamings is to be suitably reinforced by a horizontal section, normally not more than 170 to 190 mm from the upper edge of the coamings.

7.13.3.3 For small hatch covers of circular or similar shape, the cover plate thickness and reinforcement is to be according to the requirements of the Rules.

7.13.3.4 For small hatch covers constructed of materials other than steel, the required scantlings are to provide equivalent strength.

7.13.4 Primary securing devices

7.13.4.1 Small hatches located on exposed fore deck subject to the application of this Section are to be fitted with primary securing devices such that their hatch covers can be secured in place and weather-tight by means of a mechanism employing any one of the following methods:

i) Butterfly nuts tightening onto forks (clamps),

ii) Quick acting cleats, or

iii) Central locking device.

7.13.4.2 Dogs (twist tightening handles) with wedges are not acceptable.

7.13.5 Requirements for primary securing

7.13.5.1 The hatch cover is to be fitted with a gasket of elastic material. This is to be designed to allow a metal to metal contact at a designed compression and to prevent over compression of the gasket by green sea forces that may cause the securing devices to be loosened or dislodged. The metal-to-metal contacts are to be arranged close to each securing device in accordance with Figure 7.13.3.1-1, and of sufficient capacity to withstand the bearing force.

7.13.5.2 The primary securing method is to be designed and manufactured such that the designed compression pressure is achieved by one person without the need of any tools.

7.13.5.3 For a primary securing method using butterfly nuts, the forks (clamps) are to be of robust design. They are to be designed to minimise the risk of butterfly nuts being dislodged while in use; by means of curving the forks upward, a raised surface on the free end, or a similar method. The plate thickness of unstiffened steel forks is not to be less than 16 mm. An example arrangement is shown in Figure 7.13.3.1-2.

7.13.5.4 For small hatch covers located on the exposed deck forward of the fore-most cargo hatch, the hinges are to be fitted such that the predominant direction of green sea will cause the cover to close, which means that the hinges are normally to be located on the fore edge.

7.13.5.5 On small hatches located between the main hatches, for example between Nos. 1 and 2, the hinges are to be placed on the fore edge or outboard edge, whichever is practicable for protection from green water in beam sea and bow quartering conditions.

7.13.6 Secondary securing device

Small hatches on the fore deck are to be fitted with an independent secondary securing device e.g. by means of a sliding bolt, a hasp or a backing bar of slack fit, which is capable of keeping the hatch cover in place, even in the event that the primary securing device became loosened or dislodged. It is to be fitted on the side opposite to the hatch cover hinges.

### Table 7.13.3.1 Scantlings for small steel hatch covers on the fore deck

<table>
<thead>
<tr>
<th>Nominal size [mm x mm]</th>
<th>Cover plate thickness [mm]</th>
<th>Primary stiffeners</th>
<th>Secondary stiffeners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Flat Bar [mm x mm]; number</td>
<td></td>
</tr>
<tr>
<td>630 x 630</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>630 x 830</td>
<td>8</td>
<td>100 x 8 ; 1</td>
<td>-</td>
</tr>
<tr>
<td>830 x 630</td>
<td>8</td>
<td>100 x 8 ; 1</td>
<td>-</td>
</tr>
<tr>
<td>830 x 830</td>
<td>8</td>
<td>100 x 10 ; 1</td>
<td>-</td>
</tr>
<tr>
<td>1030 x 1030</td>
<td>8</td>
<td>120 x 12 ; 1</td>
<td>80 x 8 ; 2</td>
</tr>
<tr>
<td>1330 x 1330</td>
<td>8</td>
<td>150 x 12 ; 1</td>
<td>100 x 10 ; 2</td>
</tr>
</tbody>
</table>
Figure 7.13.3.1-1 Arrangement of stiffeners

- Hinge
- Securing device / metal to metal contact
- Primary stiffener
- Secondary stiffener
7.14 STRENGTH REQUIREMENTS FOR FORE DECK FITTINGS AND EQUIPMENT

7.14.1 General

7.14.1.1 This Section provides strength requirements to resist green sea forces for the following items located within the forward quarter length:

- air pipes, ventilator pipes and their closing devices, the securing of windlasses.

7.14.1.2 For windlasses, these requirements are additional to those appertaining to the anchor and chain performance criteria in Section 3.

7.14.1.3 Where mooring winches are integral with the anchor windlass, they are to be considered as part of the windlass.

7.14.2 Application

7.14.2.1 These requirements are applicable to the deck fittings and equipment on the exposed deck over the forward 0.25L for:

All ship types of sea going service of length 80 m or more, where the height of the exposed deck in way of the item is less than 0.1L or 22 m above the summer load waterline, whichever is the lesser.

7.14.2.2 The ship length L is as defined in 1.2.2.1.

7.14.2.3 These requirements do not apply to CSR Oil Tankers. The requirements of this Section concerning windlasses do not apply to CSR Bulk Carriers.
7.14.3 Applied loading

7.14.3.1 Air pipes, ventilator pipes and their closing devices

7.14.3.1.1 The pressures \( p \), in \([\text{kN/m}^2]\), acting on air pipes, ventilator pipes and their closing devices may be calculated from:

\[
p = 0.5 \rho V^2 C_d C_s C_p
\]

where:

- \( \rho \) = density of sea water (1.025 \( \text{t/m}^3 \))
- \( V \) = velocity of water over the fore deck
  - \( 13.5 \text{ m/sec} \) for \( d \leq 0.5 \text{ m} \),
  - \( \sqrt{2(1 - \frac{d}{d_1})} \text{ m/sec} \), for \( 0.5 \text{ m} < d < d_1 \)
  - \( d \) = distance from summer load waterline to exposed deck,
- \( d_1 \) = 0.1L or 2.2 m whichever is the lesser,
- \( C_d \) = shape coefficient
  - 0.5 for pipes, 1.3 for air pipe or ventilator heads in general, 0.8 for an air pipe or ventilator head of cylindrical form with its axis in the vertical direction,
- \( C_s \) = slamming coefficient
  - 3.2 for standard pipes of 760 mm height closed, 3.1 for ventilator pipes and heads,
  - 2.8 for ventilator heads in general, 0.7 for pipes and ventilator heads located immediately behind a breakwater or forecastle,
  - 1.0 elsewhere and immediately behind a bulwark.

7.14.3.1.2 Forces acting in the horizontal direction on the pipe and its closing device may be calculated from 7.14.3.1.1 using the largest projected area of each component.

7.14.3.2 Windlasses

7.14.3.2.1 The following pressures and associated areas are to be applied (see Figure 7.14.3.2.1):

- 200 \text{kN/m}^2 normal to the shaft axis and away from the forward perpendicular, over the projected area in this direction,
- 150 \text{kN/m}^2 parallel to the shaft axis and acting both inboard and outboard separately, over the multiple of \( f \) times the projected area in this direction, where \( f \) is defined as:
  \[ f = 1 + \frac{B}{H} \text{, but not greater than 2.5} \]

where:

- \( B \) = width of windlass measured parallel to the shaft axis,
- \( H \) = overall height of windlass.

7.14.3.2.2 Forces in the bolts, chocks and stoppers securing the windlass to the deck are to be calculated. The windlass is supported by \( N \) bolt groups, each containing one or more bolts, see Figure 7.14.3.2.2.

7.14.3.2.3 The axial force \( R_i \) in bolt group (or bolt) \( i \), positive in tension, may be calculated from:

\[
R_{yi} = P_i h \cdot y_i A_i / I_x
\]

and

\[
R_i = R_{wi} + R_{yi} - R_s
\]

where:

- \( P_i \) = force, in [kN], acting normal to the shaft axis
- \( P_y \) = force, in [kN], acting parallel to the shaft axis, either inboard or outboard whichever gives the greater force in bolt group \( i \)
- \( h \) = shaft height above the windlass mounting, in [m]
- \( x_i, y_i \) = \( x \) and \( y \) coordinates of bolt group \( i \) from the centroid of all \( N \) bolt groups, positive in the direction opposite to that of the applied force, in [cm]
- \( A_i \) = cross sectional area of all bolts in group \( i \), in \([\text{cm}^2]\)
- \( I_x \) = moment of inertia of bolt group in the horizontal direction, in \([\text{cm}^4]\)
- \( A_{si} \) = contribution of all bolts in bolt group \( i \) to the moment of inertia about the axis \( x \)

7.14.3.2.4 Shear forces \( F_{xi} \), \( F_{yi} \) applied to the bolt group \( i \), and the resultant combined force \( F_i \) may be calculated from:

\[
F_{xi} = (P_x - \alpha g M) / N
\]

and

\[
F_{yi} = (P_y - \alpha g M) / N
\]

where:

- \( \alpha \) = coefficient of friction (0.5)
- \( M \) = mass of windlass, in [tonnes]
- \( g \) = gravity acceleration (9.81 m/sec\(^2\))
- \( N \) = number of bolt groups.

7.14.3.2.5 Axial tensile and compressive forces in 7.14.3.2.3 and lateral forces in 7.14.3.2.4 are also to be considered in the design of the supporting structure.

7.14.4 Strength requirements

7.14.4.1 Air pipes, ventilator pipes and their closing devices

7.14.4.1.1 These requirements are additional to the Rules, Part 8 – Pipes, 5.1 and 1.3, see also IACS Unified Interpretation LL36.

7.14.4.1.2 Bending moments and stresses in air and ventilator pipes are to be calculated at critical positions: at penetration pieces, at weld or flange connections, at toes of supporting brackets. Bending stresses in the net section are not to exceed 0.8 \( R_{yfi} \), where \( R_{yfi} \) is the specified minimum yield stress or 0.2% proof stress of the steel at room temperature, see the Rules, Part 25 – Metallic materials, 2.5. Irrespective of corrosion protection, a corrosion addition to the net section of 2.0 mm is then to be applied.

7.14.4.1.3 For standard air pipes of 760 mm height closed by heads of not more than the tabulated projected area, pipe thicknesses and bracket heights are specified in Table 7.14.4.1.3. Where brackets are required, three or more radial brackets are to be fitted.
Brackets are to be of gross thickness 8 mm or more, of minimum length 100 mm, and height according to Table 7.14.4.1.3 but need not extend over the joint flange for the head. Bracket toes at the deck are to be suitably supported.

7.14.4.1.4 For other configurations, loads according to 7.14.3.1 are to be applied, and means of support determined in order to comply with the requirements of 7.14.4.1.2. Brackets, where fitted, are to be of suitable thickness and length according to their height. Pipe thickness is not to be taken less than as indicated in the Rules, Part 8 – Pipes, 1.3.

7.14.4.1.5 For standard ventilators of 900 mm height closed by heads of not more than the tabulated projected area, pipe thicknesses and bracket heights are specified in Table 7.14.4.1.5. Brackets, where required, are to be as specified in 7.14.4.1.3.

7.14.4.1.6 For ventilators of height greater than 900 mm, brackets or alternative means of support are to be fitted according to the requirements of the Rules, Part 2 - Hull. Pipe thickness is not to be taken less than as indicated in the Rules, Part 8 – Pipes, 1.3.

7.14.4.1.7 All component parts and connections of the air pipe or ventilator are to be capable of withstanding the loads defined in 7.14.3.1.

7.14.4.1.8 Rotating type mushroom ventilator heads are unsuitable for application in the areas defined in 17.4.2.

7.14.4.2 Windlass mounts

7.14.4.2.1 Tensile axial stresses in the individual bolts in each bolt group i are to be calculated. The horizontal forces $F_{ij}$ and $F_{ij}$ are normally to be reacted by shear chocks. Where “fitted” bolts are designed to support these shear forces in one or both directions, the von Mises equivalent stresses in the individual bolts are to be calculated, and compared to the stress under proof load. Where pour-able resins are incorporated in the holding down arrangements, due account is to be taken in the calculations.

The safety factor against bolt proof strength is to be not less than 2.0.

7.14.4.2.2 The strength of above deck framing and hull structure supporting the windlass and its securing bolt loads as defined in 7.14.3.2 is to be according to the requirements of the Rules, Part 2 – Hull, 9.2.

### Table 7.14.4.1.3

#### 760 mm air pipe thickness and bracket standards

<table>
<thead>
<tr>
<th>Nominal pipe diameter [mm]</th>
<th>Minimum fitted gross thickness, the Rules, Part 8 – Pipes, 1.3 [mm]</th>
<th>Maximum projected area of head [cm²]</th>
<th>Height (1) of brackets [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>40A(3)</td>
<td>6.0</td>
<td>-</td>
<td>520</td>
</tr>
<tr>
<td>50A(3)</td>
<td>6.0</td>
<td>-</td>
<td>520</td>
</tr>
<tr>
<td>65A</td>
<td>6.0</td>
<td>-</td>
<td>480</td>
</tr>
<tr>
<td>80A</td>
<td>6.3</td>
<td>-</td>
<td>460</td>
</tr>
<tr>
<td>100A</td>
<td>7.0</td>
<td>-</td>
<td>380</td>
</tr>
<tr>
<td>125A</td>
<td>7.8</td>
<td>-</td>
<td>300</td>
</tr>
<tr>
<td>150A</td>
<td>8.5</td>
<td>-</td>
<td>300</td>
</tr>
<tr>
<td>175A</td>
<td>8.5</td>
<td>-</td>
<td>300</td>
</tr>
<tr>
<td>200A</td>
<td>8.5(2)</td>
<td>1900</td>
<td>300(2)</td>
</tr>
<tr>
<td>250A</td>
<td>8.5(2)</td>
<td>2500</td>
<td>300(2)</td>
</tr>
<tr>
<td>300A</td>
<td>8.5(2)</td>
<td>3200</td>
<td>300(2)</td>
</tr>
<tr>
<td>350A</td>
<td>8.5(2)</td>
<td>3800</td>
<td>300(2)</td>
</tr>
<tr>
<td>400A</td>
<td>8.5(2)</td>
<td>4500</td>
<td>300(2)</td>
</tr>
</tbody>
</table>

(1) Brackets (see 7.14.4.1.3) need not extend over the joint flange for the head.
(2) Brackets are required where the as fitted (gross) thickness is less than 10.5 mm, or where the tabulated projected head area is exceeded.
(3) Not permitted for new ships - reference the Rules, Part 8 – Pipes, 1.3.

Note: For other air pipe heights, the relevant requirements of section 7.14.4 are to be applied.
Table 7.14.4.1.5
900 mm ventilator pipe thickness and bracket standards

<table>
<thead>
<tr>
<th>Nominal pipe diameter [mm]</th>
<th>Minimum fitted gross thickness, the Rules, Part 8 – Pipes, 1.3 [mm]</th>
<th>Maximum projected area of head [cm²]</th>
<th>Height of brackets [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>80A 6.3</td>
<td>-</td>
<td>-</td>
<td>460</td>
</tr>
<tr>
<td>100A 7.0</td>
<td>-</td>
<td>-</td>
<td>380</td>
</tr>
<tr>
<td>150A 8.5</td>
<td>-</td>
<td>880</td>
<td>-</td>
</tr>
<tr>
<td>200A 8.5</td>
<td>550</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>250A 8.5</td>
<td>-</td>
<td>1200</td>
<td>-</td>
</tr>
<tr>
<td>300A 8.5</td>
<td>-</td>
<td>2000</td>
<td>-</td>
</tr>
<tr>
<td>350A 8.5</td>
<td>-</td>
<td>2700</td>
<td>-</td>
</tr>
<tr>
<td>400A 8.5</td>
<td>-</td>
<td>3300</td>
<td>-</td>
</tr>
<tr>
<td>450A 8.5</td>
<td>-</td>
<td>4000</td>
<td>-</td>
</tr>
<tr>
<td>500A 8.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: For other ventilator heights, the relevant requirements of section 7.14.4 are to be applied.

Figure 7.14.3.2.1 Direction of forces and weight

Note: Py to be examined from both inboard and outboard directions separately - see 7.14.3.2.1. The sign convention for y is reversed when Py is from the opposite direction as shown.
Figure 7.14.3.2.2 Sign convention

Coordinates $x_i$ and $y_i$ are shown as either positive (+) or negative (-).

Centreline of windlass

Centroid of bolt groups
8 ARRANGEMENT AND EQUIPMENT OF SHIP'S SPACES

8.1 GENERAL PROVISIONS

The requirements for the arrangement and equipment of machinery spaces are specified in the Rules, Part 7 - Machinery installation, 1.11 and 1.12, and those relating to refrigerating machinery spaces, refrigerant store rooms as well as refrigerated cargo spaces are set forth in the Rules, Part 11 - Refrigerating plant, 3.

8.2 LOCATION OF SPACES

8.2.1 The ship's control station is to be located in an enclosed space of the wheelhouse on the navigating bridge. All navigational aids and signalling means are to be concentrated in that place.

It is to be ensure:
- proper visual control of the ship's running,
- good visibility with maximum view of water surface,
- good audibility of sound signals of approaching ships.

It is recommended to arrange the rudder wheel in the ship's centre line.

8.2.2 The chart room is to be located in a space adjacent to the wheelhouse, and a common space is to be used for both services.

8.2.3 No accommodation spaces are to be arranged forward of the collision bulkhead and abaft of the after peak bulkhead below the bulkhead deck.

8.3 EQUIPMENT OF DRY CARGO HOLDS

8.3.1 When in ships not having double bottom wooden ceiling is placed on top of the floors, it is to be solid and shall extend up to the bilge. The ceiling is recommended to be made of portable sections of such dimensions and so constructed as to allow of their ready removal at any place.

The thickness of a pine ceiling is to be:
- at least 40 mm for ships 30 m in length and less;
- at least 60 mm for ships over 30 m in length;
- at least 70 mm under cargo hatchways.

8.3.2 When in ships having double bottom wooden ceiling is fitted, it is to have a thickness as follows:
- at least 50 mm for ships 60 m in length and less;
- at least 65 mm for ships over 60 m in length.

The application of the ceiling made from synthetic material is subject to special consideration by the Register in each case.

8.3.3 Where cargo is discharged by grabs or other mechanism, the thickness of the wooden ceiling fitted under cargo hatchways is to be doubled.

8.3.4 In holds intended for carriage of grain and other bulk cargoes the wooden ceiling on the inner bottom, or, in case the latter is omitted, on the top of floors, is to be fitted so as to prevent wells, bilges and suction pipes of the bilge pumping from clogging.

8.3.5 The wooden ceiling is not to be laid directly on the inner bottom, but is to be embedded in an approved bituminous or epoxy composition, or placed on battens along the floors providing a clear space of 25-30 mm for drainage.

The wooden ceiling over the bilges is to be placed so as to be readily removable.

8.3.6 The bulkheads of the deep tanks are to be sheathed by wood from hold side.

8.3.7 In holds intended for the carriage of general cargoes, cargo battens made of wood or metal are to be fitted on the sides.

The thickness of wooden battens is to be as follows:
- at least 25 mm - on ships up to 20 m in length,
- at least 40 mm - on ships up to 70 m inclusive,
- at least 50 mm - on ships over 70 m in length.

The spacing between wooden battens is not to exceed 300 mm. Battens are to be attached to the side frame in such a way as to make for easy removal and replacement. It may not be necessary to provided battens if Register approves this on the basis of the type of cargo and ship construction.

8.3.8 All projecting parts of various equipment in the holds (manholes, air pipes sounding pipes, etc.) are to be protected with wooden screens, grids, chutes etc. Requirements for laying of piping in cargo holds are given in the Rules, Part 8 – Piping, 5.5.

8.3.9 Construction of container cellular guides

8.3.9.1 For determining scantlings of substructures for cell guide systems and lashing devices the following design forces are to be used which are assumed to act simultaneously in the centre of gravity of stock:
- ship's transverse direction:
  \[ Y = 0.5 \cdot g \cdot G, \text{ in } [kN]; \]
- ship's vertical direction:
  \[ Z = (1 + a_v) \cdot g \cdot G, \text{ in } [kN]; \]

where:

- \( G \) = stack mass, in [t];
- \( a_v \) = see the Rules, Part 2 - Hull, 3.3.

8.3.9.2 The permissible stresses are to be taken as follows:

normal: \( \sigma = 0.67 R_{eff} \)

shear: \( \tau = 0.45 R_{eff} \)

equivalent: \( \sigma_e = \sqrt{\sigma^2 + 3\tau^2} = 0.77 R_{eff} \)
8.3.10 Movable decks, platforms, ramps and other similar structures

8.3.10.1 The present requirements apply to the movable decks, platforms, ramps and other similar structures designed to be installed in two positions:
- in working position when they are used for carriage, loading or unloading of vehicles or other cargoes;
- in non-working position when they are not used for carriage, loading or unloading of vehicles or other cargoes.

8.3.10.2 The movable decks, platforms, ramps and other similar structures and also their supporting elements at ship’s sides, decks and bulkheads, the pillars or suspensions for decks and platforms ensuring their proper installation in the working position are to be designed in accordance with the Rules, Part 2 - Hull.

8.3.10.3 Arrangements are to be provided for reliable securing of the movable decks, platform ramps and other similar structures in the non-working position.

8.3.10.4 When the movable decks, platforms, ramps and other similar structures are secured in the non-working position, the hoisting gear and elements thereof are not generally to be kept under the load.

It is not permitted to secure the movable decks, platforms, ramps and other similar structures by suspending them on ropes.

8.3.10.5 The structural elements of the arrangements mentioned in 8.3.10.3 and also the associated supporting structures are to be designed to withstand the forces resulting form the application of the loads \( P_x \), \( P_y \), \( P_z \), as obtained from the formulae given below, to the centres of gravity of the considered section of the deck, platform, ramp or other similar structures:
\[
\begin{align*}
P_x &= m \cdot g \cdot a_x, \text{ in [N]}..
\end{align*}
\]
\[
\begin{align*}
P_y &= m \cdot g \cdot a_y, \text{ in [N]}..
\end{align*}
\]
\[
\begin{align*}
P_z &= m \cdot g \cdot (1 + a_z), \text{ in [N]}.
\end{align*}
\]

where:
- \( P_x \) = horizontal load parallel to the centre plane of the ship, \( n \); (consideration is to be given to the cases when the load \( P_x \) is directed both forward and aft);
- \( P_y \) = horizontal load parallel to the midstation plane, in [N], (consideration is to be given to the cases when the load \( P_y \) is directed both to the nearest ship's side and to the opposite side);
- \( P_z \) = vertical load directed downward, in [N];
- \( m \) = mass of the considered section, in [kg];
- \( g \) = 9.81 m/s\(^2\);
- \( a_x, a_y, a_z \) = dimensionless accelerations, see the Rules, Part 2 - Hull, 3.5.

8.3.10.6 When determining the forces affecting the structural elements of the arrangements specified in 8.3.10.3 and the associated supporting structures with regard to the provisions of 8.3.10.5, the loads \( P_x \), \( P_y \) and \( P_z \) are regarded as separately applied i.e. no account is taken of their combined action and of the frictional forces originating on the surfaces of the considered sections of decks, platforms, ramps or other similar structures which are in contact with the associated supporting structures.

8.3.10.7 When the structural elements of the arrangements specified in 8.3.10.3 and the associated supporting structures are under the effect of the loads determined according to the provisions of 8.3.10.5 and 8.3.10.6, the stresses in their parts are not to exceed 0.7 times the upper yield stress of material.

Under the effect of these loads the safety factor of the wire ropes in relation to their actual breaking strength is not to be less than 4; the safety factor of the chain cables in relation to the proof load of the chain is not to be less than 2; the margin of safety against buckling of the elements subjected to the compression stress is not to be less than 2.

8.3.10.8 Wire ropes used in the arrangements specified in 8.3.10.3 shall satisfy the Rules, Part 25 - Metallic materials, 8.

8.4 EXITS, DOORS, CORRIDORS, STAIRWAYS AND VERTICAL LADDERS

8.4.1 General

Location and arrangement of exits, doors, corridors, stairways and vertical ladders shall ensure ready access of persons from spaces to the places of embarkation into lifeboats and liferafts.

8.4.2 Exits and doors

8.4.2.1 In passenger ships and in special purpose ships each watertight compartment of similarly restricted space or group of spaces situated below the bulkhead deck is to have at least two means of escape, in any case one of which is to be independent of the door in the subdivision bulkhead.

8.4.2.2 In passenger ships and in special purpose ships above the bulkhead deck, each main vertical fire zone, see the Rules, Part 17 - Fire protection, 2.2, or similarly restricted space or group of spaces shall have at least two means of escape one of which shall give access to a stairway forming a vertical escape.

8.4.2.3 In passenger ships the number and location of means of escape from special category spaces, see the Rules, Part 17 - Fire protection, 2.2, are subject to special consideration by the Register, and the degree of safety for escape from these spaces to the places of embarkation into lifeboats and liferafts shall at least correspond to that specified in 8.4.2.1 and 8.4.2.2.

Two means of escape are to be provided from a machinery control room located within machinery space, at least one which will provide continuous fire shelter to a safe position outside the machinery space.

For cargo ships in all ro-ro cargo spaces where the crew is normally employed the number and locations of escape routes to the open deck are subject to special consideration by the Register, but shall in no case be less than two and are to be widely separated.
8.4.2.4 In cargo ships of 500 tons gross tonnage and upwards at each level of accommodation spaces there shall be at least two means of escape, as widely separated as possible, from each restricted space or group of spaces; from the spaces situated below the open deck the main means of escape are to be formed by a stairway, the other means of escape may be formed by a casing with a vertical ladder or by a stairway.

From the spaces situated above the open deck the means of escape are to be formed by doors of stairways leading to the open deck or combination thereof.

8.4.2.5 Exceptionally, the Register may dispense with one of the means of escape specified in 8.4.2.1 or 8.4.2.4, due regard being paid to the purpose and location of spaces and to the number of persons who normally might be quartered or employed there.

8.4.2.6 In hydrofoil boats each passenger space is to have at least two independent means of escape arranged at the opposite ends of the space and ensuring ready access to the life-saving appliances.

8.4.2.7 Stairways serving only a space and a balcony in that space, as well as lifts are not to be considered as means of escape specified in 8.4.2.1, 8.4.2.2 to 8.4.2.4 and 8.4.2.6.

8.4.2.8 Each public room in passenger ships is to be provided with at least two means of escape. Both exits are to be spaced from each other as wide as practicable. A readily seen inscription "Exit" or "Emergency exit" is to be provided above every such exit.

8.4.2.9 The wheelhouse is to have two exits, one to each side of the navigation bridge, with a passageway through the house from side to side.

8.4.2.10 The total width of exits from halls is to be determined on the basis of 0.8 m per 50 persons, however, the width of each exit is not to be less than 1.1 m, when the number of seats is more than 50, and not less than 0.8 m when the number of seats is not more than 50.

The width of each exit from accommodation and service spaces is not to be less than 600 mm. The size of the ladderways from cargo holds is not to be less than 0.6 m.

8.4.2.11 The exit doors and ladderway covers are to be so arranged that they can be operated from both sides. Doors shall open as follows:

1. doors of accommodation and service space giving access to a corridor inside the spaces;
2. doors of public rooms, outside or each side;
3. doors in the end bulkheads of superstructure and in external transverse bulkheads of deckhouse outside in the direction of the nearest side;
4. doors in the external longitudinal bulkhead of deckhouses, outside in the forward direction.

On ships of 30 m or less in length, the doors mentioned in .1 may open outward if they are located at the end of a blind corridor and if they do not block exits from other spaces.

The doors discussed in .3 and .4 may also open inward, but this is subject to special consideration.

No sliding doors are permitted on exits, other than watertight doors on bulkheads.

8.4.2.12 Doors of accommodations are to have in their lower portions detachable panels 0.4 x 0.5 m in size; which may be knocked out these panels of the passenger cabin doors are to be provided with the following inscriptions: "Means of escape-knock out in case of emergency".

The detachable panels need not be fitted where the spaces are provided with opening type side scuttles of at least 400 mm in diameter or windows the smaller side of which being at least 400 mm and on condition that persons may get to the corridor or open deck through these side scuttles or windows.

The appropriate means are to be provided, if necessary, to facilitate exit through side scuttles or windows.

8.4.3 Corridors and passageways

8.4.3.1 All corridors and passageways shall ensure free movement of persons along them. Vestibules, corridors or parts of corridors with only one means of escape are not permissible for passenger ships and special purpose ships having more than 50 persons of special personnel on board.

In cargo ships and special purpose ships having less than 50 persons of special personnel on board blind corridors longer than 7 m are not permitted.

Blind corridor is corridor, lobby or part of corridor from which there is only one route of escape.

8.4.3.2 The width of main corridors in way of passengers and crew's accommodation spaces is not to be less than 0.9 m, and that of side corridors is to be at least 0.8 m. Where the number of passengers and crew using the corridor surpasses 50 persons, the widths referred to above are to be increased by 0.1 m.

In ships (including the tugs) below 500 tons gross tonnage and in tugs of less than 370 kW the width of the main corridors and side corridors may be reduced down to 0.8 and 0.6 m, respectively.

8.4.3.3 The width of passageways in the cinema hall and in the entrance hall is not to be less than 1.1 m and 1.4 m, respectively.

The width of the main passageways in the restaurant or dining room and also the messroom is not to be less than 0.9 m and that of the side passageways are to be at least 0.65 m. In ships of less than 500 tons gross tonnage the width of main passageways in the messroom may be reduced down to 0.65 m.

8.4.3.4 The width of the main passageway in the seating passenger space is to be at least 1 m with number of passengers up to 50 and at least 1.1 m with number of passengers in excess of 50.

8.4.3.5 In passenger ships the main corridors adjacent to engine and boiler casings are to be at least 1.2 m in width, however, in ships of less than 500 tons gross tonnage this width may be reduced down to 0.9 m.
8.4.3.6 The width of passageway on the bridge is not to be less than 0,8 m in ships of 500 tons gross tonnage and over and at least 0,6 m in ships of less than 500 tons gross.

8.4.3.7 In passenger ships and special purpose ships the width of the deck passageways providing access to the lifeboat and liferaft embarkation deck is not to be less than:

.1 - 0,9 m if the number of seats in lifeboats is not more than 30 on each side of ship;
.2 - 1,0 m if the number of seats in lifeboats is 50 and over, but less than 100 on each side of ship;
.3 - 1,2 m if the number of seats in lifeboats is 100 and over, but less than 200 on each side of ship.

If number of seats in lifeboats is 200 and over on each side of ship, the width of the passageways is to be specially considered by the Register in each case.

In other ships the width of the passageways referred to above is not to be less than 0,8 m.

8.4.4 Stairways and vertical ladders

8.4.4.1 All between deck stairways are to be of steel frame construction or of equivalent material on agreement with the Register. Special requirements for arrangement of stairway enclosures and protection of means of escape are specified in the Rules, Part 17 - Fire protection, 2.1.

In passenger ships and special purpose ships having more than 50 persons of special personnel on board the stairways and escape routes shall comply with following requirements:

.1 Stairways are not to be less than 900 mm in clear width. Stairways are to be fitted with handrails on each side. The minimum clear width of stairways is to be increased by 10 mm for every one person provided for in excess of 90 persons. The maximum clear width between handrails where stairways are wider than 900 mm is to be 1,800 mm. The total number of persons to be evacuated by such stairways is to be assumed to be two thirds of the crew and the total number of passengers in the areas served by such stairways.

.2 All stairways sized for more than 90 persons are to be aligned fore and aft.

.3 Doorways and corridors and intermediate landings included in means of escape are to be sized in the same manner as stairways.

.4 Stairways are not to exceed 3.5 m in vertical rise without the provision of a landing and are not to have an angle of inclination greater than 45.

.5 Landings at each deck level are not to be less than 2 m in area and are to increase by 1 m for every 10 persons provided for an excess of 20 persons but need not exceed 16 m², except for those landings servicing public spaces having direct access onto stairway enclosure.

8.5 GUARD RAILS, BULWARK AND GANGWAYS

8.5.1 All exposed parts of the freeboard decks, superstructure decks and deckhouse tops are to be provided with efficient guard rails or bulwarks; in case of ships intended for carriage of timber deck cargo collapsible railing or storm rails are to be fitted on this cargo.

8.5.2 The height of the bulwark or guard rails above the deck is not to be less than 1 m. However, where this height would interfere with the normal operation of the ship, a lesser height may be approved provided the adequate protection of passengers and crew is ensured to the satisfaction of the Register.

8.5.3 The distance between the stanchions of the guard rails is not to be more than 1,5 m. At least every third stanchion is to be supported by a stay.

Removable and hinged stanchions are to be capable of being locked in the upright position.

8.5.4 Hand rails and guard rails are generally to be of rigid construction. Chains and wire ropes may be accepted in lieu of guard rails by the Register in special circumstances. In that case, chains and wire ropes are to be made taut by means of turnbuckles.

8.5.5 The opening below the lowest course of the guard rails is not to exceed 230 mm. The other courses of rails are not to be more than 380 mm apart. An exception is made for the guard rails above the timber deck cargo where the height from the base to the lowest course and other course spacing are not to exceed 330 mm. In the case of ships with rounded gunwale, the guard rails supports are to be placed on the flat of the deck.

8.5.6 Type "A" ships with bulwarks as well as Type "B" ships with a freeboard reduced to that required for Type "A" ships shall have open rails fitted for at least half the length of the exposed parts of the weather deck, or other effective water freeing arrangements. The upper edge of the sheer strake is not to be greater than 150 mm.

Where superstructures are connected by trunks, open rails are to be fitted for the whole length of the exposed parts of the freeboard deck.

8.5.7 The bulwark, if arranged, shall comply with the Rules, Part 2 - Hull, 5.6.

8.5.8 Satisfactory means in the form of life lines, gangways, under deck passages, etc. are to be provided for the protection of the crew in getting to and from their quarters, the machinery space and all other parts used in the necessary work of the ship.

The type, design and arrangement are to be specially considered by the Register in each case depending on the ship's type and freeboard height.

8.5.9 The gangway is to be designed in compliance with the Rules, Part 2 - Hull.
8.6 ACCESS TO THE CARGO AREA OF OIL TANKERS AND BULK CARRIERS

Special measures are to be taken for safe access to and working in spaces in and forward of the cargo area of tankers and bulk carriers for the purpose of maintenance and carrying out surveys.

NOTE: This requirement is considered to be complied with where SOLAS, Chapter II-1, Reg. 3-6, is adhered to.

For the application of this requirement see also IACS Unified Interpretations SC190 and SC191.

Abstract of this Regulation is given in the following sections:

8.6.1 Means of access and safe access to cargo holds, cargo tanks, ballast tanks and other spaces

8.6.1.1 Means of access to cargo and other spaces

8.6.1.1.1 Each space shall be provided with a permanent means of access to enable, throughout the life of a ship, overall and close-up inspections and thickness measurements of the ship's structures to be carried out by the Administration, the company, as defined in regulation IX/1, and the ship's personnel and others as necessary. Such means of access shall comply with the requirements of paragraph 8.6.3.10 to 8.6.3.12 and with the Technical provisions for means of access for inspections, adopted by the Maritime Safety Committee by resolution MSC.133(76), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the SOLAS Convention concerning the amendment procedures applicable to the Annex other than Chapter 1.

Interpretation:
Each space for which close-up inspection is not required such as fuel oil tanks and void spaces forward of cargo area, may be provided with a means of access necessary for overall survey intended to report on the overall conditions of the hull structure.

8.6.1.1.2 Where a permanent means of access may be susceptible to damage during normal cargo loading and unloading operations or where it is impracticable to fit permanent means of access, the Administration may allow, in lieu thereof, the provision of movable or portable means of access, as specified in the Technical provisions, provided that the means of attaching, rigging, suspending or supporting the portable means of access forms a permanent part of the ship's structure.

All portable equipment is to be capable of being readily erected or deployed by ship's personnel.

8.6.1.1.3 The construction and materials of all means of access and their attachment to the ship's structure shall be to the satisfaction of the Administration. The means of access shall be subject to survey prior to, or in conjunction with, its use in carrying out surveys in accordance with regulation I/10.

8.6.1.2 Safe access to cargo holds, cargo tanks, ballast tanks and other spaces

8.6.1.2.1 Safe access to cargo holds, cofferdams, ballast tanks, cargo tanks and other spaces in the cargo area are to be direct from the open deck and such as to ensure their complete inspection. Safe access to double bottom spaces may be from a pump-room, deep cofferdam, pipe tunnel, cargo hold, double hull space or similar compartment not intended for the carriage of oil or hazardous cargoes.

8.6.1.2.2 Tanks, and subdivisions of tanks, having a length of 35 m or more, are to be fitted with at least two access hatchways and ladders, as far apart as practicable. Tanks less than 35 m in length are to be served by at least one access hatchway and ladder.

When a tank is subdivided by one or more swash bulkheads or similar obstructions which do not allow ready means of access to the other parts of the tank, at least two hatchways and ladders are to be fitted.

8.6.1.2.3 Each cargo hold is to be provided with at least two means of access as far apart as practicable.

In general, these accesses are to be arranged diagonally, for example one access near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side.

8.6.2 Definitions

8.6.2.1 Rung
Rung means the step of a vertical ladder or step on the vertical surface.

8.6.2.2 Tread
Tread means the step of an inclined ladder or step for the vertical access opening.

8.6.2.3 Flight of an inclined ladder
Flight of an inclined ladder means the actual stringer length of an inclined ladder. For vertical ladders, it is the distance between the platforms.

8.6.2.4 Stringer
Stringer means:
- the frame of a ladder; or
- the stiffened horizontal plating structure fitted on the side shell, transverse bulkheads and/or longitudinal bulkheads in the space.

For the purpose of ballast tanks of less than 5 m width forming double side spaces, the horizontal plating structure is credited as a stringer and a longitudinal permanent means of access, if it provides a continuous passage of 600 mm or more in width past frames or stiffeners on the side shell or longitudinal bulkhead. Openings in stringer plating utilised as permanent means of access are to be arranged with guard rails or grid covers to provide safe passage on the stringer or safe access to each transverse web.
8.6.2.5 Vertical ladder
Vertical ladder means a ladder of which the inclined angle is 70º and over up to 90º. A vertical ladder is not to be skewed by more than 2º.

8.6.2.6 Overhead obstructions
Overhead obstructions mean the deck or stringer structure including stiffeners above the means of access.

8.6.2.7 Distance below deck head
Distance below deck head means the distance below the plating.

8.6.2.8 Cross deck
Cross deck means the transverse area of the main deck which is located inboard and between hatch coamings.

8.6.3 Technical provisions

8.6.3.1 Structural members subject to the close-up inspections and thickness measurements of the ship's structure, except those in double bottom spaces, are to be provided with a permanent means of access to the extent as specified in Table 8.6.3.1 and Table 8.6.3.2, as applicable. For oil tankers and wing ballast tanks of ore carriers, approved alternative methods may be used in combination with the fitted permanent means of access, provided that the structure allows for its safe and effective use.

8.6.3.2 Permanent means of access should as far as possible be integral to the structure of the ships, thus ensuring that they are robust and at the same time contributing to the overall strength of the structure of the ship.

8.6.3.3 Elevated passageways forming sections of a permanent means of access, where fitted, are to have a minimum clear width of 600 mm, except for going around vertical webs where the minimum clear width may be reduced to 450 mm, and have guard rails over the open side of their entire length. Sloping structures providing part of the access are to be of a non-skid construction. Guard rails are to be 1,000 mm in height and consist of a rail and an intermediate bar 500 mm in height and of substantial construction. Stanchions are to be not more than 3 m apart.

8.6.3.4 Access to permanent means of access and vertical openings from the ship's bottom are to be provided by means of easily accessible passageways, ladders or treads. Treads are to be provided with lateral support for the foot. Where the rungs of ladders are fitted against a vertical surface, the distance from the centre of the rungs to the surface is to be at least 150 mm. Where vertical manholes are fitted higher than 600 mm above the walking level, access is to be facilitated by means of treads and hand grips with platform landings on both sides.

8.6.3.5 Permanent inclined ladders are to be inclined at an angle of less than 70º. There shall be no obstructions within 750 mm of the face of the inclined ladder, except that in way of an opening this clearance may be reduced to 600 mm. Resting platforms of adequate dimensions are to be provided, normally at a maximum of 6 m vertical height. Ladders and handrails are to be constructed of steel or equivalent material of adequate strength and stiffness and securely attached to the structure by stays. The method of support and length of stay is to be such that vibration is reduced to a practical minimum. In cargo holds, ladders are to be designed and arranged so that cargo handling difficulties are not increased and the risk of damage from cargo handling gear is minimised.

8.6.3.6 The width of inclined ladders between stringers is not to be less than 400 mm. The treads are to be equally spaced at a distance apart, measured vertically, of between 200 mm and 300 mm. When steel is used, the treads are to be formed of two square bars of not less than 22 mm by 22 mm in section, fitted to form a horizontal step with the edges pointing upward.

The treads are to be carried through the side stringers and attached thereto by double continuous welding. All inclined ladders are to be provided with handrails of substantial construction on both sides, fitted at a convenient distance above the treads.

8.6.3.7 For vertical ladders or spiral ladders, the width and construction are to be in accordance with international or national standards accepted by the Administration.

8.6.3.8 No free-standing portable ladder is to be more than 5 m long.

8.6.3.9 Alternative means of access include, but are not limited to, such devices as:
- hydraulic arm fitted with a stable base
- wire lift platform
- staging
- rafting
- root arm or remotely operated vehicle (ROV)
- portable ladders more than 5 m long are only to be utilised if fitted with a mechanical device to secure the upper end of the ladder
- other means of access, approved by and acceptable to the Administration.

Means for safe operation and rigging of such equipment to and from and within the spaces are to be clearly described in the Ship Structure Access Manual.

8.6.3.10 For access through horizontal openings, hatches or manholes, the minimum clear opening is not to be less than 600 mm x 600 mm. When access to a cargo hold is arranged through the cargo hatch, the top of the ladder is to be placed as close as possible to the hatch coaming. Access hatch coamings having a height greater than 900 mm is to also have steps on the outside in conjunction with the ladder.

8.6.3.11 For access through vertical openings, or manholes, in swash bulkheads, floors, girders and web frames providing passage through the length and breadth of the space, the minimum opening is not to be less than 600 mm x 800 mm at a height of not more than 600 mm from the passage unless gratings or other foot holds are provided.

8.6.3.12 For oil tankers of less than 5000 tonnes deadweight, the Administration may approve, in special circumstances, smaller dimensions for the openings referred to in 8.6.3.10 and 8.6.3.11, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Administration.
8.6.3.13 For bulk carriers, access ladders to cargo holds and other spaces are to be:

8.6.3.13.1 Where the vertical distance between the upper surface of adjacent decks or between deck and the bottom of the cargo space is not more than 6 m, either a vertical ladder or an inclined ladder.

8.6.3.13.2 Where the vertical distance between the upper surface of adjacent decks or between deck and the bottom of the cargo space is more than 6 m, an inclined ladder or series of inclined ladders at one end of the cargo hold, except the uppermost 2.5 m of a cargo space measured clear of overhead obstructions and the lowest 6 m may have vertical ladders, provided that the vertical extent of the inclined ladder or ladders connecting the vertical ladders is not less than 2.5 m.

The second means of access at the other end of the cargo hold may be formed of a series of staggered vertical ladders, which should comprise of one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder. Adjacent sections of ladder are to be laterally offset from each other by at least the width of the ladder. The uppermost entrance section of the ladder directly exposed to a cargo hold is to be vertical for a distance of 2.5 m measured clear of overhead obstructions and connected to a ladder-linking platform.

8.6.3.13.3 A vertical ladder may be used as a means of access to topside tanks, where the vertical distance is 6 m or less between the deck and the longitudinal means of access in the tank or the stringer or the bottom of the space immediately below the entrance. The uppermost entrance section from deck of the vertical ladder of the tank is to be vertical for a distance of 2.5 m measured clear of overhead obstructions and comprise a ladder linking platform, unless landing on the longitudinal means of access, the stringer or the bottom within the vertical distance, displaced to one side of a vertical ladder.

8.6.3.13.4 Unless allowed in 8.6.3.13.3 above, an inclined ladder or combination of ladders is to be used for access to a tank or a space where the vertical distance is greater than 6 m between the deck and a stringer immediately below the entrance, between stringers, or between the deck or a stringer and the bottom of the space immediately below the entrance.

8.6.3.13.5 In case of 8.6.3.13.4 above, the uppermost entrance section from deck of the ladder is to be vertical for a distance of 2.5 m clear of overhead obstructions and connected to a landing platform and continued with an inclined ladder.

The flights of inclined ladders are not to be more than 9 m in actual length and the vertical height is not normally to be more than 6 m. The lowermost section of the ladders may be vertical for a distance of not less than 2.5 m.

8.6.3.13.6 In double-side skin spaces of less than 2.5 m width, the access to the space may be by means of vertical ladders that comprise of one or more ladderlinking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder.

Adjacent sections of ladder are to be laterally offset from each other by at least the width of the ladder.

8.6.3.13.7 A spiral ladder is considered acceptable as an alternative for inclined ladders. In this regard, the uppermost 2.5 m can continue to be comprised of the spiral ladder and need not change over to vertical ladders.

8.6.3.13.8 The uppermost entrance section from deck of the vertical ladder providing access to a tank is to be vertical for a distance of 2.5 m measured clear of overhead obstructions and comprise a ladder linking platform, displaced to one side of a vertical ladder.

The vertical ladder can be between 1.6 m and 3 m below deck structure if it lands on a longitudinal or athwartship permanent means of access fitted within that range.

8.6.4 Ship structure access manual

8.6.4.1 A ship’s means of access to carry out overall and close-up inspections and thickness measurements are to be described in a Ship structure access manual approved by the Administration, an updated copy of which is to be kept on board. The Ship structure access manual shall include the following for each space in the cargo area:

- plans showing the means of access to the space, with appropriate technical specifications and dimensions,
- plans showing the means of access within each space to enable an overall inspection to be carried out, with appropriate technical specifications and dimensions. The plans shall indicate from where each area can be inspected,
- instructions for inspecting and maintaining the structural strength of all means of access and means of attachment, taking into account any corrosive atmosphere that may be within the space,
- instructions for safety guidance when rafting is used for close-up inspections and thickness measurements,
- instructions for the rigging and use of any portable means of access in a safe manner,
- an inventory of all portable means of access,
- records of periodical inspections and maintenance of the ship’s means of access.

8.6.4.2 For the purpose of these regulations "critical structural areas" are locations which have been identified from calculations to require monitoring or from the service history of similar or sister ships to be sensitive to cracking, buckling, deformation or corrosion which would impair the structural integrity of the ship.

8.6.4.3 For the guidelines when compiling the Ship structure access manual described in Section 8.6.4, see IACS Rec. 90 and Rec. 91.
8.6.5 Safe access to tanker bows

8.6.5.1 Every tanker is to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions.

8.6.5.2 For the purpose of this regulation, tankers include oil tankers as defined in SOLAS, Chapter II-1, Reg.2, chemical tankers as defined in regulation VII/8.2 and gas carriers as defined in regulation VII/11.2.

8.6.5.3 Such means of access are to be in accordance with the requirements of guidelines for safe access to tanker bow (Res. MSC. 62(67)) and are to be approved by the Register. Interpretation of SOLAS II-1/3-3.2, Safe access to tanker bows, for all vessels subject to that regulation, is provided in IACS Unified Interpretations SC138 and LL50.

### Table 8.6.3.1 Means of access for ballast and cargo tanks of oil tankers

<table>
<thead>
<tr>
<th>Access to the underdeck and vertical structure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Water ballast tanks except those specified in the right column, and cargo oil tanks</td>
<td>2. Water ballast wing tanks of less than 5 m width forming double side spaces and their bilge hopper sections</td>
</tr>
<tr>
<td>1.1 For tanks of which the height is 6 m and over containing internal structures, permanent means of access are to be provided in accordance with .1 to .6:</td>
<td>2.1 For double side spaces above the upper knuckle point of the bilge hopper sections, permanent means of access are to be provided in accordance with .1 to .3:</td>
</tr>
<tr>
<td>.1 continuous athwartship permanent access arranged at each transverse bulkhead on the stiffened surface, at a minimum of 1.6 m to a maximum of 3 m below the deck head;</td>
<td>.1 the vertical distance between horizontal uppermost stringer and deck head is 6 m or more, one continuous longitudinal permanent means of access is to be provided for the full length of the tank with a means to allow passing through transverse webs installed at a minimum of 1.6 m to a maximum of 3 m below the deck head with a vertical access ladder at each end of the tank;</td>
</tr>
<tr>
<td>.2 at least one continuous longitudinal permanent means of access at each side of the tank. One of these accesses is to be at a minimum of 1.6 m to a maximum of 6 m below the deck head and the other is to be at a minimum of 1.6 m to a maximum of 3 m below the deck head;</td>
<td>.2 continuous longitudinal permanent means of access, which are integrated in the structure, at a vertical distance not exceeding 6 m apart; and</td>
</tr>
<tr>
<td>.3 access between the arrangements specified in .1 and .2 and from the main deck to either .1 or .2;</td>
<td>.3 plated stringers are, as far as possible, to be in alignment with horizontal girders of transverse bulkheads.</td>
</tr>
<tr>
<td>.4 continuous longitudinal permanent means of access which are integrated in the structural member on the stiffened surface of a longitudinal bulkhead, in alignment, where possible, with horizontal girders of transverse bulkheads are to be provided for access to the transverse webs unless permanent fittings are installed at the uppermost platform for use of alternative means, as defined in paragraph 8.6.3.9 of the Technical provisions, for inspection at intermediate heights;</td>
<td></td>
</tr>
<tr>
<td>.5 for ships having cross-ties which are 6 m or more above tank bottom, a transverse permanent means of access on the cross-ties providing inspection of the tie flaring brackets at both sides of the tank, with access from one of the longitudinal permanent means of access in .4; and</td>
<td></td>
</tr>
<tr>
<td>.6 alternative means as defined in paragraph 8.6.3.9 of the Technical provisions may be provided for small ships as an alternative to .4 for cargo oil tanks of which the height is less than 17 m.</td>
<td></td>
</tr>
</tbody>
</table>
1.2 For tanks of which the height is less than 6 m, alternative means as defined in paragraph 8.6.3.9 of the Technical provisions or portable means may be utilised in lieu of the permanent means of access.

2.2 For bilge hopper sections of which the vertical distance from the tank bottom to the upper knuckle point is 6 m and over, one longitudinal permanent means of access is to be provided for the full length of the tank. It is to be accessible by vertical permanent means of access at each end of the tank.

2.2.1 The longitudinal continuous permanent means of access may be installed at a minimum 1.6 m to maximum 3 m from the top of the bilge hopper section. In this case, a platform extending the longitudinal continuous permanent means of access in way of the webframe may be used to access the identified structural critical areas.

2.2.2 Alternatively, the continuous longitudinal permanent means of access may be installed at a minimum of 1.2 m below the top of the clear opening of the web ring allowing a use of portable means of access to reach identified structural critical areas.

2.3 Where the vertical distance referred to in 2.2 is less than 6 m, alternative means as defined in paragraph 3.9 of the Technical provisions or portable means of access may be utilised in lieu of the permanent means of access. To facilitate the operation of the alternative means of access, in-line openings in horizontal stringers are to be provided.

The openings are to be of an adequate diameter and are to have suitable protective railings.

**Fore peak tanks**

1.3 For fore peak tanks with a depth of 6 m or more at the centre line of the collision bulkhead, a suitable means of access are to be provided for access to critical areas such as the underdeck structure, stringers, collision bulkhead and side shell structure.

1.3.1 Stringers of less than 6 m in vertical distance from the deck head or a stringer immediately above are considered to provide suitable access in combination with portable means of access.

1.3.2 In case the vertical distance between the deck head and stringers, stringers or the lowest stringer and the tank bottom is 6 m or more, alternative means of access as defined in paragraph 3.9 of the Technical provisions are to be provided.
### Table 8.6.3.2 Means of access for bulk carriers

<table>
<thead>
<tr>
<th>Cargo holds</th>
<th>Ballast tanks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access to the underdeck structure</strong></td>
<td><strong>Top side tanks</strong></td>
</tr>
<tr>
<td>1. Permanent means of access are to be fitted to provide access to the overhead structure at both sides of the cross deck and in the vicinity of the centreline. Each means of access are to be accessible from the cargo hold access or directly from the main deck and installed at a minimum of 1.6 m to a maximum of 3 m below the deck.</td>
<td>2.1 For each topside tank of which the height is 6 m and over, one longitudinal continuous permanent means of access are to be provided along the side shell webs and installed at a minimum of 1.6 m to a maximum of 3 m below deck with a vertical access ladder in the vicinity of each access to that tank.</td>
</tr>
<tr>
<td>1.1</td>
<td>2.2 If no access holes are provided through the transverse webs within 600 mm of the tank base and the web frame rings have a web height greater than 1 m in way of side shell and sloping plating, then step rungs/grab rails are to be provided to allow safe access over each transverse web frame ring.</td>
</tr>
<tr>
<td>1.2 An athwartship permanent means of access fitted on the transverse bulkhead at a minimum 1.6 m to a maximum 3 m below the cross-deck head is accepted as equivalent to 1.1.</td>
<td>2.3 Three permanent means of access, fitted at the end bay and middle bay of each tank, are to be provided spanning from tank base up to the intersection of the sloping plate with the hatch side girder. The existing longitudinal structure, if fitted on the sloping plate in the space may be used as part of this means of access.</td>
</tr>
<tr>
<td>1.3 Access to the permanent means of access to overhead structure of the cross deck may also be via the upper stool.</td>
<td>2.4 For topside tanks of which the height is less than 6 m, alternative means as defined in paragraph 8.6.3.9 of the Technical provisions or portable means may be utilised in lieu of the permanent means of access.</td>
</tr>
<tr>
<td>1.4 Ships having transverse bulkheads with full upper stools with access from the main deck which allows monitoring of all framing and plates from inside do not require permanent means of access of the cross deck.</td>
<td></td>
</tr>
<tr>
<td>1.5 Alternatively, movable means of access may be utilised for access to the overhead structure of the cross deck if its vertical distance is 17 m or less above the tank top.</td>
<td></td>
</tr>
<tr>
<td><strong>Access to the vertical structure</strong></td>
<td><strong>Bilge hopper tanks</strong></td>
</tr>
<tr>
<td>1.6 Permanent means of vertical access are to be provided in all cargo holds and built into the structure to allow for an inspection of a minimum of 25 % of the total number of hold frames port and starboard equally distributed throughout the hold including at each end in way of transverse bulkheads. But in no circumstance shall this arrangement be less than 3 permanent means of vertical access fitted to each side (fore and aft ends of hold and mid-span). Permanent means of vertical access fitted between two adjacent hold frames is counted for an access for the inspection of both hold frames. A means of portable access may be used to gain access over the sloping plating of lower hopper ballast tanks.</td>
<td>2.5 For each bilge hopper tank of which the height is 6 m and over, one longitudinal continuous permanent means of access are to be provided along the side shell webs and installed at a minimum of 1.2 m below the top of the clear opening of the web ring with a vertical access ladder in the vicinity of each access to the tank.</td>
</tr>
<tr>
<td>1.7 In addition, portable or movable means of access are to be utilised for access to the remaining hold frames up to their upper brackets and transverse bulkheads.</td>
<td>2.5.1 An access ladder between the longitudinal continuous permanent means of access and the bottom of the space is to be provided at each end of the tank.</td>
</tr>
<tr>
<td>1.8 Portable or movable means of access may be utilised for access to hold frames up to their upper bracket in place of the permanent means required in 1.6. These means of access are to be carried on board the ship and readily available for use.</td>
<td>2.5.2 Alternatively, the longitudinal continuous permanent means of access can be located through the upper web plating above the clear opening of the web ring, at a minimum of 1.6 m below the deck head, when this arrangement facilitates more suitable inspection of identified structurally critical areas. An enlarged longitudinal frame can be used for the purpose of the walkway. For double-side skin bulk carriers, the longitudinal continuous permanent means of access may be installed within 6 m from the knuckle point of the bilge, if used in combination with alternative methods to gain access to the knuckle point.</td>
</tr>
<tr>
<td>1.9 The width of vertical ladders for access to hold frames is to be at least 300 mm, measured between stringers.</td>
<td>2.6 If no access holes are provided through the transverse ring webs within 600 mm of the tank base and the web frame rings have a web height greater than 1 m in way of side shell and sloping plating, then step rungs/grab rails are to be provided to allow safe access over each transverse web frame ring.</td>
</tr>
</tbody>
</table>
1.10 A single vertical ladder over 6 m in length is acceptable for the inspection of the hold side frames in a single skin construction.

1.11 For double-side skin construction no vertical ladders for the inspection of the cargo hold surfaces are required. Inspection of this structure is to be provided from within the double hull space.

2.7 For bilge hopper tanks of which the height is less than 6 m, alternative means as defined in paragraph 8.6.3.9 of the Technical provisions or portable means may be utilised in lieu of the permanent means of access. Such means of access are to be demonstrated that they can be deployed and made readily available in the areas where needed.

Double-skin side tanks

2.8 Permanent means of access are to be provided in accordance with the applicable sections of Table 8.6.3.1.

Fore peak tanks

2.9 For fore peak tanks with a depth of 6 m or more at the centreline of the collision bulkhead, a suitable means of access are to be provided for access to critical areas such as the underdeck structure, stringers, collision bulkhead and side shell structure.

2.9.1 Stringers of less than 6 m in vertical distance from the deck head or a stringer immediately above are considered to provide suitable access in combination with portable means of access.

2.9.2 In case the vertical distance between the deck head and stringers, stringers or the lowest stringer and the tank bottom is 6 m or more, alternative means of access as defined in paragraph 8.6.3.9 of the Technical provisions are to be provided.

Note:
For ore carriers, permanent means of access are to be provided in accordance with the applicable sections of Table 8.6.3.1 and Table 8.6.3.2.
ANNEX A SPECIFIC REQUIREMENTS FOR THE PASSENGER SHIPS IN DOMESTIC SERVICE CLASS "D"

A.1 GENERAL

A.1.1 Requirements of this Section apply to passenger ships in domestic service class "D" operating exclusively in the area of navigation 6 and 7, in the period from April 1 to October 31, and carrying passengers on a daily trips or carrying not more than 36 cabin passengers.

A.2 WINDOWS IN THE SIDE SHELL PLATING, EXTERNAL SUPERSTRUCTURE AND FORECASTLE BULKHEADS LEADING TO COMPARTMENTS WHICH ARE INCLUDED IN STABILITY CALCULATIONS

A.2.1 Glass intended for ship's windows shall be safety toughened glass approved by the Register.

A.2.2 In order to accept the windows it is necessary the following:
- the drawings of the windows are to be submitted for approval;
- that the arrangement of the window onboard complies with the approved documentation;
- the verification of the windows arrangement in relation to approved documentation is to be carried out;
- after installation onboard the weathertightness testing (hose test) in accordance with the Rules, Part 3 - Hull equipment, 1.2.4.2, in the presence of Register's surveyor is to be carried out.

A.2.3 In the drawings of the windows shall be specified: dimensions of clear light openings, glass thicknesses, opening type /non-opening type, frame materials, the method of fastening, sealing arrangements and the type of glass.

A.2.4 As a basis for approval the following to be submitted: an individual Register's approval for such or similar windows, appropriate standard or type approval according to which the windows are made or submit documentation with construction details for approval.

A.2.5 The manufacturer shall be approved by the Register or by other recognized classification society (member of IACS).

A.2.6 Based on special consideration Register can accept the oval windows at the places where the side scuttles are required provided that they comply with the following requirements:
- the lower edge of the opening must be located at least 600 mm above the freeboard deck; and
- thickness of toughened glass shall be at least 30% higher than those required by the Rules for the window at the position under consideration and actual area of the clear light opening.

If such windows are easily accessible from the protected spaces they can be provided with removable weathertight covers (blanking plates) kept in sea lashing inside that watertight compartment or in its immediate vicinity instead of hinged inside deadlights.

A.3 WINDOWS IN THE EXTERNAL WALLS OF THE SUPERSTRUCTURE OR DECKHOUSES NOT LEADING TO COMPARTMENTS WHICH ARE INCLUDED IN STABILITY CALCULATIONS

A.3.1 Glass intended for ship's windows shall be safety toughened glass approved by the Register.

A.3.2 For arrangement and thickness of the glass ISO standard 11336-1 may be accepted.

A.3.3 In order to accept the windows it is necessary the following:
- the drawings of the windows are to be submitted for approval;
- that the arrangement of the window onboard complies with the approved documentation;
- the verification of the windows arrangement in relation to approved documentation is to be carried out;
- after installation onboard the weathertightness testing (hose test) in accordance with the requirements in 1.2.4.2, in the presence of Register's surveyor is to be carried out. The test pressure required by Section 1.2.4.2 can be reduced to the equivalent of 2 m of water column height at the hose outlet. For the windows on the upper decks outside the bow exposed areas (more than 7 m behind the forward collision bulkhead) test pressure may be further reduced to a minimum ("spraying" around the window frame).

A.3.4 In the drawings of the windows shall be specified: dimensions of clear light openings, glass thicknesses, opening type/non-opening type, frame materials, the method of fastening, sealing arrangements and the type of glass.

A.3.5 As a basis for approval the following to be submitted: an individual Register’s approval for such or similar windows, appropriate standard or type approval according to which the windows are made or submit documentation with construction details for approval.

A.3.6 The required thicknesses of toughened safety glass panes in standard rectangular windows above weather deck are given in Table A.3.6 as a function of the standard sizes of clear light (final approval thickness may be different from those in the Table A.3.6):
Table A.3.6

<table>
<thead>
<tr>
<th>Nominal sizes (clear light) of rectangular window, in [mm]</th>
<th>Thickness of toughened glass, in [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 x 500</td>
<td>6</td>
</tr>
<tr>
<td>355 x 500</td>
<td>6</td>
</tr>
<tr>
<td>400 x 560</td>
<td>6</td>
</tr>
<tr>
<td>450 x 630</td>
<td>6</td>
</tr>
<tr>
<td>500 x 710</td>
<td>6</td>
</tr>
<tr>
<td>560 x 800</td>
<td>7</td>
</tr>
<tr>
<td>900 x 630</td>
<td>8</td>
</tr>
<tr>
<td>1000 x 710</td>
<td>8</td>
</tr>
<tr>
<td>1100 x 800</td>
<td>9</td>
</tr>
</tbody>
</table>

The Register reserves the right to limit the sizes of the windows or to require increased thickness of the glass of windows that are located on the front wall of the superstructure.

A.3.7 The use of other materials (except toughened safety glass) may be approved provided that the required thickness of the toughened glass is increased by 1.3 times for polycarbonate panels, or 1.5 times of acrylic sheets.

The thickness of the laminated glass is not to be less than the value given by following formula:

\[ t_e = t_{i1} + t_{i2} + \ldots + t_{in} \]

where:

- \( t_e \) = equivalent thickness of the monolithic glass;
- \( t_i \) = the thickness of a single plate in the laminate;
- \( n \) = the total number of laminated panes.

A.4 SIDESCUTTLES BELOW THE MAIN DECK

A.4.1 The sidescuttles below the main deck shall be made in accordance with the requirements of Rules, Part 3 - Hull equipment, 7.2.

A.4.2 The required thicknesses of toughened safety glass for openings below the weather deck having surfaces not exceeding 0.16 m² are given in Table A.4.2 as a function of the standard sizes of clear light (final approval thickness may be different from those in the Table A.4.2):

<table>
<thead>
<tr>
<th>Clear light diameter, in [mm]</th>
<th>Thickness of toughened glass, in [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>8</td>
</tr>
<tr>
<td>250</td>
<td>8</td>
</tr>
<tr>
<td>300</td>
<td>10</td>
</tr>
<tr>
<td>350</td>
<td>12</td>
</tr>
<tr>
<td>400</td>
<td>12</td>
</tr>
<tr>
<td>450</td>
<td>15</td>
</tr>
</tbody>
</table>

Acceptance of the openings with surface exceeding 0.16 m² is subject to special consideration and approval of the Register.

A.5 WOODEN FRAMES ON THE SALON WINDOWS

A.5.1 The wooden frames on the salon window are generally acceptable.

A.6 EXTERNAL DOORS ON THE MAIN DECK LEADING TO COMPARTMENTS BELOW THE MAIN DECK

A.6.1 External doors on the main deck leading to compartments below the main deck shall be weathertight.

Alternatively, if the doors are not weathertight, the companionways to the ship's spaces located below the main deck can be protected by a weathertight cover behind the door and openable from both sides (eg. companionway to the machinery space).

A.6.2 In order to accept the doors it is necessary the following:

- the drawings of the doors are to be submitted for approval;
- that the arrangement of the doors onboard complies with the approved documentation;
- after installation on board the weathertightness testing (hose test) in accordance with the Rules, Part 3 - Hull equipment, 1.2.4.2, in the presence of Register’s surveyor is to be carried out.

A.6.3 In the drawings of the doors shall be specified: dimensions of clear light openings, opening direction, wing and frame materials, the method of fastening, closing and sealing arrangements.

A.6.4 As a basis for approval the following to be submitted: an individual Register’s approval for such or similar doors, appropriate standard or type approval according to which the doors are made or submit documentation with construction details for approval.

A.6.5 All doors shall be fitted with a self closing devices. All doors must be fitted with a gasket. Self closing device can be replaced by a clearly visible inscription “close after passing” on both sides of the door.
A.6.6 In addition to the above for the wooden or fiberglass (non-metallic) door on the subject positions following permanent remark (mem) shall be entered in the ship's documents:

“The external doors on the main deck leading to compartments below the main deck - at each annual survey the weathertightness testing (hose test) in accordance with the Rules, Part 3 - Hull equipment, 1.2.4.2, in the presence of Register's surveyor is to be carried out”.

A.7 EXTERNAL DOORS ON THE MAIN DECK NOT LEADING TO COMPARTMENTS BELOW THE MAIN DECK AND ARE NOT INCLUDED IN STABILITY CALCULATIONS

A.7.1 In order to accept the doors it is necessary the following:
- the drawings of the doors are to be submitted for approval;
- that the arrangement of the doors onboard complies with the approved documentation;
- the verification of the doors arrangement in relation to approved documentation is to be carried out;
- after installation onboard the weathertightness testing (hose test) in accordance with the requirements in 1.2.4.2, in the presence of Register's surveyor is to be carried out. The test pressure required by Section 1.2.4.2 can be reduced to the equivalent of 2 m of water column height at the hose outlet. For the doors on the upper decks outside the bow exposed areas (more than 7 m behind the forward collision bulkhead) test pressure may be further reduced to a minimum (“spraying” around the door frame).

A.7.2 In the drawings of the doors shall be specified: dimensions of clear light openings, opening direction, wing and frame materials, the method of fastening, closing and sealing arrangements.

A.7.3 As a basis for approval the following to be submitted: an individual Register's approval for such or similar doors, appropriate standard or type approval according to which the doors are made or submit documentation with construction details for approval.

A.8 WOODEN FRAMES OF THE DOORS

A.8.1 Wooden frame shall be properly attached to the surrounding structure with the screws, and to justified that door wings and wooden frames will not be twisted or otherwise deformed in use, the wood shall be adequately stiffened (with metal fittings on the door leaf, as appropriate) and surface protected.

A.8.2 The frame, together with the doors shall be weathertight tested in accordance with the Rules, Part 3 - Hull equipment, 1.2.4.2, in the presence of Register's surveyor.

A.8.3 Testing of tightness of external doors with wooden frames on the main deck leading to below the main deck during ship's service shall be in accordance with the requirements of Section A.6.7.

A.9 CERTIFICATES OF THE MOORING EQUIPMENT (BOLLARDS, FAIRLEADERS ETC.)

A.9.1 Bollards, chocks and fairleads shall be at least in accordance with SB standards and made by an approved manufacturer (or shipyard). Upon completion of the works the manufacturer's certificate should be issued.

A.9.2 If this is the case in the drawing "anchoring and mooring plan" is sufficient to state a reference to the applied SB standard.

A.9.3 If a given design is not according to SB standards, it shall be demonstrated equivalence of the design (by submitting for approval detailed technical documentation for each mooring element, then to build it by approved manufacturers and, finally, to properly test it) to, consequently, be regarded as equivalent to relevant SB standard (for appliance at passenger ships in domestic service, area of navigation 6).

A.10 ACCEPTANCE OF THE ATTESTATION OF THE ANCHORING EQUIPMENT (ANCHORS AND CHAIN CABLES)

A.10.1 In order to accept the anchors and chain cables it is necessary the following:
- the drawings Anchoring arrangement and Calculation of equipment number are to be submitted for approval;
- that the anchoring arrangement onboard complies with the approved documentation;
- the verification of the anchoring arrangement in relation to approved documentation is to be carried out.

A.10.2 Anchors and chains shall be of an approved type (they must have Register's certificates or certificates of any other recognized classification society (a member of IACS) issued on behalf of the CRS).

A.10.3 The length of anchor chain cables shall be in accordance with the calculated equipment number.

A.10.4 The mass of anchors shall be in accordance with the calculated equipment number.

A.10.5 The procedure in case of re-attestation of the anchors that do not have the appropriate certificate

A.10.5.1 For all anchors the following tests shall be carried out:
- visual inspection and control of dimensions: dimension values must be within the tolerances specified in the Rules, Part 25 - Metallic materials, 6.3.1;
- non-destructive testing (NDT): fabrication welds, local weld repairs, feeders and risers of castings should be tested by PT or MT method;
- proof load test: all anchors are to be tested by proof load exceeding 33% of that which is stated in the Rules, Part 3 - Hull equipment, Table 3.3.5.9-1 for normal anchor equal weight. As example, for the high holding power anchor of 360 kg of the mass
proof load is 1.33 x 90.6 kN which amounts to 120.5 kN.

A.10.5.2 If all anchors meet the above tests is necessary to select at least one anchor of each type of anchor for further destructive testing.

Tests of the anchors parts are set forth in the Rules, Part 25 - Metallic materials, 6.4.2.

- Parts of anchors that should be tested are:
  - Fluke;
  - Shank;
  - Trunnion pin;
  - Shackles;
  - Shackles pin.

A.10.5.4 Before starting the test procedure a detailed plan for the required inspection and testing of the anchor cables are given in the Rules, Part 25 - Metallic Materials, Table 7.4.1.2.

A.10.5.3 The above tests are given under the assumption that all parts of the anchor are castings.

A.10.6 The procedure in case of re-attestation of the anchor chain cables that do not have the appropriate certificate

A.10.6.1 For all anchor chain cables in accordance to submitted list the visual inspection and control of dimensions is to be carried out. Dimension values must be within the tolerances specified in the Rules, Part 25 - Metallic materials, 7.2 and 7.3.

It is necessary to determine the diameter of the chain and the composition of the chain, as appropriate:
- how the individual chain lengths are interconnected if the chain cable is not in one piece,
- type and number of joining shackles (kenter) and the end link,
- chain links with anchor shackles,
- type and number of swivels in the chain.

A.10.6.2 After the test with acceptable results it is necessary on the part of the chain length of about 2 m for all diameters chains to perform the following tests:
- tensile test with proof loads (proof and breaking load to be calculated in accordance to the Rules, Part 25 - Metallic materials, Table 7.4.1.2);
- the chain cable is to be subjected to a proof load for the category CRS-L2;
- the chain cable is to be subjected to a breaking load for the category CRS-L2;
- testing of mechanical properties (as defined in the Rules, Part 25 - Metallic Materials, 7.4.3);
- chemical analysis.

Tests of individual chain lengths of the chain cable are given in the Rules, Part 25 - Metallic Materials, 7.4.

A.10.6.3 All samples shall be taken and marked in the presence of Register’s surveyor.

A.10.6.4 For all anchors and anchor chains is necessary to calculate the test loads in accordance with the applicable sections of the Rules.

A.10.6.5 Before starting the test procedure a detailed plan for the required inspection and testing of the anchor cables based on above shall be submitted to the Register for approval.

A.11 STRUCTURAL TEST OF CHAIN LOCKERS

A.11.1 If a conventional anchor chain locker is not fitted onboard (separate watertight and drained area in which anchor chain are stowed), then there are no special requirements for its pressing by filling water column in order to determine the structural integrity.

A.11.2 However, since the chain locker always should be dry at the bottom of such space below the chain should be placed grids (may be wooden grid), below which should be the opening for the outflow of water in the bilge, or into a separate chamber where it will be drain by pump.

A.11.3 However, in this case, such a space for the stowage of the chain cable (in front of the forward collision bulkhead or its continuation above the main bulkhead deck) should be tested, depending on the basic categorization of that space. Requirements for the testing of certain types of spaces are explained in detail in the Rules, Part 2 - Hull, Table 11.6.1.

A.12 CHAIN STOPPERS

A.12.1 Instead of testing of the chain stopper an equivalent technical solution can be accepted. For this purpose a complete calculation of the stopper, including solution of the securing of stopper’s self-unlocking and other accompanying technical documentation (connection of the stopper with the deck construction and under deck reinforcements in way of the stopper) should be submitted to the Register for approval.

After the approval of the technical documentation and stopper is installed on the ship the Register has to check the stoppers arrangement in relation to approved documentation and, if required, carry out testing.

A.13 WATERTIGHT DOORS

A.13.1 The doors connecting the engine room and the steering gear compartment shall be watertight unless both compartment are considered as simultaneously flooded in damaged stability calculations and the results of the calculations prove that all requested stability criteria have been met after flooding.

A.13.2 The watertight doors (for example, on the watertight bulkhead between the aft peak and the engine room, for vessels that can not satisfy the stability criteria in the case of simultaneously flooding of the two aft compartment, mentioned above) shall be certified to a head of water at least to the level of freeboard deck at the position of bulkhead in question.

A.13.3 It is also necessary to obtain and submit to the Register a certificate for the fitted door to confirm the watertightness to a head of water at least to the level stated above. Since the doors are mostly standard SB version of the “watertight doors”, it is enough to test one example of the corresponding SB type to be approved (can also be the example from a new buildings before it’s installation) to the appropriate head of water (up to 3 m) and then re-inspect the already fitted doors (tested by the appropriate method of
weathertightness after installation) to confirm that those are of the tested standard version.

A.13.4 The watertight doors inside the hull shall additionally be fitted with a device which indicates that the doors are in the open position and provides appropriate signaling on the navigation bridge (for example, red light, with the plate labeled "Open watertight door at R.xx").