

Uniform Shipping Laws Code 2008

**Section 5L: Construction – Steel
(CTH, NSW, QLD, SA, NT, TAS, VIC & WA)**

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The official version is that last published by the Australian Government Publishing Service, Canberra, copies of which can be obtained from the National Marine Safety Committee.

SUB-SECTION L

STEEL

PRELIMINARY

This Sub-section forms part of the Construction Section and shall be read in conjunction with its other Sub-sections.

The Construction Section shall be read in conjunction with the Introduction, Definitions and General Requirements Section.

L. 1 General

L.1.1 Application

This Sub-section shall apply to displacement vessels of Class A, B and C, of fully welded steel construction. Vessels of the light displacement or planing type, non-seagoing vessels and vessels considered to be of other than normal form or proportion shall be subject to special consideration at the discretion of the Authority.

L.1.2 Materials

Steel used shall be of welding quality to AS/NZS 3678 (Structural steel – Hot-rolled plates, floorplates and slabs; AS/NZS 3679.1 (Structural steel – Hot-rolled bars and sections) or equivalent. The maker's certificate or steel supplier's invoice will generally be acceptable as proof of quality.

(Amendment dated 1 October 2008)

Where any doubt exists as to the steel quality, tests may be required to be carried out. Any costs involved in such testing shall be borne by the owner. Where higher tensile steels are to be used, full particulars of such steel and welding processes are to be submitted in advance to the Authority.

L.1.3 Workmanship

All workmanship is to be of the best quality. Welding is to be in accordance with clause L.21. Plates which have been subjected to excessive furnacing are to undergo a satisfactory heat treatment before being worked into the hull.

If riveting is to be used, full particulars should be submitted in advance, to the Authority.

L.1.4 General Principles of Structural Design

L.1.4.1 Longitudinal Strength

Although the necessary midship section modulus to ensure sufficient longitudinal strength in vessels of normal form usually is obtained if the longitudinal member and plating requirements in this Section are satisfied, the Authority may require that longitudinal hull strength calculations be submitted, especially where vessels are shallow in depth or have wide hatch openings.

L.1.4.2 Continuity

Structural continuity must be maintained. Scantlings should not change section or direction abruptly. Major longitudinal members should not in general, end abruptly at transverse members but should be tapered off at either end of the member over not less than two frame spaces.

Pillars and bulkheads should be so located as to be aligned with their loads to avoid eccentric loading. Appendages and strength bulkheads in superstructures should be collinear with the major structural hull members.

Sharp corners are to be avoided. The corners of all openings in the strength deck and shell plating are to be well rounded. The radius should not be less than 1/24th of the breadth of the opening, but in no case should it be less than 150 mm for openings exceeding 25 per cent of the beam and 75 mm for openings which are a lesser percentage of the beam.

L.1.4.3 Openings

Major openings such as doors, hatches, vents and exhausts should not in general penetrate the stringer plate or sheer strake within a distance of 0.3L forward or aft of midships.

Corners of openings in strength members should be well rounded with appropriate compensation where required.

L.1.4.4 Brackets

L.1.4.4.1 Main structural members and secondary stiffening forming part of the hull structure shall be connected at their ends in accordance with the requirements of this subparagraph, except that bracketless beam frame connections may be made in accordance with sub-paragraph L.1.4.4.13.

Where end connections in the form of brackets are fitted to a member, the length l of that member shall be the clear span between bracket toes increased by a distance $a/4$ or $b/4$ whichever is appropriate at each end of the span. Where end connections other than brackets are fitted to a member they may be taken into account in determining the effective span of that member and details provided on the plans or in calculations submitted to the Authority.

L.1.4.4.2 Where longitudinal strength member is connected to a main structural member, the scantlings of the bracket are to be such that the section modulus and effective cross sectional area of the bracket are not less than those of the longitudinal strength member.

The scantlings of brackets at the heads of main transverse side frames at decks where the frames terminate and at the lower deck in the panting region are to be based on the modulus of the frame or beam, whichever is the greater.

At all other decks the scantlings are to be based on the modulus of the beam.

Typical arrangements of stiffener end brackets are shown in Figure 1.

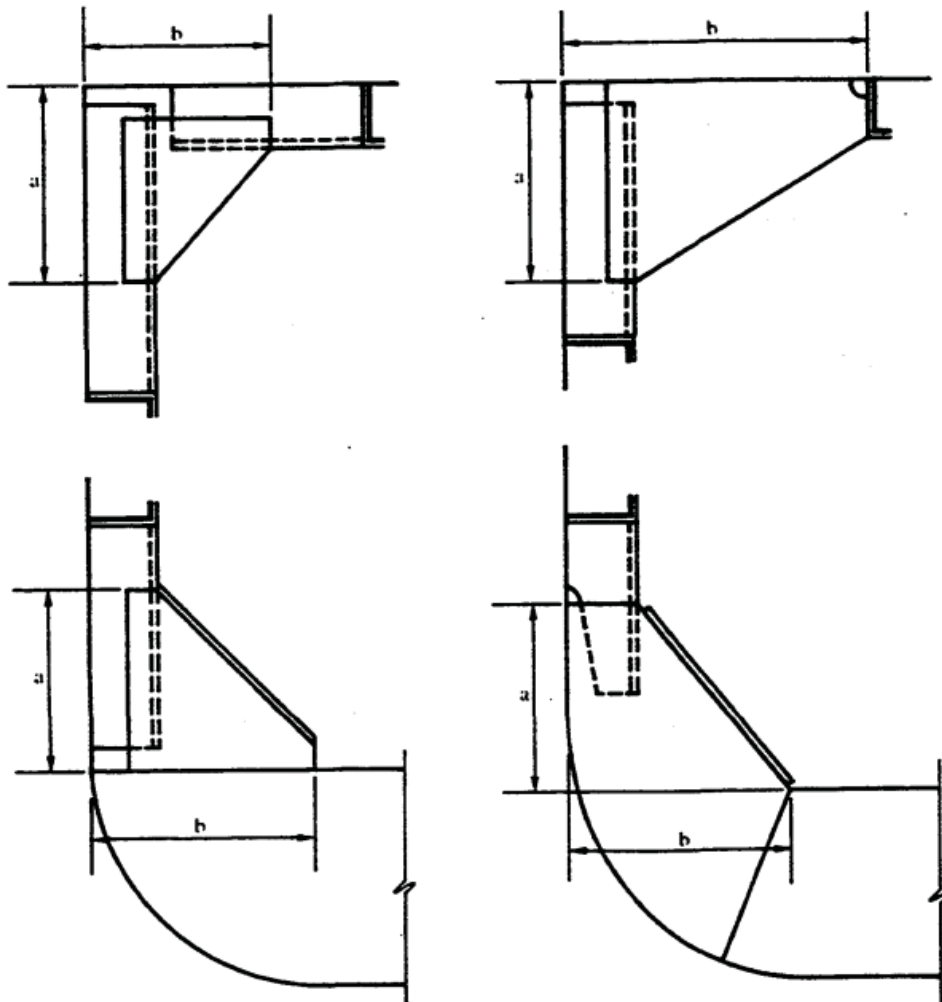


Figure 1

L.1.4.4.3 The length of a and b of the arms of end brackets are to be measured from the plating to the toe of the bracket and are to comply with the following conditions:

(i) $a + b \geq 2k$

(ii) $a \geq 0.8k$

(iii) $b \geq 0.8k$

where:

$$k = 90 \left(\sqrt{\frac{Z}{t}} - 1 \right) \text{ mm}$$

Z = the modulus of the stiffener, cm³

t = the thickness of the bracket web, mm

In no case should k be taken as less than twice the web depth of the stiffener on which the bracket scantlings are to be based.

L.1.4.4.4 The thickness of the bracket is to be not less than:

$$t = 3.5 + 0.25 \sqrt{Z} \text{ mm}$$

but in no case should it be less than 6.5 mm nor need it exceed 12.5 mm.

Where the free edge is unstiffened the thickness should not be less than 20 per cent greater than that required by the above formula.

L.1.4.4.5 Where the modulus of the stiffener exceeds 500 cm³, or the length of the free edge of the bracket exceeds 50 x t mm, the free edge of the bracket is to be stiffened.

Where a flange is fitted, the breadth of the flange f is to be not less than:

$$f = 40 \left(1 + \frac{Z}{1000} \right) \text{ mm}$$

but in no case should it be less than 50 mm. Where the edge is stiffened by a welded face flat, the cross-sectional area of the face flat is to be not less than:

(i) for offset edge stiffening:

$$\text{Area} = 0.9 f t \text{ mm}^2$$

(ii) for symmetrically placed stiffening:

$$\text{Area} = 1.4 f t \text{ mm}^2$$

L.1.4.4.6 Where the stiffening member is lapped on to the bracket, the length of overlap is to be adequate to provide the required area of welding.

In general, the length of the overlap should not be less than $10\sqrt{Z}$ mm, or the depth of the stiffener, whichever is the greater.

The design of the overlap is to be such as to ensure that at no point in the connection is the modulus reduced to less than that of the stiffener with associated plating.

L.1.4.4.7 The length of the arm of tank side and hopper side brackets is not to be less than 20 per cent greater than that required by sub-paragraphs L.1.4.4.3, L.1.4.4.4 and L.1.4.4.5, and the edge is to be stiffened. The modulus of the bracket (including effective area of shell plating) clear of the end of the main frame is not to be less than that of the main frame.

L.1.4.4.8 The thickness of end brackets in tanks is to be 10 per cent greater than required by sub-paragraphs L.1.4.4.3, L.1.4.4.4 and L.1.4.4.5.

L.1.4.4.9 The design of end connections and their supporting structure shall provide adequate resistance to rotation and displacement of the joint.

L.1.4.4.10 The end connections of main structural members, such as underdeck girders, transverses, webs and stringers should comply with the requirements of sub-paragraphs L.1.4.4.3 to L.1.4.4.6 inclusive, but in no case should the bracket thickness be less than the web thickness of the member.

Alternative arrangements will be considered by the Authority.

along an opening, the effective width of plating is equal to either one half the spacing or 16.5 per cent of the unsupported span, whichever is less.

The section modulus of a shape, bar or fabricated section not attached to plating is that of the member only.

To ensure stability, any plate or flat bar section having a depth to thickness ratio in excess of 16:1 shall have to be flanged or have a face bar fitted.

L.1.4.6 Tripping Brackets and Stiffeners

Tripping brackets are to be fitted on all webs, stringers, girders and transverses which exceed 250 mm in depth and are to have a spacing of about 3 metres. Stiffeners are to be fitted when the depth to thickness ratio exceeds 75.

L.2 Bar Keels

The thickness and depth of a bar keel are not to be less than those obtained from the following formulae:

$$t = 10 + 0.6L \text{ mm}$$

$$h = 100 + 1.5L \text{ mm}$$

where:

t = thickness in mm

h = depth in mm

L.3 Stems

L.3.1 Bar Stems

The thickness and width of bar stems should not be less than those obtained from the following formulae:

$$t = 12 + 0.48L \text{ mm}$$

$$w = 90 + 1.20L \text{ mm below waterline}$$

$$70 + 0.90L \text{ mm at stemhead}$$

where:

t = thickness in mm

w = width in mm

L.3.2 Cast or Forged Stems

Cast or forged stems should be proportioned to provide strengths at least equivalent to those of bar stems given in L.3.1. All joints and connections should be at least as effective as would be required for bar stems.

L.3.3 Plate Stems

Where plate stems are fitted they should not be less in thickness than that of the adjacent bottom shell plating given in sub-clause L.15.2.

The minimum thickness shall not be less than given by the formula:

$$t = 5.5 + 0.05L \text{ mm}$$

where t = thickness in mm

Plate stems are to be supported by horizontal webs between the decks and below the lowest deck; the unsupported length of stem plates is not to exceed 1.5 m. Where the curvature of the plate is large, a centreline web may be required.

L.4 Sternposts

L.4.1 Bar Sternposts (without a Propeller Post Boss)

Where a bar sternpost without a propeller post boss is used, its thickness and width are not to be less than obtained from the following formulae:

$$t = 0.73L + 10 \text{ mm}$$

$$b = 1.283L + 87.4 \text{ mm}$$

where:

t = thickness in mm

b = width in mm

Above the moulded line of the bottom shell plating, a sternpost may be reduced gradually in section until the area at its head is half the area obtained from the above equations.

L.4.2 Bar Sternposts (with a Propeller Post Boss)

Where a bar sternpost in a single screw vessel with propeller post boss and an outerpost is fitted, the sternpost is to have thickness and width below the propeller post boss not less than those obtained from the following equations:

$$t = 1.458L + 9.52 \text{ mm}$$

$$b = 1.283L + 87.4 \text{ mm}$$

where:

t = thickness in mm

b = width in mm

Above the propeller post boss the width of the inner post may be 85 per cent of that obtained from the above equation.

L.4.3 Cast, Forged or Fabricated Sternposts

A cast, forged or fabricated sternpost of special shape is to be so proportioned as to provide strength at least equivalent to that of a bar sternpost as given in L.4.1 or L.4.2.

All joints and connections are to be at least as effective as would be required on an equivalent bar sternpost.

L.4.4 Propeller Post Bosses

The thickness of the boss of a propeller post is not to be less than 60 per cent of the thickness of the propeller post.

L.4.5 Outer Posts

The width of outer posts may be 85 per cent of the widths obtained from L.4.2.

L.5 Stern Frames with Propeller Apertures

L.5.1 Inner Posts

The scantlings of fabricated propeller posts in single screw vessels are not to be less than:

$$l = 53\sqrt{L} \text{ mm}$$

$$b = 37\sqrt{L} \text{ mm}$$

$$t = 2.4\sqrt{L} \text{ mm}$$

where l, b and t are shown in figure 3a.

Where the section adopted differs from that shown in the figure, the section modulus about the longitudinal axis is not to be less than:

$$Z = 1.35 \times 1 \times \sqrt{L} \text{ cm}^3$$

(Amendment dated 16 March 1996)

The scantlings of cast steel posts are not to be less than:

$$l = 40\sqrt{L} \text{ mm}$$

$$b = 30\sqrt{L} \text{ mm}$$

$$t_1 = 3\sqrt{L} \text{ mm}$$

$$t_2 = 3.7\sqrt{L} \text{ mm}$$

where l , b , t_1 , and t_2 are shown in figure 3b.

Where the section adopted differs from the above the section modulus about the longitudinal axis is not to be less than:

$$Z = 1.3 \times 1 \times \sqrt{L} \text{ cm}^3$$

(Amendment dated 16 March 1996)

When calculating the modulus of the section adjoining shell plates within a width equal to $53\sqrt{L}$ mm from the aft end of the post may be included.

Thick posts which are to be welded to the shell plating are to have a tapered transition zone. Cast steel propeller posts are to be of simple design with well rounded corners and are to be strengthened by webs at 600 mm spacings.

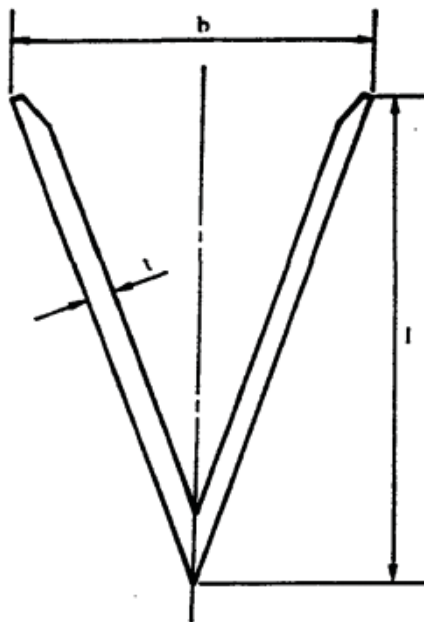


Figure 3(a)

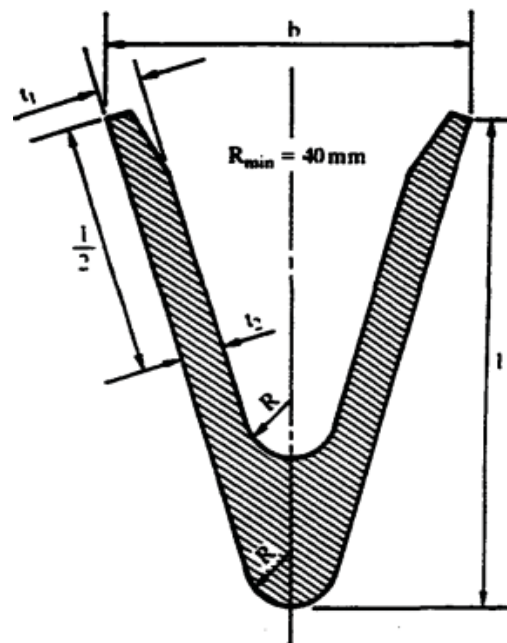


Figure 3(b)

L.5.2 Propeller Post Bosses

The thickness of t of the boss at the base for the sterntube is not to be less than:

$$T = 0.87L = 5.7 \text{ mm}$$

L.5.3 Outer Posts

The width of outer posts may be 85 per cent of the widths obtained from the equations in L.5.1.

L.5.4 Floors in Way of Outer Posts

Outer posts are to be attached to floors having thicknesses 5.0 mm greater than that required for double bottom floors in sub-clause L.10.2 and depths sufficient for welded attachments.

L.5.5 Cast, Forged or Fabricated Stern Frames

Cast, forged or fabricated stern frames of special shape are to be at least equal in strength to bar-type stern frames, and all joints and connections are to be at least as effective as would be required on equivalent bar type stern frames.

All connections to the stern frame in the vicinity of the shoe pieces are preferably to be either rabbeted or flush-buttet with backing bars where necessary.

L.6 Stern Frames Without Outer Posts

Where a stern frame is fitted with a shoe piece but does not have an outer post, the stern post above the propeller boss is to have scantlings, as required by L.4.2.

Below the boss the width and thickness is to be increased gradually in order to provide strength and stiffness in proportion to that of the shoe piece as detailed in L.7. The heel pieces are to have lengths suitably increased.

L.7 Shoe Pieces

The width to thickness ratio of shoe pieces is to be not greater than 2½:1.

The dimensions are in no case to be less than will satisfy the following equation for the minimum section modulus of any section of the shoe piece, taken about a vertical axis:

$$Z_y = CAV^2 l \text{ mm}^3$$

where:

Z_y = minimum section modulus about a vertical axis in mm^3

C = a coefficient given in the table below

A = total area of rudder in square metres

V = sea speed of vessel in knots

l = horizontal distance in millimetres between the centre line of the rudder stock and the particular section of the sternframe shoe.

Speed V	Values of C						
	10	11	12	13	14	15	16 and above
C (without an outer post)	2.054	1.811	1.617	1.464	1.339	1.235	1.138
C (with an outer post)	1.707	1.540	1.394	1.283	1.179	1.096	1.026

L.8 Rudder Horns

Where a rudder horn is fitted, it shall have ample strength and stiffness against bending and torsion to resist the forces imposed on it by the rudder.

Webs are to be arranged within the horn to extend down as far as possible and to provide effective connection with the afterpeak floors.

L.9 Propeller Shaft Brackets

L.9.1 Propeller shaft brackets should conform with the requirements laid down in the Engineering Section. Where brackets are attached to the hull, then the plate should be so arranged as to provide a close fit to the shell and the shell suitably strengthened in way.

L.10 Bottom Structures

L.10.1 Single Bottomed Vessels

L.10.1.1 Keelsons

All single bottomed vessels with breadths between the chines of the lower turns of the bilges equal to or exceeding 2.20 metres are to have centre or side keelsons or both. The maximum spacing from keelson to keelson and from outer keelson to chine or lower turn of bilge is to be 2.20 metres. The keelsons are to extend forward and aft as far as practicable and are to be equal in depth to the depths of the plate floors obtained in L.10.1.3.

Longitudinal structural members such as engine girders and wing tank bulkheads are to be considered as keelsons. Where a system of keelsons and floors is not adopted then the requirements of L.10.1.2 and L.10.3 apply.

The thickness of keelsons within the midship one half length is not to be less than that obtained from the following equation:

$$t = 0.063L + 5 \text{ mm}$$

where t = thickness in mm

the thickness of keelsons forward and aft of the midship one-half length may be reduced to 85 per cent of the keelson thickness amidships.

Where L exceeds 22.00 metres, the keelsons are to have rider plates. The rider plate area is not to be less than that obtained from the following equation:

$$a = 1.8 (L - 20.7) \text{ cm}^2$$

where a = section area in cm²

L.10.1.2 Girders

The section modulus Z of each girder where intended as a primary supporting member, in association with the plating to which it is attached, is not to be less than that obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3$$

where:

$$c = 0.915$$

h = depth in metres from the centre of area supported by the girder to the deck at side

s = girder spacing in metres

l = unsupported span of the girder in metres. Where brackets are fitted in accordance with L.1.4.4 the length l may be measured in accordance with that paragraph.

In general the depth of a girder is not to be less than 2.5 times the depth of the cutouts for the bottom frames unless effective compensation is provided for frame cutouts.

L.10.1.3 Plate Floors

L.10.1.3.1 Plate floors are to be fitted at each transverse frame.

L.10.1.3.2 The minimum depth of plate floors at the centreline (h_f) is not to be less than that obtained from the following equations:

$$h_f = 40 (B + d) \text{ mm where } B \leq 10 \text{ m}$$

$$h_f = 40 (1.5B + d) - 200 \text{ mm where } B > 10 \text{ m}$$

L.10.1.3.3 The minimum thickness of plate floors (t) at a standard spacing (S₁) of 508 + 0.83L mm is not to be less than that obtained from the following equation:

$$t = 0.01 h_f + 3 \text{ mm}$$

L.10.1.3.4 Where the floor spacing (S) exceeds the standard spacing (S₁) the thickness is not to be less than that obtained from the following equation:

$$t = \frac{S}{S_1} (0.01 h_f + 3) \text{ mm}$$

L.10.1.3.5 Floors under engine girders are to be not less in thickness than the thickness required for keelsons.

L.10.1.3.6 The minimum sectional area (A) of floor flanges or rider bars is not to be less than that obtained from the following equation:

$$A = 500 d \left[1 - \frac{2.5}{B} \right] \frac{S}{S_1} \text{ mm}^2$$

L.10.1.3.7 The floor flange or rider bar is to be not less in thickness than the thickness of the floor plate, and the ratio of width to thickness should be not less than 8 or more than 16.

L.10.2 Double Bottoms

A centre girder is to be fitted extending as far as forward and aft as practicable.

The depth of the centre girder is not to be less than that obtained from the following equation:

$$h_g = 32B + 190 \sqrt{d} \text{ mm}$$

where h_g = depth in mm

The thickness of the centre girder within the midship one half length is not to be less than that obtained from the following equation:

$$t = 0.066L + 5 \text{ mm}$$

where t = thickness in mm.

The thickness of the centre girder forward and aft of the midship one half length may be reduced to 85% of the girder thickness amidships.

L.10.2.2 Side Girders

Where the distance between the centre girder and the side shell exceeds 4.50 metres, intercostal side girders are to be fitted approximately midway between the centre girder and the side shell.

The minimum thickness of the intercostal side girders is not to be less than that obtained from the following equation:

$$t = 0.053L + 4 \text{ mm.}$$

where t = thickness in mm.

L.10.2.3 Solid Floors

Solid floors are to be fitted at every frame under the engineroom, at every frame in the peaks and under transverse bulkheads. Elsewhere the solid floors are to have a maximum spacing of 3.0 metres in association with intermediate open floors or longitudinal framing. The thickness of solid floors is to be equal in thickness to that of side girders specified in L.10.2.2.

L.10.2.4 Open Floors

In transversely framed vessels, open floors consisting of frames and reverse frames are to be fitted at all frames where solid floors are not fitted. The section modulus Z of each frame and reverse frame in association with the plating to which it is attached is not to be less than that obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3$$

where:

$c = 0.85$ clear of tanks

= 0.425 where struts are fitted in accordance with L10.2.5 and spaced not more than 1.5 metres apart, clear of tanks

= 1.00 in way of tanks

= 0.50 where struts are fitted in accordance with L.10.2.5 and spaced not more than 1.5 metres apart, in way of tanks

s = frame spacing in metres

h = vertical distance in metres from the keel to the deck at side or, in way of deep tank, the distance in metres from the keel to the top of the tank, whichever is greater. Where reverse frames are fitted without struts. It for reverse frames may be measured from the top of the double bottom

l = distance in metres between the centre girder and the side shell. When side girders are fitted, l is the greater of the spaces between the centre girder and side girder between side girders and between side girders and shell. Where brackets are fitted in accordance with L.1.4.4 the length l may be measured as provided therein.

L.10.2.5 Struts

Where struts are fitted in open floors as permitted in L.10.2.4 they are to have scantlings as necessary to comply with L.12.2.3 to resist a load calculated from the following equation:

$$w = 1.10 \text{ phs tonnes}$$

where:

w = load in tonnes

p = sum of the half lengths in metres (on each side of the strut) of the frames supported

s = frame spacing in metres

h = definition in L.10.2.4.

L.10.2.6 Inner-Bottom Plating

The thickness of the inner-bottom plating throughout the length of the vessel is to be obtained from the following equation:

$$t = 0.037L + 0.009s \text{ mm}$$

where:

t = thickness in mm

s = frame spacing in mm

Where no ceiling is fitted under cargo hatchways, the thickness of the inner-bottom plating is to be increased 2.0 mm. In vessels engaged in trades where cargo is handled by grabs or similar mechanical devices, it is recommended that flush plating be adopted and that the thickness be increased 5 mm.

L.10.2.7 Sea Chests

Where the double bottom structure forms part of a sea chest, the thickness of the plating is not to be less than that required for the shell plating.

L.10.2.8 Access, Lighting, Air and Drainage Holes

Access holes in double bottom tank tops and lightening holes in nontight members are to be sufficient in size and number to assure the accessibility to all parts of the double bottom. The proposed locations and sizes of the holes are to be indicated on the drawings submitted for approval. Tank top access hole covers are to be of steel or equivalent material and where no ceiling is fitted in a cargo hold, the covers are to be protected against damage by the cargo. Air and drainage holes are to be cut in all nontight parts of the double bottom structure to assure the free escape of gases to the vents and the free drainage of liquid to the suction.

L.10.3 Bottom Frames

L.10.3.1 Application

Reference should be made to figures 5, 6 and 7 and L.11.1.

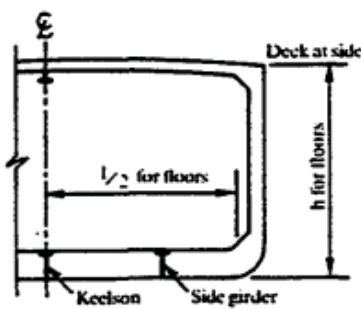


Figure 4 PLATE FLOORS

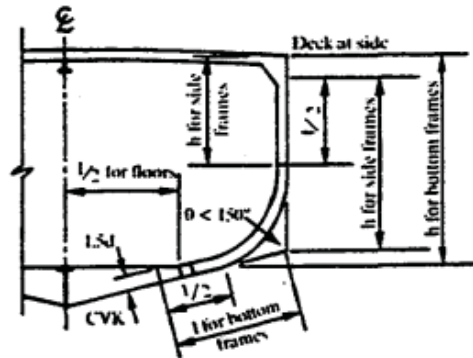


Figure 5 ROUND BOTTOM VESSELS WITH DEADRISE

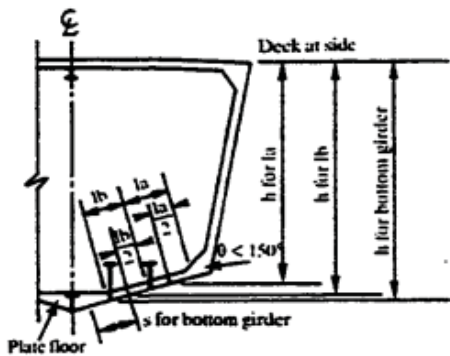


Figure 6 TRANSVERSE SIDE FRAMES WITH LONGITUDINAL SIDE GIRDERS

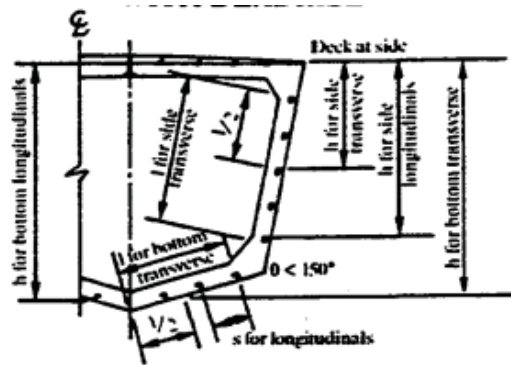


Figure 7 LONGITUDINAL FRAMES WITH TRANSVERSE WEBS

L.10.3.2 Section Modulus

The section modulus Z of each bottom frame to the chine or to the upper turn of the bilge in association with the plating to which it is attached is not to be less than that obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3$$

where:

- $c = 0.85$ for transverse frames clear of tanks
- $= 1.10$ for longitudinal frames clear of tanks
- $= 1.00$ for transverse frames in way of tanks
- $= 1.30$ for longitudinal frames in way of tanks

s = frame spacing in metres

l = unsupported straight line span in metres. Where brackets are fitted in accordance with L.1.4.4, the length l may be measured as provided therein

h = vertical distance in metres from the middle of l to the deck at side; in way of a deep tank h is the greatest of the distances in metres from the middle of l to:

- (a) the deck at side;
- (b) a point located at two-thirds of the distance from the top of the tank to the top of the overflow; and
- (c) a point located above the top of the tank not less than the greater of the following:
 - (i) $0.01L + 0.15$ metres
 - (ii) 0.45 metres.

L.10.3.3 Inner-Bottom Longitudinals

The section modulus Z of each longitudinal on the inner-bottom where fitted, may be 85 per cent of the required section modulus Z of the longitudinal frames obtained in L.10.3.2.

L.10.3.4 Bottom Web Frames

Reference should be made to figure 7. The section modulus Z of each bottom web frame supporting longitudinal framing or shell stringers, in association with the plating to which the web frame is attached, is not to be less than obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3$$

where:

$c = 0.915$

s = spacing of web frames in metres

l = unsupported straight line span in metres. Where brackets are fitted in accordance with L.1.4.4, the length l may be measured as permitted therein

h = vertical distance in metres from the middle of l to the deck at side; in way of a deep tank, h is the greatest of the distances in metres from the middle of h to:

- (a) the deck at side;
- (b) a point located at two thirds of the distance from the top of the tank to the top of the overflow; and
- (c) a point located above the top of the tank not less than the greater of the following:
 - (i) $0.01L + 0.15$ metres
 - (ii) 0.45 metres.

L.11 Side Frames, Webs and Stringers

L.11.1 General

Frames or webs and stringers are not to have less strength than is required for watertight bulkhead stiffeners or girders in the same location in association with heads to the bulkhead deck. In way of deep tanks, frames or webs and stringers are not to have less strength than is required for stiffeners or girders on deep tank bulkheads.

The calculated section moduli for frames are based on the intact sections being used. Where a hole is cut in the outstanding flange of any member or a large opening is made in the web of the frame, the net section is to be used in determining the section modulus of the member in association with the plating to which it is attached. See figures 5, 7, 8, and 9.

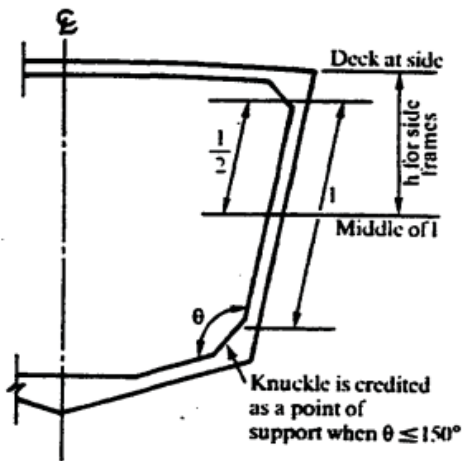


Figure 8

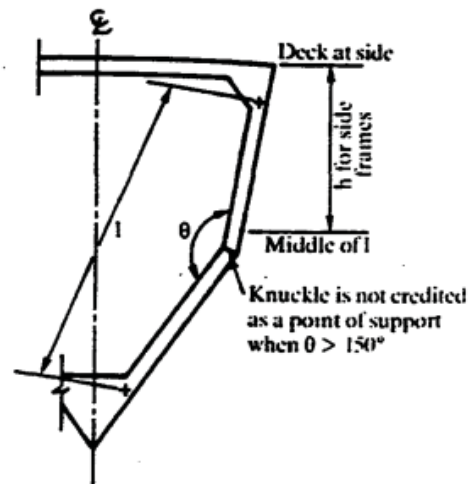


Figure 9

In general, this section applies to midship framing, and suitable fore end strengthening should be adopted to provide for any increased loads in that region expected to be encountered in service.

L.11.2 Side Frames

L.11.2.1 General

The section modulus Z of each side frame, either longitudinal or transverse, above the chine or upper turn of the bilge in both displacement and planning vessels, in association with the plating to which the frame is attached is not to be less than that obtained from the following equation:

$$Z = 7.9hs^2cm^3$$

where:

s = frame spacing in metres

l = straight-line unsupported span in metres. Where brackets are fitted in accordance with L.1.4.4, the length l may be measured as permitted therein

h = vertical distance in metres from a longitudinal frame or from the midlength of a vertical frame to the freeboard deck at side.

L.11.2.2 Recommendation For Vessels Subject to Impact

For tugs, supply vessels and other vessels subject to impact loadings during routine operations, it is recommended that side frames with a section modulus 25% greater than that obtained above be provided.

L.11.3 Side Web Frames

The section modulus Z of each side web frame, supporting longitudinal framing or shell stringers above the chine or upper turn of the bilge, in association with the plating to which the web frame is attached, is not to be less than obtained from the following equation:

$$Z = 7.9chs^2m^3$$

where:

$$c = 0.915$$

s = spacing web frames in metres

l = unsupported straight line span in metres. Where brackets are fitted in accordance with L.1.4.4, the length l may be measured as permitted therein

h = vertical distance in metres from the middle of l to the freeboard deck at side.

The depth of the web frame is not to be less than 2.5 times the depth of the cutout unless effective compensation is provided for frame cutouts.

L.11.4 Side Stringers

L.11.4.1 General

Side stringers supporting transverse side frames are to be spaced so that the lowest stringer is no more than 2.00 metres above the tops of floors or top of inner bottom and the distance between stringers is no more than 2.50 metres. The depth of the stringer is not to be less than 2.5 times the depth of the cutout unless effective compensation is provided for frame cutouts.

L.11.4.2 Section Modulus

The section modulus Z of each side stringer supporting transverse side frames is not to be less than that obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3$$

where:

$$c = 0.915$$

s = sum of half lengths in metres (on each side of the stringer) of the frames supported

h = vertical distance in metres from the middle of s to the freeboard deck at side and

l = span in metres between web frames or between web frames and bulkhead. Where brackets are fitted in accordance with L.1.4.4 the length may be measured as provided therein.

L.12 Beams, Pillars, Deck Girders and Runners L.12.1 Beams

L.12.1 Beams

L.12.1.1 Spacing

Beams may be fitted either transversely or longitudinally. Transverse beams, where fitted, are to be fitted on all frames at the tops of tanks, tunnel tops and bulkhead recesses. Elsewhere these beams are not to be more than two frame spaces apart and those in different tiers are to be fitted on the same frames.

L.12.1.2 Section Modulus

The section modulus Z of each transverse or longitudinal beam in association with the plating to which it is attached is not to be less than that obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3$$

where:

- c = 0.60 for transverse beams
- = 0.70 for longitudinal beams
- = 1.00 for transverse or longitudinal beams at the top of tanks

s = beam spacing in metres

l = unsupported span in metres. At the tops of tanks and bulkhead recesses the maximum span permissible between supports is 4.50 metres. Where brackets are fitted in accordance with L.1.4.4, the length l may be measured as provided therein.

H = height in metres as follows:

- (a) h for a deep tank top is the greater of the following distances:
 - (i) two thirds of the distance from the top of the tank to the top of the overflow; or
 - (ii) two thirds of the distance from the top of the tank to the bulkhead deck or freeboard deck.
- (b) h for a deck on which cargo or stores are carried is the tween deck height at side. Where the cargo weights are greater or less than normal, h is to be suitably adjusted.
- (c) h for an exposed deck on which cargo is carried is 3.65 metres. Where it is intended to carry deck cargoes in excess of 2640 kg/m² this head is to be increased in proportion to the added loads which will be imposed on the structure.
- (d) h elsewhere is obtained from the appropriate equations below:
 - (i) exposed freeboard deck having no deck below:
 - h = 0.02L + 0.75 metres
 - (ii) exposed freeboard deck having a deck below, forecastle deck, superstructure deck forward of amidships 0.5L:
 - h = 0.02L + 0.50 metres
 - (iii) freeboard deck within superstructure, any deck below freeboard deck, superstructure deck between 0.25L forward of and 0.30L aft of amidships:
 - h = 0.01L + 0.60 metres
 - (iv) all other locations:
 - h = 0.01L + 0.30 metres

L.12.1.3 Special Heavy Beams

Special heavy beams are to be fitted under concentrated loads such as ends of deckhouses, masts, winches, auxiliary machinery etc. Beams at the heads of web frames are to be suitably increased in strength and stiffness.

L.12.2 Pillars

L.12.2.1 General

Supports under pillars are to be of sufficient strength to distribute the load effectively. Tweendeck pillars are to be arranged directly above those below, or effective means are to be provided for transmitting their loads to supports below.

L.12.2.2 Pillar Load

The load on a pillar is to be obtained from the following equation:

$$W = 0.715 \text{ bhs tonnes}$$

where:

w = load in tonnes

b = mean breadth in metres of area supported

s = mean length in metres of area supported

h = height in metres above the deck supported as defined below:

- (a) h for a pillar below an exposed deck on which cargo is carried is the distance from the deck supported to a point 3.65 metres above the exposed deck. Where it is intended to carry deck cargoes in excess of 2640 kg/m² this head is to be increased in proportion to the added loads which will be imposed on the structure. Where tweendeck cargo is carried and its weight is greater or less than normal, h is also to be suitably adjusted.
- (b) h for a pillar below the freeboard deck is to be measured to a point not less than 0.02L + 0.75 metres above the freeboard deck.
- (c) h for a pillar below the superstructure deck is to be measured to a point not less than 0.02L + 0.50 metres above the superstructure deck.

L.12.2.3 Permissible Load

The permissible load a pillar can carry is to be equal to or greater than the pillar load w as determined above. The permissible load may be obtained from the following equation:

$$w_a = A \left[1.232 - 0.00452 \left(\frac{l}{r} \right) \right] \text{tonnes}$$

where:

w_a = load in tonnes

A = area of pillars in cm²

l = the unsupported length of the pillar in mm

r = least radius of gyration of pillar in mm.

L.12.2.4 Pillars in Double Bottoms And Under Tank Tops

Pillars in double bottoms and under the tops of deep tanks are to be solid in cross section. Pillars under the tops of deep tanks are not to be less than required by L.12.2.2 and L.12.2.3, nor are they to have less sectional area than 1.015w where w is to be obtained from the following equation:

$$w = 1.07 \text{ bhs tonnes}$$

where:

b = breadth in metres of the area of the top of the tank supported by the pillar

s = length in metres of the area of the top of the tank supported by the pillar

h = height in metres as required by L.12.1.2 for the tanktop beams.

L.12.2.5 Bulkheads

Bulkheads supporting girders or bulkheads fitted in lieu of girders, are to be stiffened to provide supports not less effective than required for pillars.

L.12.3 Deck Girders

L.12.3.1 General

Girders are to be fitted as required to support beams and longitudinals. Additional girders are to be fitted as required under masts, king posts, deck machinery, or other heavy concentrated loads.

L.12.3.2 Deck Girders Clear of Tanks

Section Modulus Z of each longitudinal deck girder clear of tanks is not to be less than obtained from the following equation:

$$Z = 7.9cbhl^2 \text{ cm}^3$$

where:

c = 0.60

b = mean breadth in metres of area of deck supported

h = height in metres as required by L.12.1.2 for the beams supported

l = unsupported span in metres. Where brackets are fitted in accordance with L.1.4.4, the length l may be measured as provided therein.

L.12.3.3 Deck Transverses Clear of Tanks

Section Modulus Z of each deck transverse that supports longitudinal deck beams clear of tanks is not to be less than that obtained from L.12.3.2 where c, h and l are as defined and b is the spacing of deck transverses in metres.

L.12.3.4 Proportions

Except in way of accommodation spaces, the minimum depth of a deck girder or transverse supporting member is to be 0.0583 l and the minimum thickness is to be 1 mm per 100 mm of depth plus 4 mm.

L.12.3.5 Deck Girders and Transverses in Tanks

The requirements for deck girders or transverses supporting members in tanks may be obtained in the same manner as given in L.12.3.2, L.12.3.3 and L.12.3.4, except that c is 0.915 and the minimum depth of a girder or transverse supporting member is to be 0.0833 l.

L.12.4 Dock Runners

The section modulus for deck runners should be derived from the formula:

$$Z = 2.75 bh^2 \text{ cm}^3$$

where:

l = span of deck runner in metres

b = mean width of deck supported by the runners in metres

Z = section modulus.

h = height of loading in metres (see clause L.16)

L.13 Watertight Bulkheads

L.13.1 Number of Bulkheads

All vessels of Classes 1, 2 and 3 are to be provided with watertight bulkheads. For passenger vessels, the number, position and extent of the bulkheads are to be in accordance with Subsection C, Watertight Subdivision of Passenger Vessels.

All vessels of Classes 2 and 3 are to be provided with bulkheads, the number, position and extent of which are to be in accordance with Sub-section D, Watertight Sub-division of Class 2 and Class 3 Vessels.

L.13.2 Construction of Watertight Bulkheads

L.13.2.1 Plating

Thickness of plating of watertight bulkheads should not be less than

$$T = \frac{s(h + 6.1)}{1830} + 3.05 \text{ mm}$$

where:

t = thickness

s = spacing of stiffeners in mm

h = distance of lower edge of the plate to the bulkhead deck at centre in metres.

The plating of a collision bulkhead is to be obtained from the equation using a spacing 150 mm greater than that actually adopted.

For vessels less than 35 metres in length, the following deductions may be made to the thickness obtained from the above equation:

<i>Length</i>	<i>Deduction (mm)</i>
25 metres and over but less than 35 metres	0.25
20 metres and over but less than 25 metres	0.50
15 metres and over but less than 20 metres	0.75

Less than 15 metres

1.00

L.13.2.2 Stiffeners

The section modulus Z of each bulkhead stiffener in association with the plating to which it is attached is to be not less than that obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3$$

where:

h = distance from the middle of l to the bulkhead deck at the centre in metres

s = spacing of stiffeners in metres

l = distance in metres between the heels of the end attachments, where horizontal girders are fitted, l is the distance from the heel of the end attachment, to the first girder, or the distance between the horizontal girders

$c = 0.29$ for a stiffener with effective brackets at both ends of its span

= 0.38 for a stiffener with an effective bracket at one end and a lug connection or horizontal girder at the other end

= 0.46 for a stiffener with lug connection at both ends or a lug connection at one end and a horizontal girder at the other end

= 0.58 for a stiffener between horizontal girders or for a stiffener with no end attachments.

The section moduli of stiffeners on collision bulkheads are to be increased by 25 per cent over the section moduli of stiffeners on ordinary watertight bulkheads.

L.13.2.3 Girders and Webs

Each horizontal girder or vertical web supporting bulkhead stiffeners is to have a section modulus Z not less than that obtained from the following equation:

$$Z = 7.9chs^2 \text{ cm}^3 \text{ where:}$$

$c = 0.6$

l = unsupported span of girder or web in metres. Where brackets are fitted in accordance with L.1.4.4 the length l may be measured as required therein.

s = sum of half lengths in metres (on each side of the girder or web) of the stiffeners supported by the girder or web.

h = vertical distance in metres to the bulkhead deck at centre from the midlength of s in the case of a horizontal girder or from the middle of h in the case of a vertical web.

The required section moduli of girders or webs on collision bulkheads are to be increased by 25 per cent over the required section moduli of girders or webs on ordinary bulkheads. The depth of a girder or web is not to be less than twice the depth of the cutout unless effective compensation is provided for the stiffener cutouts.

L.13.3 Chain Lockers

A chain locker located abaft the collision bulkhead or extending into forepeak deep tanks shall be watertight.

L.14 Deep Tanks**L.14.1 General**

Boundary bulkheads and tight divisions of all deep tanks are to be constructed in accordance with the requirements of this clause where they exceed the requirement of L.13.

L.14.2 Construction of Deep Tank Bulkheads**L.14.2.1 Plating**

The minimum thickness of deep tank boundary bulkheads and tight divisions is to be obtained from the following equation:

$$t = \frac{s\sqrt{h}}{250} + 2.50 \text{ mm}$$

where:

t = thickness in mm

s = stiffener spacing in mm

h = greatest of the distances, in metres, from the lower edge of the plate to:

- (a) a point located two-thirds of the distance to the bulkhead or freeboard deck
- (b) a point located at two-thirds of the distance from the top of the tank to the top of the overflow
- (c) a point located above the top of the tank not less than the greater of the following:
 - (i) 0.01L + 0.15 metres
 - (ii) 0.50 metres

L.14.2.2 Stiffeners

The section modulus Z of each deep tank stiffener in association with the plating to which it is attached is not to be less than obtained from the following equation:

$$Z = 7.9 \text{ chsl}^2 \text{ cm}^3$$

where:

l = distance in metres between the heels of the end attachments; Where horizontal girders are fitted, l is the distance from the heel of the end attachments to the first girder or the distance between the horizontal girders

s = stiffeners spacing in metres

h = greatest of the distances in metres from the middle of l to:

- (a) a point located at two thirds of the distance from the middle of l to the bulkhead or freeboard deck
- (b) a point located at two thirds of the distance from the top of the tank to the top of the overflow
- (c) a point located above the top of the tank not less than the greater of the following-
 - (i) 0.01L + 0.15 metres
 - (ii) 0.46 metres

c = 0.59 for stiffeners having efficient bracket attachments at both ends

= 0.75 for stiffeners having efficient bracket attachments at one end and lug connections or horizontal girders at the other end

= 0.90 for stiffeners having lug connections at both ends or having such attachments at one end and horizontal girders at the other end

= 1.17 for stiffeners having horizontal girders at both ends or free ends.

L.14.2.3 Girders and Webs

Horizontal girders or vertical webs supporting bulkhead stiffeners in deep tanks are to have section moduli as required by this sub-clause.

Girders or webs supporting frames or beams in deep tanks are to have section moduli as required by clauses L.11 and L.12 respectively or as required by this sub-clause, whichever is the greater.

The section modulus Z of each girder or web is not to be less than obtained from the following equation =

$$Z = 7.9\text{chsl}^2 \text{ cm}^3$$

where:

c = 0.9

l = unsupported length of girder or web in metres. Where brackets are fitted in accordance with sub-clause L.1.4.4, the length l may be measured as required therein

s = sum of half lengths in metres (on each side of the girder or web) of the frames or stiffeners supported by the girder or web

h = vertical distance in metres from the middle of s in the case of a girder or from the middle of l in the case of a web to the same heights to which h for the stiffeners is measured (vide L.14.2.2).

The depth of a girder or web is not to be less than 2.5 times the depth of the cut-out unless effective compensation is provided for stiffener cut outs.

L.14.3 Drainage and Air Escape

Limber and air holes are to be cut as required in non-tight parts of the tanks to ensure the free flow of liquids to the suction pipes and the escape of air to the vents.

Arrangements are to be, made for draining the tops of the tanks.

L.14.4 Testing

All deep tanks if required by the Authority are to be tested with heads of water to the tops of the overflows or to two thirds of the distance from the tops of the tanks to the bulkhead or freeboard deck, whichever is the greater, or by an equivalent air test.

Testing should be carried out before the application of any coatings.

L.15 Shell Plating

L.15.1 General

The thickness of bottom and side shell plating shall not be less than the thickness given in the sub-clause L.15.2 or L.15.3 as appropriate.

L.15.2 Bottom Shell Plating

L.15.2.1 Extent of Bottom Shell Plating

The term “bottom plating” refers to the plating from the keel to the upper turn of the bilge or upper chine.

L.15.2.2 Bottom Shell Plating

The thickness of the bottom shell plating is not to be less than that obtained from the following equations:

(a) For vessels with Transversely- framed Bottoms

$$t = \frac{s}{519} \sqrt{(L - 19.8) \left(\frac{d}{D} \right)} + 2.5 \text{ mm}$$

(b) For vessels with Longitudinally-framed Bottoms

$$t = \frac{s}{671} \sqrt{(L - 18.3) \left(\frac{d}{D} \right)} + 2.5 \text{ mm}$$

(c) $t = \frac{s \sqrt{h}}{250} + 2.50 \text{ mm}$

where:

t = thickness of bottom shell plating in mm

s = frame spacing in mm

L = length of the vessel as defined in sub-clause A.4.8 or 20 metres whichever is the greater.

h = distance from the lower edge of the plate to the freeboard deck side in m.

L.15.2.3 Flat of Bottom

For vessels 35 metres in length and above the plating on the flat of the bottom forward of the midship three fifths length in vessels having machinery amidships, and forward of the midship one half length in vessels having machinery aft, is not to be less than required by L.15.2.2 or the following equation: