J. Steel

Contents

J.1 General

J.1.1 Application

This sub-section shall apply to all fully welded steel displacement vessels of Class A, B and C. non sea going vessels, planning hull and light displacement or vessels that are considered not of normal form or portion shall require special consideration by AUSCLASS.

J.1.2 Materials

The welding of steel shall be to the quality standards of AS/NZS 3678 (Structural steel – Hot-rolled plates, floorplates and slabs; AS/NZS 3679.1 (Structural steel – Hot-rolled bars and sections) or equivalent. Proof of steel quality shall be required; makers certificate of the steel suppliers' invoices shall generally be accepted by AUSCLASS. If any doubt arises of the steels quality additional testing shall be conducted at the owner's expense. Additional information shall be submitted to AUSCLASS on the welding and steel particulars prior to construction if higher tensile steel is to be used.

J.1.3 Workmanship

All workmanship shall be to the best quality. Plates which are subject to excessive furnacing shall require sufficient heat treatment prior to being worked into the hull. Where the construction of a vessel includes riveting, a full set of particulars shall be submitted to AUSCLASS prior to construction.

J.2 General structural design particulars

J.2.1 Longitudinal strength

The vessels midship section modulus to ensure sufficient longitudinal strength, for vessels of standard form usually will be obtained if the longitudinal member and plating requirements of this section are satisfied. AUSCLASS may require in addition the longitudinal hull strength calculations to be submitted, especially for vessels of sallow depth or wide hatch openings.

J.2.2 Continuity

The structural continuity of the vessel must be retained. Scantlings should not change direction or section abruptly. All the major longitudinal members shall not end abruptly at a transverse member but instead be tapered off at each end over a minimum of two frame spacings. Pillars and bulkheads shall be aligned with their loads to avoid eccentric loading. Superstructure appendages and strength bulkheads should be collinear the major structural hull members. Sharp corners should be avoided and openings in strength decks and shell plating shall have well rounded corners. The corner radius shall be no less than 75mm or 1/24th of the opening breadth whichever is larger but for all openings exceeding 25% of the beam, it shall be no less than 150mm.

J.2.3 Openings

Major openings such as doors, vents, exhausts and hatches should not penetrate stringer plate of sheer strake within a distance of 0.3L forward or aft of midships, and all opening corners shall be well rounded with appropriate compensation.

J.2.4 Brackets

All main structural members and secondary stiffening members that are a part of the hulls structure shall be connected at the ends in accordance with this clause except for bracketless beam frames connections which shall be in accordance with figure 2 and associated sub-clause.

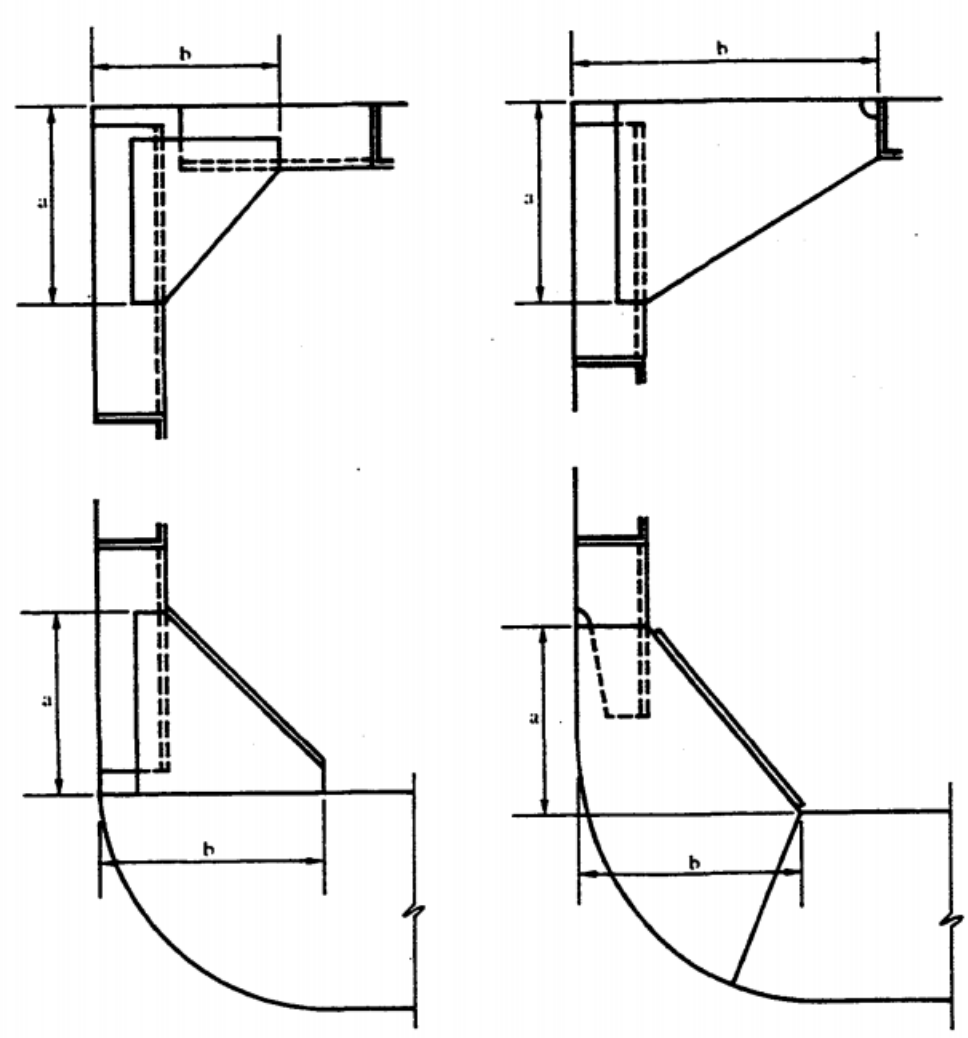
Where brackets are fitted to a member as end connections, the length 1 of that member shall be the clear span between bracket toes increased by a distance a/4 or b/4 whichever is appropriate at each end of the span. Where end connections other than brackets are fitted to a member, they may be taken into account in determining the effective span of that member and details provided on the plans or in calculations submitted to AUSCLASS.

Where a longitudinal strength member is bracketed to a main structural member, the bracket scantling shall have a section modulus (Z) and effective cross-sectional area no less than 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 shall 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.



The lengths a and b shall be measure from the plating to the toe of the bracket and shall comply with the following conditions:

$$a + b \geq 2k$$

$$a \geq 0.8k$$

$$b \geq 0.8k$$

Where:

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

Z is the modulus of the stiffener, cm^3

t is the thickness of the bracket web, mm

k shall in no case be less than twice the web depth of the stiffener on which the bracket scantlings are to be based.

The bracket thickness shall not be less than

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

But in no case shall the thickness be less than 6.5mm nor shall it need to exceed 12.5mm

If the free edge is unstiffened, then the thickness shall be increased by a minimum of 20% greater than the value determined by the above equation.

The free edge shall be stiffened if the modulus of the stiffener exceeds $500cm^3$ or the length of the free edge of the bracket exceeds 50*t mm.

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

$$\mathrm{f} = 40\left(1 + \frac{Z}{100}\right) mm$$

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

For offset edge stiffening:

Area = 0.9 f t mm^2

For symmetrically placed stiffening:

Area = 1.4 f t mm^2

Where a stiffening member is lapped on a bracket there shall be sufficient length of overlap to provide the required area for welding. In general, the length of overlap shall be at a minimum $10\sqrt{Z}\ mm$ or the depth of the stiffener, whichever is greater. The design of the overlap shall ensure that the modulus shall not be reduced to less than that of the stiffener with associated plate at any point along the connection.

The length of the arm of tank side and hopper side brackets shall be at least 20% greater than the previous equation and have the edge stiffened. The modulus of the bracket clear of the end of the main frame is not to be less than that of the main frame.

The thickness of end brackets in tanks be increased by 10% than required by the previous equation in the brackets sub-section.

The design of end connections and their supporting structure shall prevent rotation and displacement of the joint.

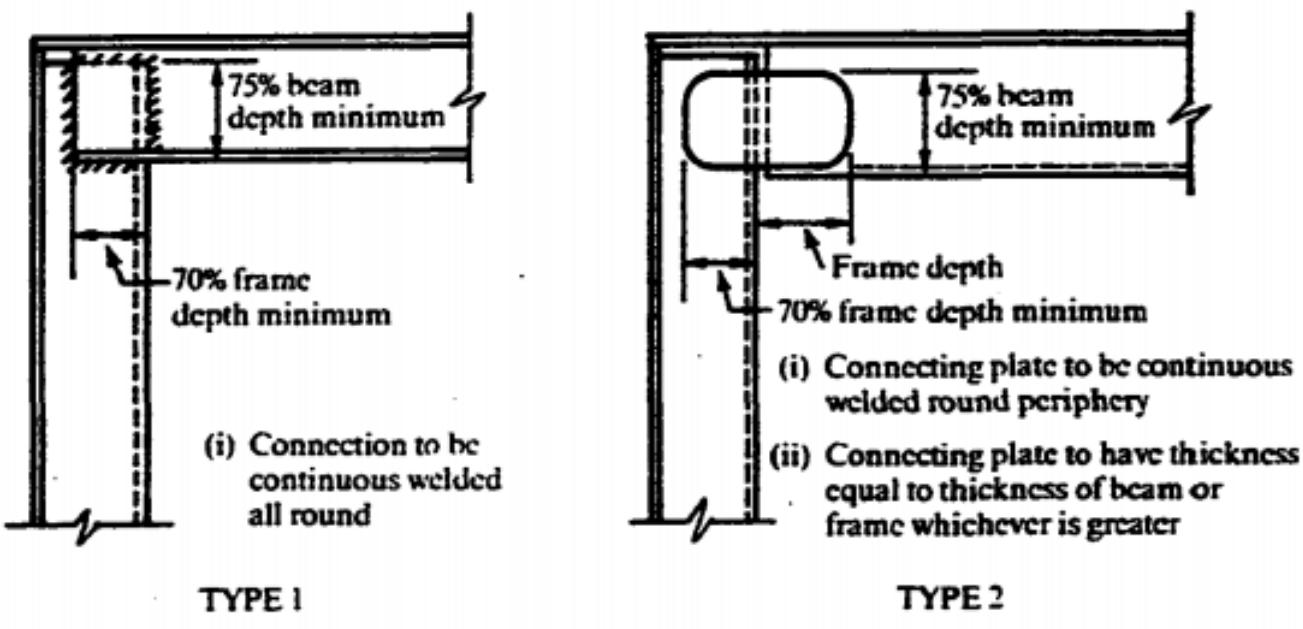
End connections of main structural members such as underdeck girders, transverses, webs and stringers shall comply with the bracket sub-clause inclusive, and in no case shall the thickness of the bracket be less than the web thickness of the member.

Alternative arrangements may be considered by AUSCLASS.

Attention shall be given to the strength and stiffness of the structure that supports the end connections.

Where the structural analysis of the vessel is produce suing direct calculation, the assumptions used, and calculations shall be submitted to AUSCLASS. The design and scantlings of end connection shall be considered in conjunction with the structural calculations.

where prosed that backless beam framed connections should be used, the connections shall be arranged as shown:



The weld area (A) connecting each arm of a bracket to the stiffeners or plating is to be not less than:

$A = 120\ Z\ mm^2$ in general, or

$A = 140\ Z\ mm^2$ in tanks

where:
A is the throat thickness * total length of weld
Z modulus of the stiffener on which the scantlings of the brackets are based, cm^3

The throat thickness of the weld shall be no less than:

- 0.28 x bracket thickness in general
- 0.35 x bracket thickness in tanks

The throat thickness shall be in all circumstances be no less than 3.5mm

In the case where the stiffener on a watertight bulkhead is connected at its end to a deck, beam or tank top, the throat thickness of the weld shall be no less than 0.44 times the stiffener thickness.

J.3 Structural members

The scantlings that are determined by these requirements are applicable to standards structural shapes and bars and fabricated sections.

The section modulus (Z) of a stiffener or frame is provided by the member and a panel equal in width to one frame spacing of the plating to which it is attached.

The section modulus of webs, girder, etc, supporting stiffeners or frames shall be obtained on an effective width of plating with the associated plating to which it is attached.

The effective width of plating shall be equal to the lesser of wither one half the spacing on each side of the member of 33% of the unsupported span of the member. For a member along an opening the effective width shall be the less of either one half the spacing or 16.5% of the unsupported span.

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

To ensure stability of plates or flat bars, that have a depth to thickness ratio that is in excess or 16:1, shall be flanged or fitted with a face bar.

J.3.1 Tripping brackets and stiffeners

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

J.4 Bar Keels

The thickness and depth of a bar keel shall not be less than the thickness determined by the equations:

$$t = 10 + 0.6L\ mm$$

$$h = 1000 + 1.5L\ mm$$

Where:

t is the thickness in mm
h is the depth in mm

J.5 Stems

J.5.1 Bar stems

The thickness and depth of bar stems shall not be less than the thickness determined by the equations:

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

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

$$\mathrm{w} = 90 + 0.9\mathrm{L\ mm\ at\ stemhead}$$

Where:

t is the thickness in mm
w is the width in mm

J.5.2 Cast or forged stems

Cast of forged stems shall provide the equivalent strength as bar stems and have joints that are at least as effective as joints required for bar stems.

J.5.3 Plate stems

The plate stems shall be at a minimum the thickness of the adjacent bottom shell plating or the thickness given by the following formula, whichever is greater:

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

Where:

t is the thickness in mm

Plate stems shall be supported by webs in between decks and have a maximum below to bottom deck the unsupported stem plate shall not exceed 1.5m. A centreline web may be required if the plate curvature is large.

J.6 Stern Post

J.6.1 Bar Sternpost (without a propeller post boss)

Where a Bar Sternpost without a propeller post boss is used it shall have a minimum thickness and width determined by the following formulas:

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

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

Where:

t is the thickness in mm
b is the width in mm

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

J.6.2 Bar Sternposts (with a propeller post boss)

Where a bar sternpost in a single screw vessel with propeller post boss and an outer post is fitted, the bar sternpost shall have at a minimum the thickness and with determined by the following formulas:

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

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

Where:

t is the thickness in mm
b is the width in mm

Above the propeller post boss, the width of the inner post may be reduced to 85% of that obtained value from the above equation.

J.6.3 Cast, Forged or Fabricated Sternposts

Cast, forged or fabricated sternpost of special shape shall be proportioned as to provide strength at least equivalent to that of a bar sternpost as given in the previous two sub-sections. All joints and connections shall be at least as effective as the requirements on an equivalent bar sternpost.

J.6.4 Propeller Post Bosses

The thickness of the boss of a propeller post shall not be less than 60% of thickness of the propeller post.

J.6.5 Outer Posts

The width of the outer post ay be up to 85% of the widths obtained from the equations in Bar Sternposts (with a Propeller Post Boss).

J.7 Stern Frames with Propeller Apertures

J.7.1 Inner Posts

The scantlings of fabricated propeller posts in single screw vessels shall 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 below

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

$$Z = 1.35 * l * \sqrt{L}\ \text{cm}^3$$

The scantlings of cast steel post shall not be less than:

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

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

$$t_1 = 3.7\sqrt{L}\ \text{mm}$$

$$t_2 = 40\sqrt{L}\ \text{mm}$$

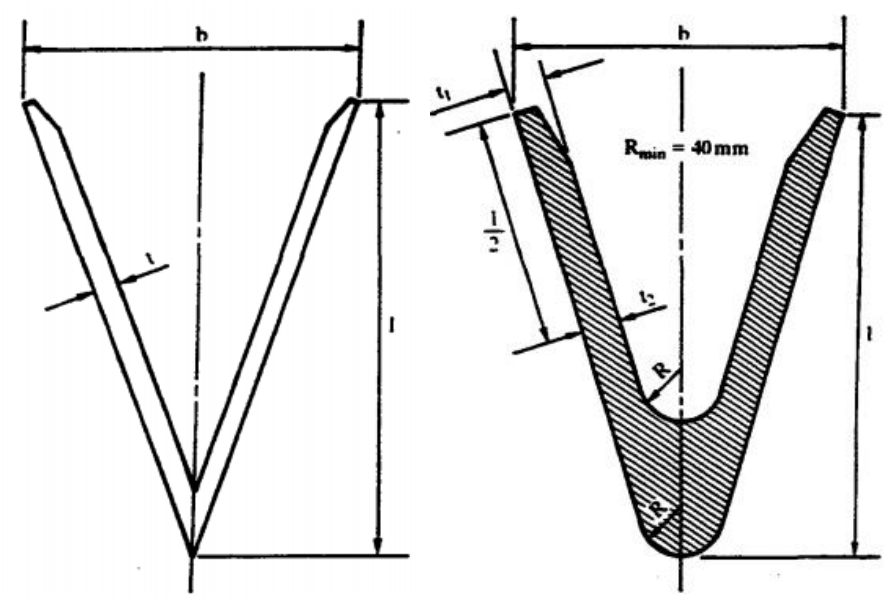
where l, b, t_1, and t_2 are shown in figure below.

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

$$Z = 1.3 * l * \sqrt{L}\ \text{cm}^3$$

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

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



J.7.2 Propeller Post Bosses

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

$$t = 0.87L \text{ or } 5.7\text{mm}$$

J.7.3 Outer Posts

The width of the outer post may be reduced to 85% of the widths determined from the equations in Inner Posts.

J.7.4 Floors in way of outer posts

Outer posts shall be fitted to floors of thickness 5.0mm greater the that required for double bottom floors and depths sufficient for welded attachments.

J.7.5 Cast, Forged or Fabricated Stern Frames

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

Connections to the stern frame located close to the shoe pieces should be either rabbeted or flush-butted with backing weds where necessary.

J.8 Stern Frames Without Outer Posts

In the case where a stern frame is fitted with a shoe patience be does not have an outer post, the stern post above the propeller boss shall have scantlings in accordance with the previous cluse ‘Bar Sternpost (with a propeller post boss)’.

Below the boss, the width and thickness shall be gradually increased to provide the required strength and stiffness in proportion to the shoe pieces as detailed in the following clause. The heel pieces shall have lengths suitably increased.

J.9 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:

$$Zy = C * A * V * 21 \text{ mm}^3$$

where:

Zy 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 stern frame shoe.

	Values of C						
Speed V	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

J.10 Rudder Horns

A rudder horn shall be constructed of ample strength the resit the torsion and bending forces acting on it imposed by the ruder. Webs shall be designed to extend as far down the horn as possible to ensure an effective connection with the afterpeak decks.

Propeller Shaft Brackets

Propeller shaft brackets shall conform to the requirements and where brackets are attached to the bull, the palm shall be so arranged to provide a close fit to the shell, with the shell suitably strengthened.

J.11 Bottom structure

J.11.1 Single Bottomed Vessels

J.11.2 Keelsons

Vessels of single bottoms that have breadths of 2.20 metres or greater between chines or the lower turns of the bilge shall be centre or side keelsons or both. The maximum spacing between keelsons and between outer keelson and chine or lower turn of the bilge shall be no greater than 2.20 metres. The keelsons shall extend as far aft and forward of the vessel as possible and shall have a depth equal to that of the depth off the plate floors determined in this sub-clause following.

Longitudinal structural members such as engine girders and wing tank bulkheads shall be considered as keelsons. Where a system of keelsons and floors is not adopted then the following relevant clauses shall apply.

The keelson thickness at midship shall not be less than the value determined by the equation:

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

where

t thickness in mm

the thickness of the keelson may be reduced up to 85% of the midship thickness, forward and aft of the midship one-half length.

keelsons shall have rider plates if L exceeds 22.0 m in length and the rider plate area, she shall not be less than then that obtained by the equation:

$$a = 1.8\,(L - 20.7)\,cm^2$$

Where

a section area in cm^2

J.11.3 Girders

The section modulus (Z) of each girder designed to be a primary supporting member, in association with the plating to which it is attached shall be at a minimum the value determined from the following equation:

$$Z = 7.9c * h * s * l^2 \text{ cm}^3$$

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 the bracket clause, 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 cut-outs for the bottom frames unless effective compensation is provided for frame cut-outs.

J.11.4 Plate Floors

Plate floors shall be fitted at each transverse frame.

The minimum depth of plate floors at the centreline (hf) shall be no less than that obtained from the equations:

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

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

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:

$$t = 0.01\,hf + 3\,mm$$

Where the floor spacing (S) exceeds the standard spacing (S1) the thickness shall not be less than that obtained from the following equation:

$$t = \frac{S}{S1} * (0.01\,hf + 3)\,mm$$

Floors under engine girders shall not be less in thickness than the thickness required for keelsons.

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

$$A = 500 * d * \left(\frac{12.5}{B}\right) * \frac{S}{S_1}\,mm^2$$

The floor flange or rider bar shall be at a minimum, the thickness of the floor plate, and the ratio of width to thickness shall be in between 8 or more than 16 inclusively.

J.11.5 Double Bottoms

A centre girder shall be fitted to all it to extend as far as practical forward.

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

$$hg = 32 * B + 190\sqrt{d}\,mm$$

where:

hg depth in mm

The centre girder within the midship one half-length shall be of a minimum thickness obtained from the following equation:

$$t = 0.066L + 5\,mm$$

Where

T thickness in mm

The centre girder forward and aft of the midship one half-length may reduce the thickness up to a maximum 85% of the girder thickness at amidships.

J.11.6 Side Girders

Side girder are required to be installed approximately in the centre between the side shell and entre girder if the distance between is great than 4.5m. The minimum thickness of the side girders shall be no less than that determined from the equation:

$$t = 0.053L + 4\,mm$$

Where

t thickness in mm

J.11.7 Solid Floors

Solid floors shall be fitted at every frame under the engine room, at every frame in the peaks and under the transverse bulkheads. In all other locations solid floors shall be spaced at a maximum of 3 metres in association with intermediate open floors or longitudinal framing. The solid floor thickness shall be the same as side girders obtained in sub-clause 'side girders'.

J.11.8 Open Floors

In transversely framed vessels with open floors of frames and revere frame shall be fitted to frames where solid floors are not fitted. The section modulus (Z) of each frame and reverse frame in assentation with the attached plating shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

c	0.85	clear of tanks
	0.425	where struts are fitted to meet the requirements and spaced not more than 1.5 metres apart, clear of tanks
	1.00	in way of tanks
	0.50	where struts are fitted to meet the requirements and spaced not more than 1.5 metres apart, in way of tanks
s	frame spacing in metres	
h	the vertical distance in metres from either the keel to the deck at side or from the keel to the top of the tank, whichever is greater. Where reverse frames may be measured from the top of the double bottom when fitted without struts.	
l	distance in metres between the centre girder and the side shell.	

J.11.9 Struts

Fitted struts in open floors as permitted shall require scantlings that comply with the directly previous sub-clause in order to resist the load obtained from the following equation:

$$\mathrm{w} = 1.10\,\mathrm{p} * \mathrm{h} * \mathrm{s}\ \text{tonnes}$$

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.

J.11.10 Inner-Bottom Plating

The inner-bottom plating of the vessel shall have a thickness throughout, determined by the equation:

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

Where:

t	thickness in mm
s	frame spacing in mm

In the case that no ceiling is fitted under cargo hatchways, the inner-bottom plate thickness shall be increased by 2.0 mm. Vessels that operating in trade where the cargo shall be handled with grabs or similar methods, it is recommended that flush plating is used and the thickness be increased by 5mm.

J.11.11 Sea Chests

In the case where the double bottom structure us integrated as art of the sea chest; the platting thick shall require a plate thickness no less than that required of the double bottom plating.

J.11.12 Access, Lighting, Air and Drainage Holes

Access holes in double bottom tank tops and lightening holes in non-tight members shall be sufficient in size and number to assure the accessibility to all parts of the double bottom. The prosed locations and size for the hole shall be indicated on drawings submitted to AUSCLASS for approval. Top tank access hole covers shall be fitted and constructed of steel or equivalent material. Where ceilings are not fitted in cargo holds, the covers shall be protected against damage by the cargo. Air and drainage holes shall be cut in all non-tight parts of the double bottom structure for the free escape of gases to the vents and the free drainage of liquid to the suctions.

J.11.13 Bottom Frames

Application

Reference shall be made to figures 5, 6 and 7

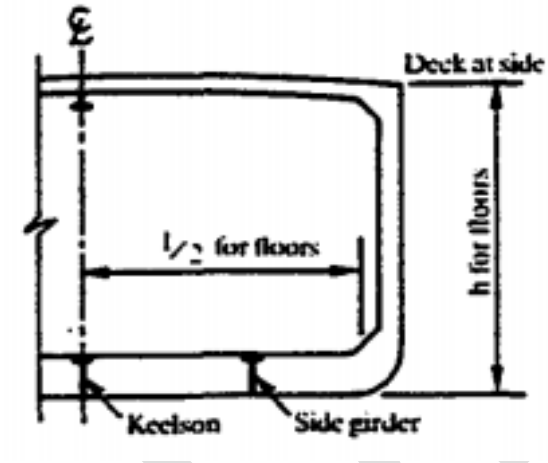


Figure 4 PLATE FLOORS

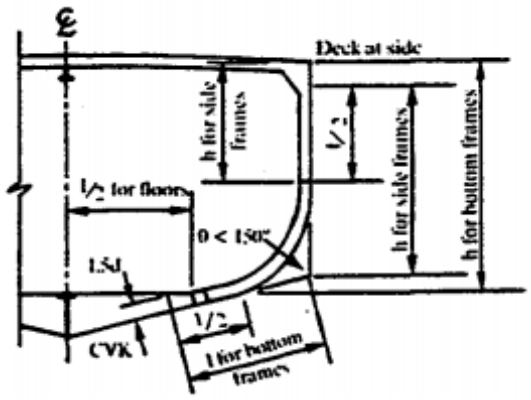


Figure 5 ROUND BOTTOM VESSELS WITH DEADRISE

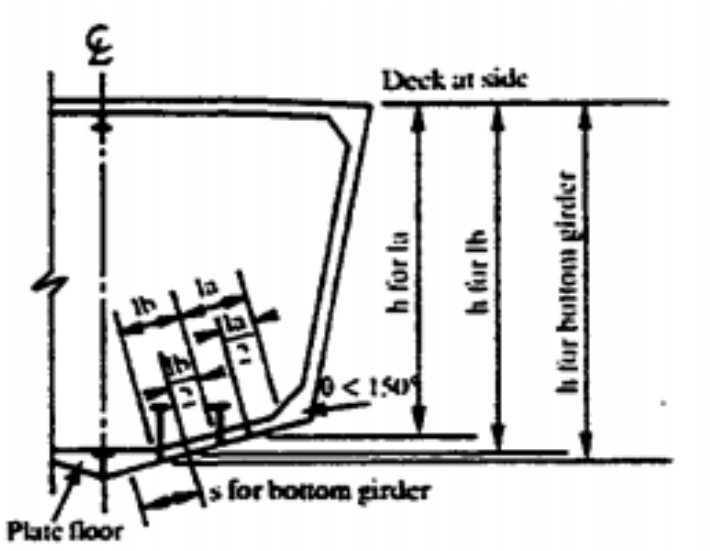


Figure 6 TRANSVERSE SIDE FRAMES WITH LONGITUDINAL SIDE GIRDERS

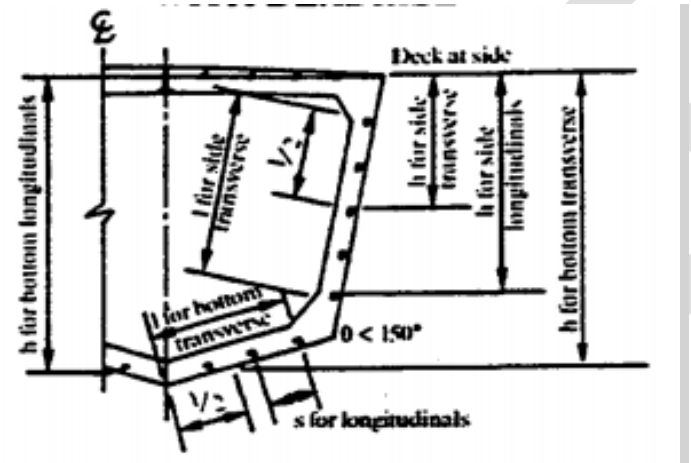


Figure 7 LONGITUDINAL FRAMES WITH TRANSVERSE WEBS

J.11.14 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, shall not to be less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * L^2 \ cm^3$$

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 this section.

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

(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

J.11.15 Inner-Bottom Longitudinals

The section modulus Z of each longitudinal fitted on the inner bottom, may be reduced to 85% of the required section modulus Z of longitudinal frames obtained previously above.

J.11.16 Bottom Web Frames

Reference shall be made to figure 7. The section modulus (Z) of each bottom web that supports shell stringers or longitudinal framing and in association with the platting it is affixed to shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

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 this section

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

(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 metre

J.12 Side Frames, Webs and Stringers

J.12.1 General

Frames or webs and stringers shall have at a minimum the same strength required for watertight deck stiffeners and girders located in the same position in association with the heads of the bulkhead deck. Frames or webs and stringers shall have at a minimum the same strength required stiffeners and girders located on deep tank bulkheads.

The calculated section modulus (Z for frames are based on the intact section being used. In the case where a hole in the outstanding member of large opening in the web of the frame occurs, the net section shall be used in determining the section modulus (Z) of the member with associated attached plate. See figure 5, 7, 8 and 9.

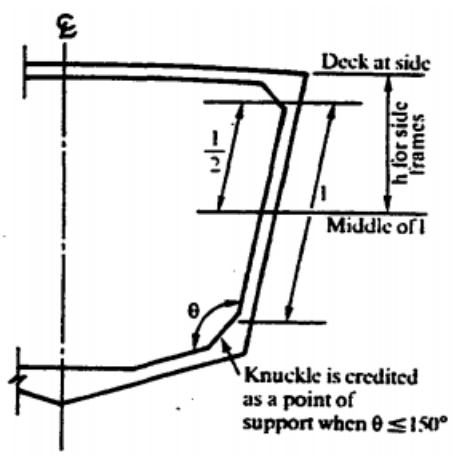


Figure 8

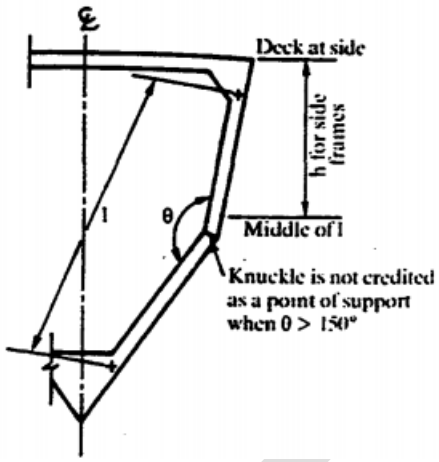


Figure 9

This section applies to midship framing, and suitable for end strengthening and shall be adopted to provide for any increased loads in that region expected to be encountered in service.

J.13 Side Frames

J.13.1 L.11.2.1 General

The section modulus (Z) for longitudinal and transverse side frame above the chine or upper turn of the bilge of both planning and displacement vessels, in association with the plating to which the frame is attached shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

s frame spacing in metres

l straight-line unsupported span in metres. Where brackets are sufficiently fitted, the length l may be measured as permitted therein

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

J.13.2 Recommendation for vessels subject to impact

For vessels subject to impact during operation, such as tugs and supply vessels, it is recommended that the side frame with a section modulus 25% greater than that obtained above be utilised.

J.13.3 Side Web Frames

The section modulus (Z) of each side web that supports shell stringers or longitudinal framing above the chine or upper bilge and in association with the platting it is affixed to shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

c 0.915

s spacing web frames in metres

l unsupported straight-line span in metres. Where brackets are sufficiently fitted, 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 shall be no less than 2.5 times the depth of the cut out, unless effective compensation is provided for frame cut-outs.

J.14 Side Stringers

J.14.1 General

Side stringers which support transverse side frames shall be spaced so the lowest stringer is no greater than 2.00 metres above the tops of floors or the top of the inner bottom, with a distance between stringers of no greater than 2.50 metres. The stringer depth shall be at least 2.5 times the depth cut-out unless the frames cut-outs have effective compensation.

J.14.2 Section Modulus

The section modulus (Z) for side stringers that support transverse side frames shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

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 sufficiently, the length may be measured as provided therein.

J.15 L.12 Beams, Pillars, Deck Girders and Runners

J.15.1 L.12.1 Beams

J.15.2 Spacing

Beams may be either transversely or longitudinally fitted. Where beams are fitted transversely, they shall be fitted to all frames that are at the top of tanks, tunnel top and bulkhead recesses. Beams fitted elsewhere shall not be greater than two frame spacings apart and when fitted on different tiers they shall be fitted on the same frame.

J.15.3 Section Modulus

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

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

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 sufficiently fitted, the length 'l' may be measured as provided therein.

h height in metres as follows:

- The greater of the following distances for a deep tank top:
  (i) two thirds of the distance from the top of the tank to the top of the overflow
  (ii) two thirds of the distance from the top of the tank to the bulkhead deck or freeboard deck.
- 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.
- 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.

1 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:

$$h = 0.01L + 0.30 \, metres$$

J.15.4 Special Heavy Beams

Special heavy beams shall be fitted under areas of concentrated loads, these include, ends f deckhouses, masts, winches another auxiliary machinery. The beams located at the heads of web frames shall be increased in strength ad stiffness.

J.16 Pillars

J.16.1 General

Supports located under pillars shall be of sufficient strength in order to distribute the lead effectively. Tween deck pillars shall be located directly above those below or positioned with an effective means to transmit their loads the supports below.

J.16.2 Pillar Load

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

$$\mathrm{W} = 0.715 * \mathrm{b} * \mathrm{h} * \mathrm{s}\ \text{tonnes}$$

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:

- 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.
- h for a pillar below the freeboard deck shall be measured to a point not less than $0.02L + 0.75$ metres above the freeboard deck.
- h for a pillar below the superstructure deck shall be measured to a point not less than $0.02L + 0.50$ metres above the superstructure deck.

J.16.3 Permissible Load

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

$$\mathrm{wa} = \mathrm{A}\,(1.232 - 0.00452\,\left(\frac{1}{\mathrm{r}}\right))\ \text{tonnes}$$

where:

wa load in tonnes
A area of pillars in cm^2
l the unsupported length of the pillar in mm
r least radius of gyration of pillar in mm

J.17 Pillars in Double Bottoms and Under Tank Tops

Pillars shall have a solid cross section if located in double bottoms and under the tops of deep tanks. The pillars located under the tops of deep tanks shall at a minimum meet the requirements of the previous two sub-clauses and nor shall have a cross sectional area less than 1.015w, where w shall be obtained from the following equation:

$$w = 1.07 * b * h * s \text{ tonnes}$$

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 the section modulus sub-clause previous for the tank top beams

J.17.1 Bulkheads

Bulkheads supporting girders or bulkheads fitted in lieu of girders, shall be stiffened to be as effective and strong as the required for pillars.

J.18 Deck Girders

J.18.1 General

Girder shall be fitted when required to support beams and longitudinals. Additional girders shall be fitted un heavy concentrated loads which include under masts, deck machinery, kingposts and others.

J.18.2 Deck Girders Clear of Tanks

Section Modulus (Z) of each longitudinal deck girder clear of tanks shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * b * h * l^2 \text{ cm}^3$$

where:

c 0.60
b mean breadth in metres of area of deck supported
h height in metres as required by the section modulus sub-clause previous for the beams supported
l unsupported span in metres. Where brackets are sufficiently fitted, the length l may be measured as provided therein

J.18.3 Deck Transverses Clear of Tanks

Deck transverse which support longitudinal deck beams clear of tanks shall have a section modulus (Z) no less than that obtained from the directly previous sub-clause where c, h and I are defined and b shall be the spacing in metres of the deck transverses.

J.18.4 Proportions

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

J.18.5 Deck Girders and Transverses in Tanks

Deck girders or transverses supporting members located in tanks may have their requirements obtained in the same manner as the previous three sub-clauses, with the alteration that c=0.915 and that minimum depth shall be 0.0833*I for a girder or transverse supporting member.

J.18.6 Deck Runners

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

$$Z = 2.75 * b * h * l^2 \text{ cm}^3$$

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

J.19 Watertight Bulkheads

J.19.1 Number of Bulkheads

All vessels of Classes 1, 2 and 3 shall be required to have watertight bulkheads.

For passenger vessels, the number, position and extent of the bulkheads shall be in accordance with the Watertight Subdivision of Passenger Vessels.

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

J.19.2 Construction of Watertight Bulkheads

J.19.3 Plating

Thickness of plating of watertight bulkheads shall be no 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 thickness of collision bulkheads shall be obtained from the above equation with spacings of 150mm greater than generally adopted.

The plate thickness for vessels under 35 metres may be reduced by the following deductions:

Length	Deduction (mm)
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

J.19.4 Stiffeners

The section modulus (Z) of each bulkhead in association with the attached plating shall be at a minimum that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

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, the distance from the heel of the end attachment, to the first girder, or the distance between 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 modulus (Z) of collision bulkheads shall 25% greater than the section modulus (Z) of ordinary watertight bulkheads.

J.19.5 Girders and Webs

The section modulus (Z) of each horizontal girder or vertical web that support bulkhead stiffeners shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

c 0.6

l unsupported span of girder or web in metres.

s sum of half lengths in metres (on both sides 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 section modulus (Z) of girders on collision bulkheads shall be increased by 25% over the required section modulus (Z) of girders and webs located on ordinary bulkheads. the girder or web depth shall be no less than twice the depth of the cut out expect if compensation is provided for the stiffener cut-outs.

J.19.6 chain Lockers

Chain lockers shall be watertight if located abaft of the collision bulkhead or extends into the forepeak deep tanks.

J.20 Deep Tanks

J.20.1 General

Boundary bulkheads and tight divisions of all deep tanks shall be constructed in accordance with the following requirements when they exceed the previous requirements under watertight bulkheads.

J.20.2 Construction of Deep Tank Bulkheads

J.20.3 Plating

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

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

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 point located two-thirds of the distance to the bulkhead or freeboard deck
- a point located at two-thirds of the distance from the top of the tank to the top of the overflow
- a point located above the top of the tank no less than the greater of the following:
  (i) 0.01L + 0.15 metres
  (ii) 0.50 metres

J.20.4 Stiffeners

The section modulus (Z) of each deep tank stiffener in association with the attached plating shall not be less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \text{ cm}^3$$

where:

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

s stiffeners spacing in metres

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

- A point located at two thirds of the distance from the middle of l to the bulkhead or freeboard deck
- A point located at two thirds of the distance from the top of the tank to the top of the overflow
- A point located above the top of the tank no less than the greater of the following:
  - 0.01L + 0.15 metres
  - 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.

J.20.5 Girders and Webs

The section modulus (Z) of horizontal girders and vertical webs that support bulkhead stiffeners in deep tanks shall meet the requirements of this section.

Girders or webs supporting frames or beams located in deep tanks shall have a section modulus (Z) as required in clauses 'side frames, webs and stringer' and 'Beams, pillars deck girder and runners' respectively, or required by this section, whichever is greater.

The section modulus (Z) of each girder or web shall be no less than that obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

c 0.9

l unsupported length of girder or web in metres. Where brackets are sufficiently fitted, 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

The girder or web depth shall be no less than 2.5 time the depth of the cut out unless compensation is provided for stiffener cut outs.

J.20.6 Drainage and Air Escape

Limber and air holes shall be cut when required in non-tight parts of the tank to allow the free flow of liquids to the suction pipes and the escape of air to the vents

Arrangements shall be made for draining the tops of the tanks.

J.20.7 Testing

AUSCLASS requires that all deep tanks shall be tested to a head of water to the top of the overflow or two thirds the distance between the tops of the tank and the bulkhead or freeboards head, whichever us the greater, or by and equivalent air test.

Testing shall be conducted prior to any coating being applied.

J.21 Shell Plating

J.21.1 General

The minimum shell plating thickness shall be that in the following subclauses.

J.21.2 Bottom Shell Plating

J.21.2.1 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.

J.21.2.2 Bottom Shell Plating

The thickness of the bottom shell plating shall be no less than that obtained from the following equations:

(a) For vessels with Transversely framed Bottoms

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

(b) For vessels with Longitudinally framed Bottoms

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

(c)

$$t = \frac{s\sqrt{h}}{250} + 2.5 \text{ mm}$$

where:

t thickness of bottom shell plating in mm
s frame spacing in mm
L length of the vessel or 20 metres whichever is the greater
h distance from the lower edge of the plate to the freeboard deck side in metres

J.21.2.3 Flat of Bottom

The plating for vessels 35 metres or greater located on the flat of the bottom of the midship three fifths length I the vessels machinery amidships and forward of the midship one half-length in vessels having machinery aft, is not to be less than required by the previous clause or the following equation:

$$t = \frac{s}{340} * \sqrt{L - 35} + 3 \text{ mm}$$

where:

t thickness in mm
s frame spacing in mm

J.21.3 Side Shell Plating

J.21.3.1 General

The side shell plating thickness shall be no less than that obtained from the following equations:

(a)

$$t = \frac{s}{645}\sqrt{(L - 15.2)(\frac{d}{D})} + 2.5 \text{ mm}$$

(b)

$$t = \frac{s\sqrt{h}}{250} + 2.5 \text{ mm}$$

where:

t thickness in mm
s spacing of transverse frames or longitudinals in mm
L the greater o either the length of vessel or 30 metres
h distance from the lower edge of the plate to the freeboard deck at side in m

J.21.3.2 Vessels Subject to Impact

For all vessel subject to impact in operations such as tugs and supply vessels, AUSCLASS recommends that the side plating thickness be increased by 25% from the previous thickness equations.

J.21.3.3 Forecastle and Poop Side Plating

The minimum side hell thickness as determined previously in way of the poop of forecastle may be reduced by the amount given by equation a below but shall not be any less than equation b.

$$t_{reduction} = 2.667\left(\frac{d}{D} - 0.65\right) + 0.50 \text{ mm}$$

where:

$t_{reduction}$ allowable reduction of side shell plating in way of forecastle or poop

$$t = 0.006\, s * \sqrt{\frac{d}{D}} + 2.5 \text{ mm}$$

where:
t thickness in mm
s spacing of frames in mm

The side plating thickness located above the freeboard deck may be reduced to the thickness required for the forecastle and poop sides at the forward and aft ends respectively if the strength deck at the ends is located above the freeboard deck.

J.22 Compensation

Compensation shall be made for large openings in shell plating to ensure that transvers and longitudinal strength remains sufficient and all openings shall have well rounded corners. Cargo and gangway openings shall be located away from other discontinuities in the bull girder. Around hawse pipe, thick plating or doublers shall be fitted of sufficient breadth the prevent damage occurring from the fluke of stockless anchors. Fitted side scuttles shall have their upper edge two times the diameter below the edge of the deck above.

J.23 Breaks

The side plating of superstructures, includes forecastles and poops, shall extend past the end of superstructure in order to provide a long gradual taper.

Gangways, large freeing ports, and other sizeable openings in the shell or bulwarks shall be kept clear of the breaks. Unavoidable holes required to be cut into the shell adjacent to breaks shall be circular or oval and kept as small as possible

J.24 Decks

J.24.1 General

The thickness of deck plates shall be no less than required for the purpose of longitudinal hull girder strength but in any case, shall be no less than 0.01mm per mm of frame spacing or no less than that required in this clause.

J.24.2 Deck Plating

The deck thickness plating on each deck shall not be less than that 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 height of load in metres, determined as follows:

2 For a deck or portion of deck forming a tank top, the greater of the following:

(a) two thirds of the distance from the tank top to the top of the overflow

(b) two thirds of the distance from the tank top to the bulkhead deck or freeboard deck whichever is applicable

3 For a deck on which cargo or stores are carried, the height is the tween deck height at side where the cargo mass is less than or equal to 720 kg/m3. Where the cargo mass exceeds 720 kg/m3, it should be adjusted correspondingly.

4 For an exposed deck on which cargo is carried, 3.65 metres. Where deck cargoes in excess of 2640 kg/m2 are to be carried, the head is to be increased in proportion to the added loads.

5 Elsewhere the height should be obtained from the following equations as appropriate:

(a) exposed freeboard deck with no deck below

$$h = 0.02L + 0.75 \text{ metres}$$

(b) exposed freeboard deck having a deck below, forecastle deck, superstructure deck, forward of the amidships 0.5L

$$h = 0.02L + 0.50 \text{ metres}$$

(c) freeboard deck within a superstructure, any deck below freeboard deck, superstructure deck between 0.25L forward of and 0.20L aft of amidships

$$h = 0.01L + 0.60 \text{ metres}$$

(d) all other locations

$$h = 0.01L + 0.30 \text{ metres}$$

L.16.3 Additional Requirements for Vehicle Deck Strengthening

J.24.2.1 Wheel Loads

6 Car Deck Single wheel at each end of axle: P = 0.5 times the axle load in tonnes
Double wheels at each end of axle: P = 0.4 times the axle load in tonnes

7 Forklift trucks with rubber tyres:
With single front wheels:

$$P = 1.2 * \frac{v + t}{n_1}$$

where:

V weight of truck in tonnes
T load capacity of truck in tonnes
n_1 number of single front wheels

With double front wheels (dual wheels):

$$P = \frac{V + T}{1.2 n_2}$$

where:

V and T are as above
n_2 number of double wheels

Pallet trucks with steel tyres:

$$P = \text{load capacity of truck in tonnes}$$

The specified strengthening for pallets shall be applied in areas where pallet trucks are frequently used. Outside those areas the plate thickness may be gradually reduced to standard strength.

J.24.3 Deck or Inner Bottom Plating

8 The plate thickness for decks or inner bottoms which are exposed to loading from vehicles shall be at a minimum that obtained from the following equation:

$$t = k\sqrt{P\,(1 - 0.1)\,\sqrt{P}} + 1\,\text{mm}$$

where:

P wheel load in tonnes

k 5.2 for wheels with pneumatic rubber tyres
6.0 for wheels with solid rubber tyres
7.8 for wheels with steel tyres

This equation shall be valid in determining the plate thickness for wheel loads up to 16 tonnes. For greater loads, the plate thickness shall require special consideration by AUSCLASS.

9 Where transverse or longitudinal deck beam spacings differ from 700 mm, the plate thickness shall be corrected by 6% for rubber wheels and 3% for steel wheels for every 100mm of difference.

10 The above equation is based on wheels of normal diameter (300- 1000 mm for pneumatic tyres, 100-200 mm for solid tyres and 75-100 mm for steel wheels). Where the diameters differ considerably from normal figures, the thickness will be specially considered by AUSCLASS.

11 For extreme beam or longitudinal spacing, wheel dimensions, and other stiffening arrangements, the scantlings shall be specially considered by AUSCLASS.

J.24.4 Deck Beams and Longitudinals

Vehicle deck may have transverse or longitudinal beams. If traverse beams are fitted, they shall have at minimum a section of modulus (Z) no less than that obtained by the following equations:

$$Z = 5.2PI\left(I + \frac{S}{0.4}\right)\text{cm}^3 \quad \text{where } I < 2.5\text{m}$$

$$Z = (121 - 17)P\left(I + \frac{S}{0.4}\right)\text{cm}^3 \quad \text{where } I \geq 2.5\text{m}$$

where:

P wheel load in tonnes

l unsupported span of beam in metres

s beam spacing in metres

The section modulus (Z) for beams located in decks where loading and unloading is performed by forklift trucks with rubber tyres shall be no less than that obtained by the following equation:

$$Z = 6.5P(I - 0.9)\left(1 + \frac{S}{0.4}\right)\text{cm}^3$$

where:

P wheel load in tonnes

l span of beams in metres (for beams that are not supported by girders or pillars the span shall be increased by 10 per cent)

s beam spacing in metres

J.25 Superstructures and Deckhouses

J.25.1 Superstructures

J.25.1.1 Side Plating

The thickness of superstructure side plating shall not be less than:

$$t = \frac{s}{645}\sqrt{(L - 15.0) * \frac{d}{D}} + 2.5\ mm$$

where:

t	thickness in mm
s	spacing of transverse frames or longitudinals in mm 500 + 0.83L mm
L	length of vessel or 30.0 m whichever is the greater
d	draft for scantlings
D	depth of vessel in metres

The thickness shall be at minimum:

$$\mathrm{t} = 0.05\mathrm{L} + 2.80\ \mathrm{mm}$$

where:

t thickness in mm with a maximum value of 7.5 mm.

J.25.2 Frames

Main bulkheads and elsewhere that require transvers structure rigidity shall have additional bulkheads, partial bulkheads or web frames fitted.

J.25.3 End Bulkheads

The thickness of plating required in superstructure end-bulkheads on the freeboard deck shall be at a minimum the value obtained from the following equation:

$$\mathrm{t} = 0.05\mathrm{L} + \mathrm{C}\ \mathrm{mm}$$

where:

t	bulkhead plating thickness in mm	
C	5.40	for exposed front ends of poops and bridges
	3.80	for partially protected front ends of poops
	2.80	for exposed after ends of bridges and forecastles

Where the spacing of stiffeners are greater (or less) than 760mm, the side and end plating thickness shall be increased (or reduced) at a rate of 0.5mmvfor every 100mm od difference in spacing with a maximum reduction of 1.50mm

J.25.4 Stiffeners

The section modulus Z of each bulkhead stiffener in association with the attached plating shall not be less than:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

s stiffener spacing in metres

l moulded height of the superstructure in metres, or in the case of horizontal stiffeners, web spacing in metres

c 0.10L for exposed front ends of poops and bridges

0.023L for superstructure sides and partially protected front ends of poops

0.015L for exposed after ends of bridges and forecastles

Stiffeners in the front bulkheads of poops and bridges shall be attached to the deck plating at their upper and lower ends by welding all round.

J.25.5 Superstructures located above the first tier are to be considered as deckhouses.

J.26 Deckhouses

J.26.1 Definition

A deckhouse is an enclosed structure above the freeboard deck having side plating set inboard of the hull's side shell plating by more than 4% of the breadth B of the vessel.

J.26.2 Scantlings

Deckhouses' side and aft bulkhead plating and stiffeners are to have scantlings equal to the requirements for after bulkheads of bridge and forecastle superstructures.

Deckhouses' front plating and stiffeners are to have scantlings equal to the requirements for partially protected poop front bulkheads.

Stiffeners on deck houses are to be attached in the same manner as stiffeners on superstructure bulkheads.

Bulkheads, partial bulkheads, or deep webs shall be fitted in long deckhouses in order to provide resistance to racking.

J.27 Protection of Deck Openings

J.27.1 General

All openings in decks shall be framed I order to provide efficient support and attachment to the ends of deck/beams.

J.27.2 Hatchway Coaming Plates

Coaming plates thickness shall be at a minimum value obtained from the following equation:

$$t = 0.05L + 5\,\text{mm}$$

where:

t thickness in mm.

The thickness is not required to exceed the thickness of the surrounding deck plating when the hatchway is less than 30% of the vessels beam.

J.27.3 Coaming Stiffeners

Horizontal stiffeners shall be fitted to coaming 450mm or greater in height. The breadth of the stiffener shall be no less than that obtained from the following equation:

$$b = 1.67L + 50\,\text{mm}$$

where:

b breadth in mm.

The thickness shall not to be less than that of the coaming plate.

Brackets or stays shall be fitted from stiffener to deck at intervals no mor then 3 metres apart. Where exposed coamings are 760mm or greater in height, the arrangement of stiffeners and brackets or stays shall be so that sufficient support is provided. Protected end coamings may allow the stiffeners and brackets f stays to be modified.

J.27.4 Hatchways within open superstructures

Hatchways located within open superstructures shall be considered as exposed.

J.27.5 Hatchways within deckhouses

Hatchways located within deckhouses shall have coaming with closing arrangements appropriate for the required protection of the deckhouse in regards of its construction and the means of closing all deckhouse openings.

J.27.6 Machinery Casings

J.27.6.1 Exposed Casings on Freeboard or Raised Quarter Decks

Exposed casings on freeboard or raised quarter decks shall be constructed from plating of a thickness no less than that obtained from the following equation:

$$t = 0.0164L + 6\,\text{mm}$$

where:

t thickness in mm

Stiffeners shall be at least as effective as those determined from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

Z section modulus of each stiffener in association with the plating to which it is attached

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 connections 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

h 0.51 metres

l tween deck height in metres

s spacing of stiffeners in metres.

J.27.7 Exposed Casings on Superstructure Decks

Exposed casings located on superstructure decks shall have plating with a minimum thickness obtained from the following equation:

$$t = 0.033L + 3.5 \ mm$$

where:

t thickness in m

The section modulus (Z) for stiffeners in association with the plating they are fitted to, shall be obtained from the following equation:

$$Z = 7.9 * c * h * s * l^2 \ cm^3$$

where:

c 0.25
s spacing of stiffeners in metres
h 0.51 metres
l length between supports of the stiffeners in metres

J.27.8 Casings within Open Superstructures

Casings within open superstructures are to be of similar scantlings to those obtained directly previous in exposed casings on superstructure decks clause.

J.27.9 Casings Within Enclosed Superstructures, Deckhouses or Below Freeboard Decks

The plating thickness of casings located within enclosed superstructures or in decks below the freeboard deck where cargo is carried shall be obtained from the following equation:

$$t = 0.0164L + 3.5\ \text{mm}$$

where:

t thickness in mm

Stiffeners shall be fitted to beams and shall have a section modulus (Z) as required by in 'Exposed Casings on Superstructure Deck' clause, with the alteration of the coefficient © shall be 0.14 instead of 0.25 and h shall be the tween deck height.

J.28 Cargo, Gangway or Fuelling Ports, Ventilation Coamings

J.28.1 Cargo Gangway or Fuelling Ports

J.28.1.1 Construction

Cargo, gangway or fuelling ports located in the side of a vessel shall be able to be made watertight and constructed with sufficient strength. Web frames shall be fitted on the side of the openings in the case where frames are cut in the way of ports, suitable arrangements shall be organized to support any above beams.

Thick shell plates or doublers are to be fitted as required to compensate for the openings with the corners of the openings to be well rounded.

Waterway angles and scuppers shall be required on decks, in way of ports into cargo spaces below the freeboard deck and in cargo spaces that are enclosed within a superstructure in order to prevent any leakage of water over decks.

J.28.1.2 Location

Cargo, gangway or fuelling port openings shall be positioned so that the lower edge is no lower than a parallel line to the freeboard deck at side with the lowest point being the designed waterline or upper edge to the uppermost load line mark.

J.28.2 Ventilator Coamings

Ventilators on exposed freeboard decks, superstructure decks or deckhouses shall be fitted with steel coamings or equivalent material. The minimum thickness of the coaming shall be obtained from the following equation:

$$t = 0.01d + 5.5\ \text{mm}$$

where

t thickness of coaming in mm

d diameter of ventilator in mm

The coaming plate shall have a maximum thickness equal to the surrounding deck thickness or 10mm, whichever is less, and the coamings shall be effectively fastened to the deck.

J.28.3 Vessels Intended to Carry Oil in Bulk

Scantlings for vessels designed for the purpose of carry oil in bulk shall be specially considered by AUSCLASS.

J.29 Welding Practice

J.29.1 Scope

This clause applies to manual electric arc welding used in steel hull construction. Alternative modes of welding and techniques shall be considered by AUSCLASS upon submission of full details. Unless otherwise approved by AUSCLASS, all welds shall comply with this subclause.

J.29.2 Welding details to be submitted

The plans submitted to AUSCLASS shall clearly indicate which welding process is proposed for the main structural and principle parts of the vessel.

Detail drawings or separate welding specifications detailing the welding procedure, type of joints and amount of welding to be conducted shall be submitted to AUSCLASS for approval. Welding sequences shall be indicated in all cases. Once approved the welding procedure shall be followed without deviation unless approved by AUSCLASS prior.

J.29.3 Welding Personnel, Plant and Equipment

Welding operates shall be proficient and certified in the work they are engaged in. when by the opinion of an AUSCLASS surveyor that the quality of welds produced by the welder do not meet requirements under this subsection, shall be required to under tests to show that the welder is capable of producing satisfactory welds. These practical welding tests shell be undertaken in the positions specified in AS 1796 (Certification of welders and welding supervisors).

At all stages of assembly there shall be a sufficient number of skilled supervisors to ensure the quality of work.

The welding plant and appliances shall be sufficient for the work required and maintained regularly to safe operational conditions.

J.29.4 Preparation, Assembly and Completion

Structural arrangements shall be designed to allow the easy access for welding operations and down hand welding shall be used where possible.

Care shall be taken in the preparation of plate edges to ensure that they are accurate and uniform. All joints shall be properly aligned and positions before welding without excessive force. The means to align and hold plates for welding shall be such to not be rigid when welding operations are conducted.

Tack welds shall be kept to a minimum and when used shall be produced to the same quality of that of the final weld. All defective welds shall be cut out prior to the finishing weld and care shall be taken when removing tack welds and temporary fillings for assembly to ensure that the material is not damaged.

Prior to welding all surfaces shall be cleaned to ensure that it is clean, dry and free from rust, scale and grease. The surfaces of each run of deposit shall be cleaned to remove all slag prior to the following run. Prior to a scaling run is applied to the back of a weld, the original root run shall be cut back to sound metal. All welding shall follow an approved process and each weld joint shall be performed in proper sequence with undue interruption.

Finished welds shall be sound, uniform and free of defects that include slag inclusions, under cutting and porosity. There shall be thorough penetrations and fusion and the Australian Standard AS 1554.1 (Structural steel welding – Welding of steel structures) may be used as a basis for good practice.

Primer coats of ordinary thickness may be used on plates prior to welding if there is provided evidence that the coating has no effect on the strength and quality of the weld.

J.29.5 Welding Procedure

Precautions shall be taken to ensure that welding is performed under condition and location that protects against moisture, wind and serve cold.

The type and disposition of connections and sequences of welding shall be planned and executed reduce the restraint during welding operations.

When stiffening members cross completely, finished but and seam welds shall be made flush in way of the faying surface. If either butt or seam weld are not complete, the web stiffening member shall be scalloped.

Scallops shall be fitted to the ends of welded butts in the webs of stiffening members. Scallops may by omitted if provided that the butt weld is completed and flush with the plate prior to the fillet weld.

Any local concentration of welds should be avoided.

Seam welds and welds which join continuous longitudinal members of plating shall stop prior to unwelded butt or butt-lap joints until such in is welded. The weld shall stop at least 300mm prior to the unwelded butt of butt-lap joint.

Where thick plates of two different thickness are to be butt welded together the thicker plate shall be chamfered at a ratio 1 to 5 what the difference between thickness is greater than 3mm.

Intermittent welds shall have the length measured over the correctly proportioned fillets and shall be clears of end craters.

Intermittent welds shall be doubled at the ends of all structural members and shall be carried round the ends of brackets, lugs, etc.

The maximum reinforcement of fillet welds should be in accordance with the following scale:

Size of fillet weld mm	*Maximum reinforcement mm*
less than 12	2
12 and over but less than 25	3
25 and over	4

Gaps that exceed the maximum 3mm distance between abutting edges of plates for vee type welds shall be reduced by building up one edge by welding. Once the weld has cooled, it shall be angled and set to the correct distance apart prior to the two pieces being welded together. Excessive gaps by use a plate of at minimum 230mm wide to be inserted. Bridging of gaps by weaving is not to exceed 3 times he diameter of the electrode used.

J.29.6 Electrodes

Electrodes used in manual metal arc welding shall be of an approved type, regarding the parent metal and position on a type of joint to be welded.

Electrodes shall be stored as recommended by the manufacturers and at minimum in a dry space that is adequately protected from the effects of weather.

Electrodes that have become damaged due to dampness, but no other reason may be used after being dried out in a manner specified by the manufacturer

Any electrode with damaged or missing flux shall not be used.

J.29.7 Inspection

Arrangements shall be made to inspect the quality of welds in order to check that they are of satisfactory quality

Visual inspections of the welds shall be accompanied by the use of non-destructive testing or by the production of a test piece. All weld section found to contain defects shall be cut out, re-welded and tested again for defects.

J.29.8 Welded Joints and Connections

In general, the preparation of the edges of plates to be joined by manual welding are to comply with the requirements of Schedule 1.

Fillet welds for various structural connections are to be as required by Schedule I.

The connections for various structural members should be made by fillets on both sides of the abutting plate and in general the design is to comply with the requirements of Schedule I. Where the abutting plate is bevelled, a sealing run should be applied on the reverse side.

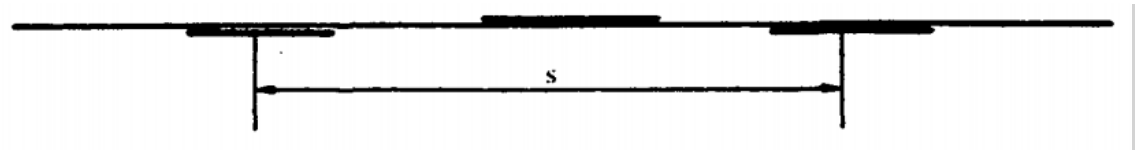
Details of scallops and notches are to be in accordance with Schedule I.

Where slot welds are permitted, they shall be arranged and have dimensions as shown in Schedule I.

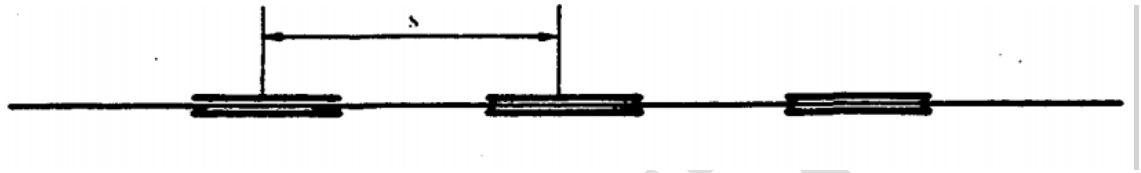
J.30 Schedule 1 welded joints and connections

I SIZE AND SPACING OF FILLET WELDS

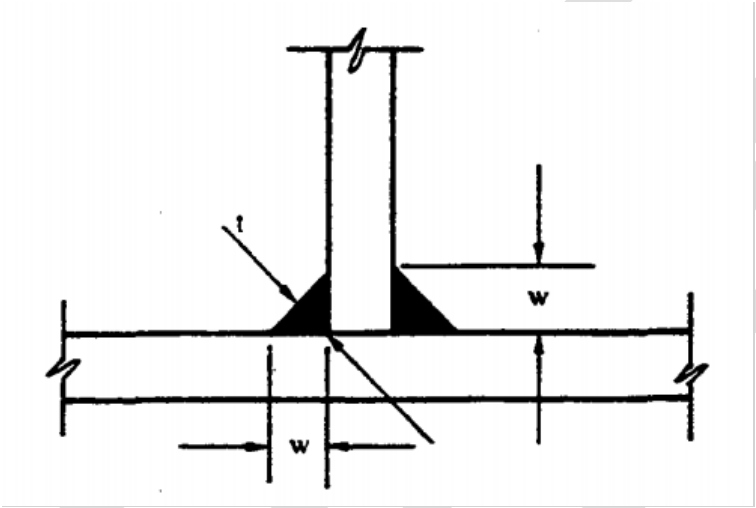
1. Staggered intermittent (S.I.)



2. Chain intermittent (C.I.)



II SIZES OF INTERMITTENT FILLET WELDS



NOTES: TABLE "A"

Note 1 Where a double continuous weld is required in Table A or where double continuous welds are adopted in preference to intermittent welds, the size of the welds may be reduced by 1.6mm provided that such reduction shall not apply to plates up to 4.8mm in thickness.

Note 2 All members that are crossed by or carry the ends of structural members are to have a pair of matched intermittent welds on each side of such intersection.

Note 3 Unbracketed stiffeners of shell, watertight and oil-tight bulkheads and house fronts are to have double continuous welds for one tenth of their length at each end. Unbracketed stiffeners of non-tight structural bulkheads, deckhouses sides and after ends are to have a pair of matched intermittent welds at each end.

Note 4 "o" fillets are to be staggered.

"#" normal size fillet "W" may be reduced 1.5mm.

SCHEDULE 1

J.31 Required type and size of welds for various structural connection

TABLE A

REQUIRED TYPE AND SIZE OF WELDS FOR VARIOUS STRUCTURAL CONNECTIONS

LESSER THICKNESS OF MEMBERS JOINED	Not over 5 mm	Over 5 to 6.5mm	Over 6.5 to 8 mm	Over 8 to 9.5mm
LENGTH OF FILLET WELD	40	65	75	75
NOMINAL SIZE OF FILLET-w-	3	5	6.5	6.5
NOMINAL SIZE OF FILLET-t-	2	3.5	4.5	4.5
		SPACING-s-		
Single Bottom				
Centre Keelson to Keel Plate		double continuous		
Floors to Centre Keelson		double continuous		
Intercostals to Bar Keel		double continuous		
Intercostals to Floors		double continuous		
Rider Bar to Centre Keelson or Intercostals (Tee Joint)	*260	*260	*280	*300
Rider Bar to Floors (Tee Joint) in way of Engines and Propellors		double continuous		
Rider Bar to Floors Else Where (Tee Joint)	*260	*260	*280	*300
Rider Bar to Floors (Corner Joint)		double continuous		
Floors to Bottom in way of Propellor		double continuous		
Floors to Bottom in way of Engine		double continuous		
Floors to Bottom in Frd. 0.25L	225	225	250	225
Floors to Bottom in Tanks	*225	*225	250	225
Floor to Bottom Else Where	*300	*300	300	275
Frames				
Transverse Frames to Side Shell in Frd. 0.25L	*225	*225	250	225
Transverse Frames to Side Shell in Tanks	*225	*225	250	225
Transverse Frames to Side Shell Else Where	*300	*300	300	275
Longitudinal Frames to Side Shell in Frd. 0.25L	*225	*225	250	225
Longitudinal Frames to Side Shell in Tanks	*225	*225	250	225
Longitudinal Frames to Side Shell Else Where	*300	*300	300	275
Frame Brackets to Frames, Floors and Deck Beams		double continuous		
Rider Bars to Frames (Tee Joint)	260	260	280	300
Rider Bars to Frames (Corner Joint)		double continuous		
Decks				
Peripheries of Strength Decks, Exposed Decks and all Watertight or Oiltight Decks		double continuous		
Beams (Transverse or Longitudinal) to Decks in way of Tanks	*225	*225	250	225
Beams (Transverse or Longitudinal) to Decks Else Where	*300	*300	300	275
Beam Knees to Beams, Frames and Other End Attachments		double continuous		
Hatch Coamings to Exposed Decks		double continuous		
Transverse or Deep Beams to Decks in Way of Tanks	200	200	225	200
Transverse or Deep Beams to Decks Else Where	225	225	250	225
Girders and Webs				
Girders and Webs to Shell and Bulkheads or Decks in Tanks	200	200	225	200
Girders and Webs to Shell and to Bulkheads or Decks Elsewhere	225	225	250	225
Webs to Face Plate Where Area of Face Plate Does Not Exceed 64.5 Sq. cm	*250	*250	300	275

Webs to Face Plate Where Area of Face Plate Exceeds 64.5 Sq. cm	-	-	250	225
Girder to Deck Beams		double continuous		
Web to Deck, Side and Bottom Longitudinals		double continuous		
Girder End Brackets		double continuous		
Bulkheads				
Peripheries of Swash Bulkheads	200	200	225	200
Peripheries of Nontight Structural Bulkheads	200	225	250	225
Peripheries of Watertight or Oiltight Bulkheads		double continuous		
Stiffeners to Deep Tank Bulkheads	*300	*300	300	275
Stiffeners to Watertight Bulkheads (Except in Tanks) and Deckhouse Fronts *See Note 3*	*300	*300	300	275
Stiffeners to Nontight Structural Bulkheads, Deckhouse Sides and Afterends *See Note 3*	*300	*300	*300	300
Stiffener Brackets to Beams, Decks, etc		double continuous		
Machinery Seatings				
Machinery Seatings to Floors and Shell		double continuous		
Double Bottoms				
Floor to Shell in Frd. 0.25L	225	225	250	225
Floors to Shell in Way of Engines		double continuous		
Floors to Shell Elsewhere	*300	*300	300	275
Floors to Centre Vertical Keel Plate		double continuous		
Floors to Margin Plate		double continuous		
Floors to Inner Bottom in Frd. 0.25L	*275	*275	275	250
Floors to Inner Bottom in Way of Engines		double continuous		
Floors to Inner Bottom Elsewhere	*300	*300	300	275
Wide Spaced Floors with Longitudinal Framing to Shell and Inner Bottom		double continuous		
Nontight Centre Girder to Inner Bottom or Plate Keel in way of Engines and to Shell or Bar Keel		double continuous		
Nontight Centre Girder to Inner Bottom or Plate Keel Elsewhere	150	150	150	125
Watertight or Oiltight Centre Girder to Inner Bottom, Rider Plate, Shell or Bar Keel		double continuous		
Intercostals and Continuous Longitudinal Girders to Shell and to Inner bottom in way of Engines		double continuous		
Intercostals and Continuous Longitudinal Girders to Shell Else Where and to Floors	*275	*275	275	250
Watertight and Oiltight Periphery Connections of Longitudinal Girders in Double Bottom		double continuous		
Deckhouses Superstructures etc.				
The Boundaries of Deckhouses and Superstructures etc. to Deck Plate		double continuous		

J.32 Butt joints

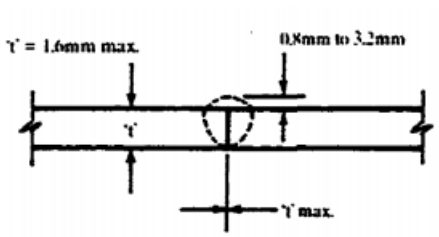
IMPORTANT Notes apply only to details where referenced.

Note 1 This joint shall not be used when root of weld is subject to tension bending.

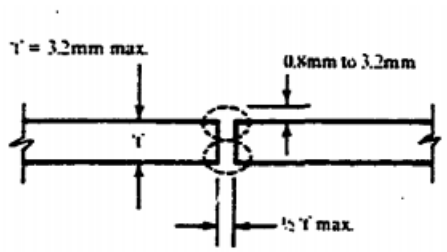
Note 2 Root of weld shall be chipped out to sound metal before opposite side is welded.

Note 3 Dimension 't' is plate thickness to which normally applicable. If desired, thickness may be greater for joints indicated.

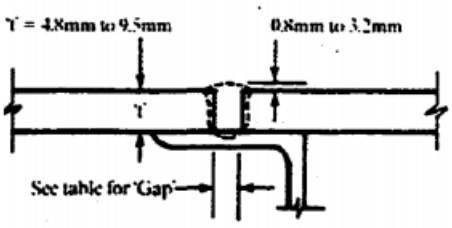
Square-Butt joint, welded one side See note 1



Square Gap-Butt joint, welded both sides



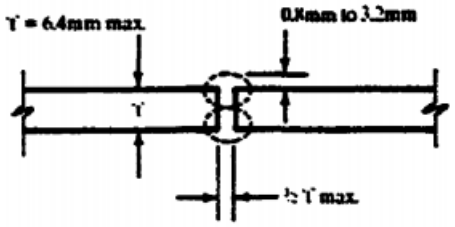
Square Open Gap-Butt joint, welded one side, on backing structure or bar.



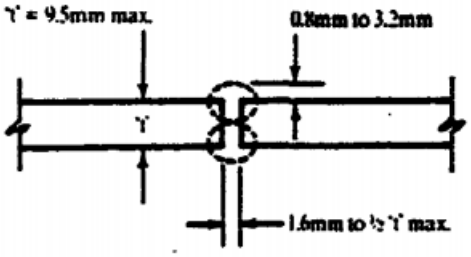
*Note 3 not applicable

't'	Position	Back Bar	'Gap'
4.8mm	Down	25.4mm x 7.9mm	1.6mm
6.4mm	Down	25.4mm x 7.9mm	3.2mm
8.0mm	Down	38.0mm x 9.5mm	4.0mm
9.5mm	Down	38.0mm x 9.5mm	4.8mm

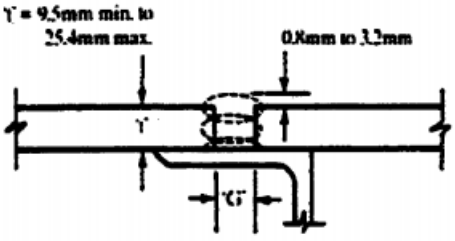
Square Gap-Butt joint, welded both sides
See note 2



Square Gap-Butt joint, welded both sides
See note 2



Square Open Gap-Butt joint welded one side, on backing structure or bar



'G' = 1.4 O.D. of electrode min.
Backing bars = 38.0mm x 9.5mm F.M.S

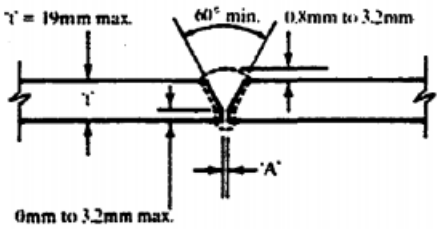
't'	Position	'Gap'
9.5mm	Down	9.5mm
12.7mm	Down	9.5mm
15.9mm	Down	12.7mm
19.0mm	Down	12.7mm
22.2mm	Down	12.7mm
25.4mm	Down	12.7mm

IMPORTANT Notes apply only to details where referenced.

Note 1 Root of weld shall be chipped out to sound metal before opposite side is welded.

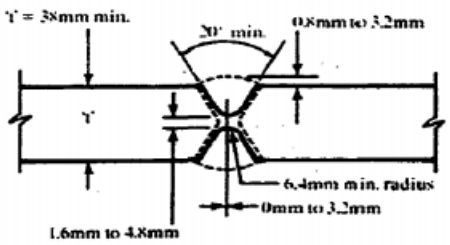
Note 2 Dimension 't' is plate thickness to which normally applicable. If desired, plate thickness may be greater for joints indicated.

Single-V Butt joint, welded both sides
See Notes 1 & 2

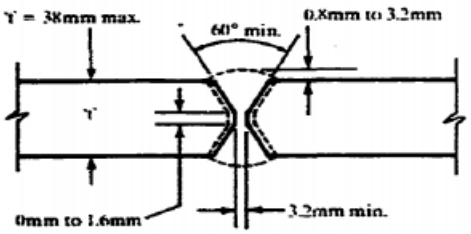


'A' = 1.6mm min, except when welding bulkheads and similar assemblies in the flat where zero root opening is permissible.

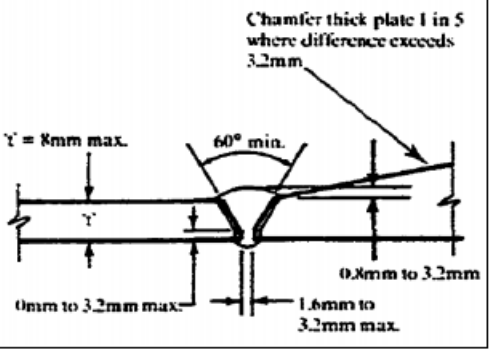
Double-U, Butt Joints
See Notes 1 & 2



Double-V, Butt joints
See Notes 1 & 2



Single-V Butt joint, unequal plates welded both sides
See Note 1 & 2



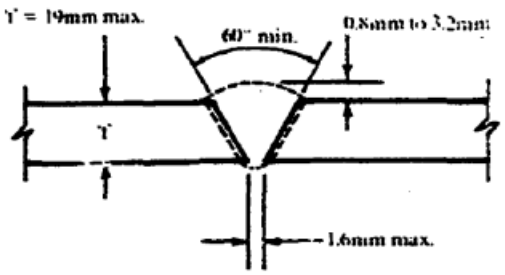
J.33 Shell butt joints

IMPORTANT Notes apply only to details where referenced.

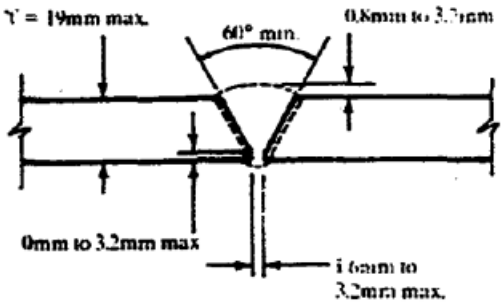
Note 1 Root of weld shall be chipped out to sound metal before opposite side is welded.

Note 2 Dimension 't' is plate thickness to which normally applicable. If desired, thickness may be greater for joints indicated.

Single Vee Vertical Butt joint
See Notes 1 & 2

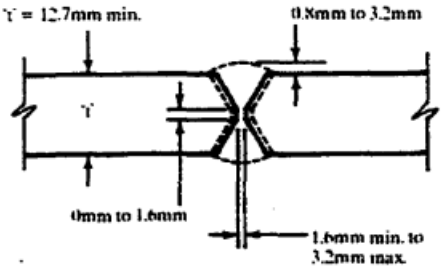


Prepare Vee as shown when 'Oxy Plate Edge Preparer' with constant nozzle to plate clearance is used.



Prepare Vee as shown when edges are planed.

Double Vee Vertical Butt joint
See Notes 1 & 2



J.34 Lap joints

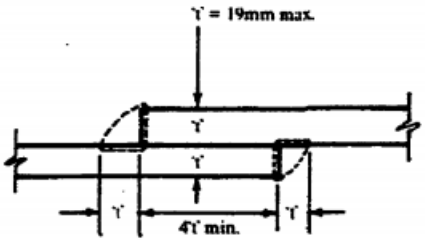
IMPORTANT Notes apply only to details where referenced.

Note 1 This joint shall not be used on members subject to high stresses or compression loading.

Note 2 Dimension 't' is plate thickness to which normally applicable. If desired, thickness may be greater for joints indicated.

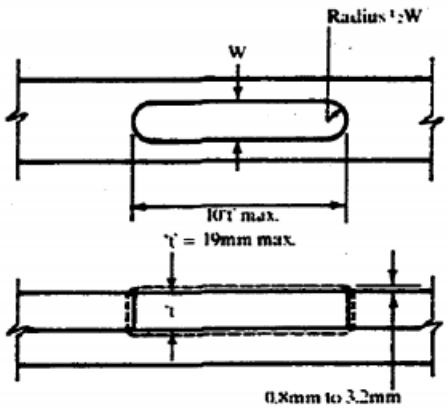
Note 3 Slot welds shall be bevelled 45° included angle when 't' is less than 12.7 m.

Double fillet welded lap joint
See Notes 1 & 2



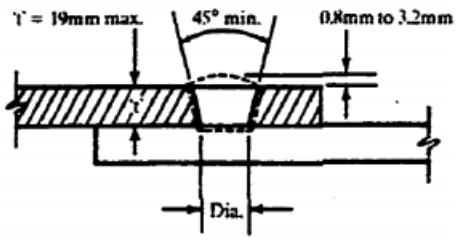
Lap 4't' need not exceed 50mm

Slot welded lap joint
See Notes 2 & 3



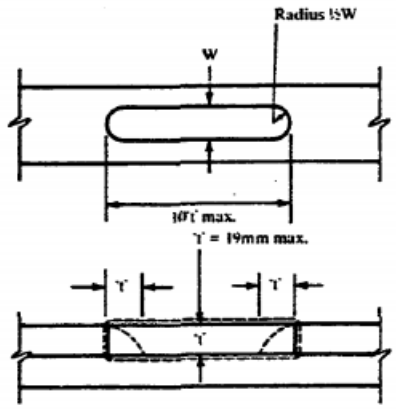
When 't' is below 6.4mm, W = 2't'min
When 't' is 6.4mm and over, W = 1½'t' min.

Plug welded lap joint
See Note 2



When 't' = 3.2mm or less, dia. = 6.4mm min.
When 't' = 3.2mm to 12.7mm, dia. = 2't'min
When 't' = 12.7mm and over, dia. = 't'+12.7mm

Slot lap joint filler welded
See Note 2



W = 1½'t'min. or 12.7mm whichever is the greater.

J.35 Tee joints

IMPORTANT Notes apply only to details where referenced.

Note 1 Where the clearance between members to be joined 'A' is greater than 1.6 mm the size of fillet weld shall be the size specified plus the clearance.

Note 2 Dimension 't' is plate thickness to which normally applicable. If desired, plate thickness may be greater for joints indicated.

Note 3 Root of weld shall be chipped out to sound metal before opposite side is welded.

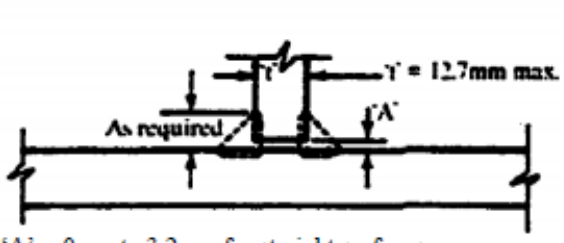
Note 4 This joint shall not be used when root of weld is subject to tension bending.

Note 5 The length of intermittent fillet welds shall be 76 mm clear of craters.

Note 6 When this joint is used no obstruction shall be closer than 456 mm to the edge of the bevelled plate.

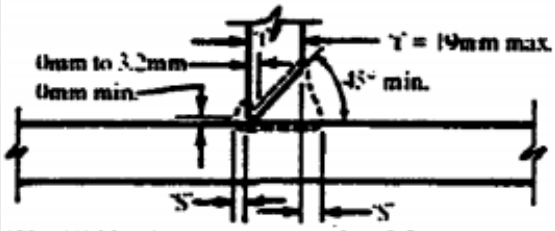
Note 7 This joint shall not be used without approval of an AUSCLASS Surveyor.

Double fillet welded tee joint
See Notes 1 & 2



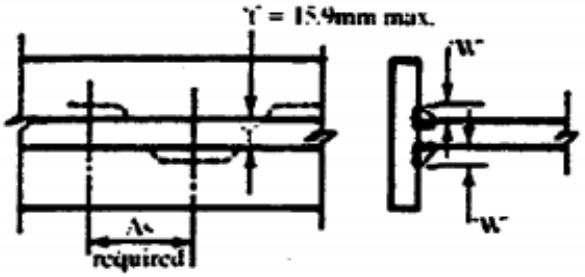
'A' = 0mm to 3.2mm for straight surfaces
'A' = 0mm to 4.8mm for curved surfaces

Single bevel tee joint, welded both sides, fillet reinforced
See Notes 1, 2, 3, & 6



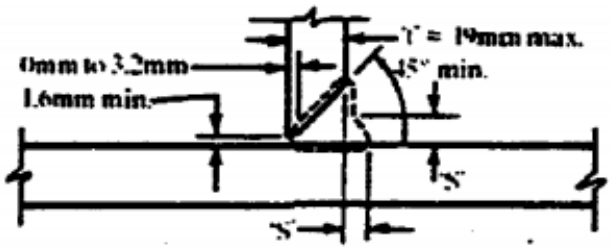
'S' = ½'t' but in no case greater than 9.5mm

Staggered intermittent welded tee joint
See Notes 2 & 5



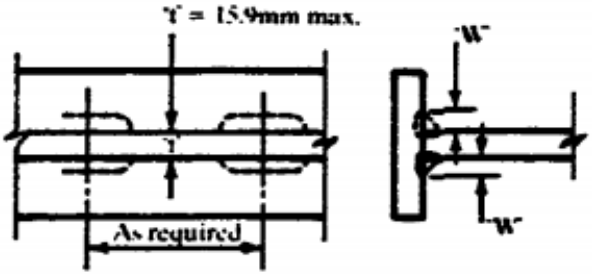
'W' as required in II of this Schedule

Single bevel tee joint welded one side fillet reinforced
See Notes 1, 2, 4, 6 & 7



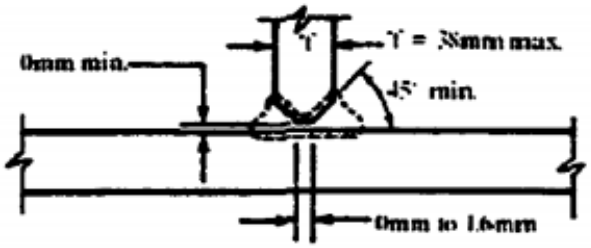
'S' = ½'t' but in no case greater than 9.5mm

Chain intermittent welded tee joint
See Notes 2 & 5



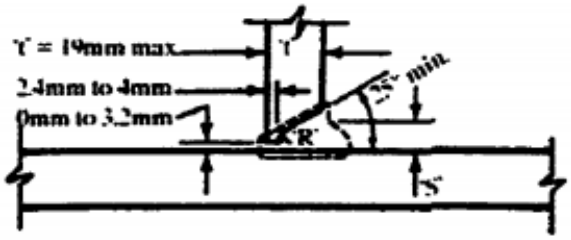
'W' as required in II of this Schedule

Double bevel tee joint fillet reinforced
See Notes 3 & 6



'S' = ½'t' but in no case greater than 9.5mm

Single-J tee joint welded both sides fillet reinforced
See Notes 2, 3, & 6



'R' = 12.7mm rad. Min.
'S' = ½'t' but in no case greater than 9.5mm

J.36 Corner joints

IMPORTANT Notes apply only to details where referenced.

Note 1 This joint shall not be used without approval of an AUSCLASS Surveyor.

Note 2 This joint shall not be used when root of weld is subject to tension bending.

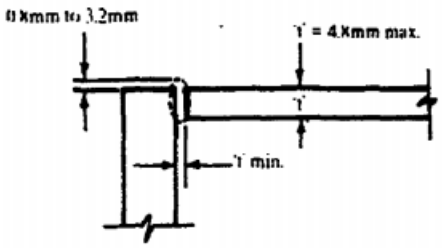
Note 3 Root of weld shall be chipped out to sound metal before opposite side is welded.

Note 4 Dimension 't' is plate thickness to which normally applicable. If desired, plate thickness may be greater for joints indicated.

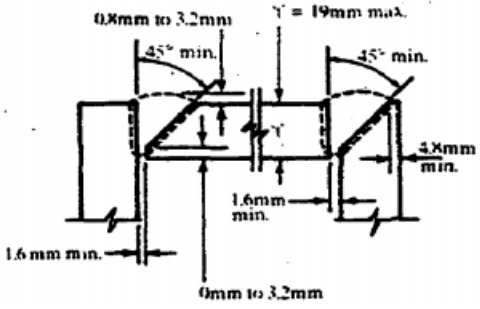
Note 5 When this joint is used in the flat and overhead positions of welding, no obstruction shall be closer than 152mm to the edge of the edge of the bevelled plate. When used in horizontal and vertical positions of welding, no obstruction shall be closer than 456mm to the edge of the bevelled plate.

Note 6 When this joint is used no obstruction shall be closer than 456mm to the edge of the bevelled plate.

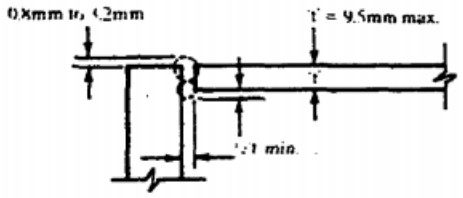
Open square corner joint, welded one side
See Notes 1 & 2



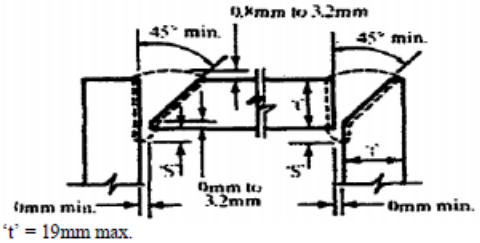
Outside single bevel corner joint welded one side
See Notes 2, 5 & 1



Open square corner joint, welded both sides
See Note 5

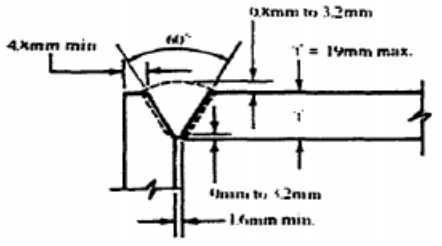


Outside single bevel corner joint welded both sides
See Notes 3 & 5

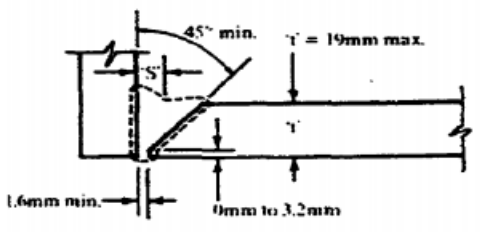


't' = 19mm max.
'S' = ½'t' but in no case greater than 9.5mm

Single-V corner joint, welded one side
See Notes 1 & 2



Inside single level corner joint, fillet reinforced
See Notes 2 & 6

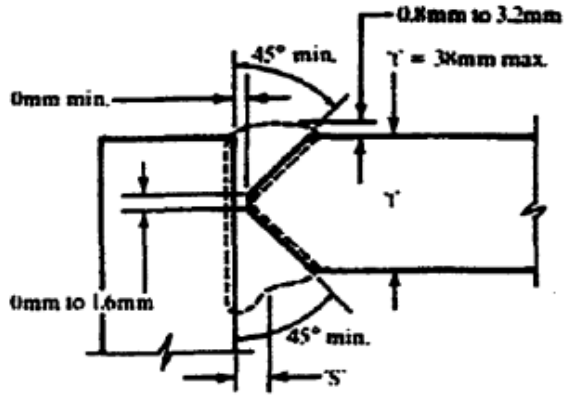


'S' = ½'t' but in no case greater than 9.5mm

Double level corner joint, fillet reinforced

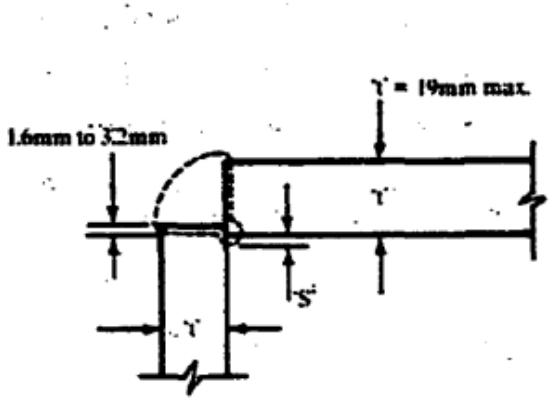
Double fillet welded corner joint

See Notes 3 & 6



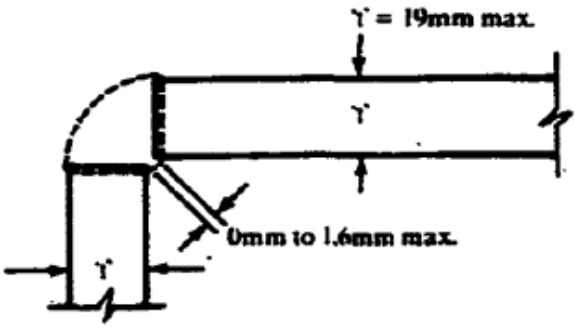
'S' = ½'t' but in no case greater than 9.5mm

See Notes 3 & 4

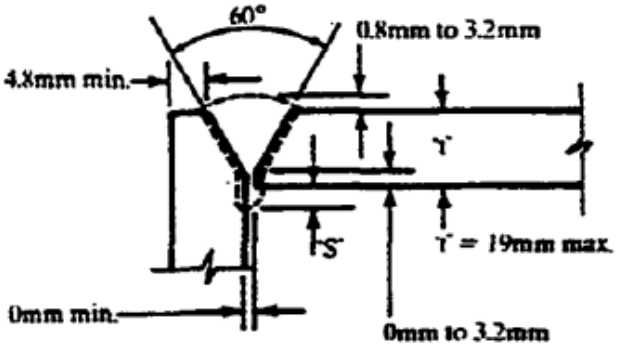


'S' = ½'t' but in no case greater than 9.5mm

Outside single fillet welded corner joint
See Notes 1, 2 & 4

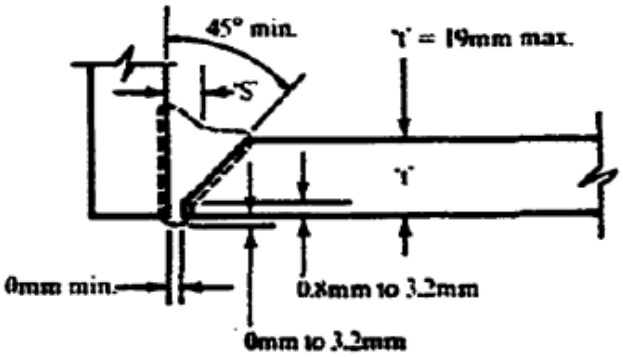


Single V corner joint fillet reinforced
See Notes 3 & 4



'S' = ½'t' but in no case greater than 9.5mm

Inside single bevel corner joint, welded both sides, fillet reinforced
See Notes 3 & 6



'S' = ½'t' but in no case greater than 9.5mm