

Australian Standard[®]

**Boat and ship design and
construction**

Part 2: Aluminium construction

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The following interests are represented on Committee ME/59:

- American Bureau of Shipping
- Australian Chamber of Shipping
- Australian Maritime Safety Authority
- Australian National Maritime Association
- Australian Shipbuilders Association
- Bureau Veritas
- Department of Defence
- Department of Transport, Qld
- Det Norske Veritas
- Institute of Marine Engineers
- Lloyds Register of Shipping
- Royal Institution of Naval Architects
- University of New South Wales

Additional interests participating in preparation of Standard:

- Aluminium Development Council
- Department of Marine and Harbours, S.A.
- Department of Transport and works, N.T.
- Maritime Services Board of New South Wales

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PREFACE

This Standard was prepared by the Standards Australia Committee on Shipbuilding following a request by the Australian Transport Advisory Council, to replace the relevant specification in the *Uniform Shipping Laws Code*.

It is Part 2 of a series of Standards on boat and ship design and construction, the other Parts being—

Part 1: *Design loadings*

Part 3: *Fibre-reinforced plastics construction*

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STANDARDS AUSTRALIA

Australian Standard

Boat and ship design and construction

Part 2: Aluminium construction

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard specifies the structural requirements for aluminium vessels not exceeding 35 m in length.

It includes multi-hull vessels but excludes novel types of vessels such as surface-effect ships (SES), hovercraft, hydrofoils and small-water-plane-area twin-hull (SWATH) vessels.

1.2 APPLICATION This Standard is intended for use by manufacturers building aluminium vessels in accordance with the Australian Transport Advisory Council *Uniform Shipping Laws Code*.

1.3 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

- 1664 SAA Aluminium Structures Code
- 1665 Welding of aluminium structures
- 1734 Aluminium and aluminium alloys—Flat sheet, coiled sheet and plate
- 1865 Aluminium and aluminium alloys—Drawn wire, rod, bar and strip
- 1866 Aluminium and aluminium alloys—Extruded rod, bar, solid and hollow shapes
- 1867 Aluminium and aluminium alloys—Drawn tubes
- 1874 Aluminium and aluminium alloys—Ingots and castings
- 2837 Wrought alloy steels—Stainless steel bars and semi-finished products
- 2848 Aluminium and aluminium alloys—Compositions and designations
- 2848.1 Part 1: Wrought products
- 4132 Boat and ship design and construction
- 4132.1 Part 1: Design loadings

Aluminium Development Council of Australia
Aluminium standards and data—Wrought products

Australian Transport Advisory Council
Uniform Shipping Laws Code

1.4 DEFINITIONS For the purpose of this Standard, the definitions given in AS 4132.1 apply.

S E C T I O N 2 M A T E R I A L S

2.1 ALUMINIUM ALLOYS

2.1.1 General Only aluminium alloys with suitable resistance to corrosion in a marine environment shall be used.

2.1.2 Sheet and plate Aluminium alloy sheet and plate shall comply with AS 1734, both in composition and temper.

The following alloys, as designated in AS 2848.1, are suitable for use as sheet and plate in a marine environment:

- (a) 5005.
- (b) 5052.
- (c) 5083.
- (d) 5086.
- (e) 5251.
- (f) 5454.

Other alloys, which comply with AS 2848.1, may be used provided that they have similar durability in a marine environment and the necessary mechanical properties.

High strength structural alloys of the 2000 series containing copper and the 7000 series alloys are susceptible to stress corrosion in a marine environment and are not recommended for use.

2.1.3 Extruded and drawn products Extruded products shall comply with AS 1866, and drawn products shall comply with AS 1865 or AS 1867, as applicable, both in composition and temper.

The following alloys, as designated in AS 2848.1, are suitable for use for extruded and drawn products in a marine environment:

- (a) 6060.
- (b) 6061.
- (c) 6063.
- (d) 6351.

Other alloys, which comply with AS 2848.1, may be suitable provided that they have similar durability in a marine environment and the necessary mechanical properties.

Alloys of the 2000 series containing copper and the 7000 series alloys are not recommended (see Clause 2.1.2).

2.1.4 Castings Aluminium castings shall comply with AS 1874. The following alloys, as specified in AS 1874, are suitable for use for castings in a marine environment:

- (a) EA 401.
- (b) AA 507.
- (c) AA 601.
- (d) CC 601.
- (e) AC 601.
- (f) AA 605.

Copper-based cast aluminium alloys are not recommended.

2.1.5 Care and storage of aluminium alloy materials All aluminium plate, sheet and sections for use in vessels shall be stored in suitable covered areas and adequate provision shall be made to segregate alloys of different grade and temper and to identify each product at all stages of fabrication.

Aluminium and steel products shall be segregated and tools used for steel fabrication, such as grinding wheels and wire brushes, shall not be brought into aluminium fabrication areas.

2.2 FILLER METALS

2.2.1 General The welding filler metals listed in AS 1665 shall be used in combination with parent metals as set out in that Standard. Other filler metals may be used subject to procedure qualification.

2.2.2 Care of filler metals Filler metals shall be stored in their original packets or cartons in a dry place adequately protected from the weather. Where special conditions for storage and use are recommended by the manufacturer, filler metals shall be stored in accordance with those conditions.

Filler metals shall be dry, smooth and free from corrosion or other matter deleterious to the weld metal.

2.3 SHIELDING GASES The arc shrouding in the conventional welding of aluminium shall be welding-grade argon.

The use of helium-argon mixtures is permissible.

Where a helium-argon mixture is substituted for argon, the welding parameters shall be requalified before commencing work.

Shielding gases shall be kept in the containers in which they are supplied.

SECTION 3 METHODS OF CONSTRUCTION

3.1 WELDING PROCEDURES AND QUALIFICATION

3.1.1 General Welds shall be made—

- (a) in accordance with a qualified welding procedure; and
- (b) by welders qualified to carry out such a procedure.

3.1.2 Qualification of welding procedures Welding procedures shall be qualified in accordance with AS 1665.

3.1.3 Quality of welds Unless otherwise specified, all butt welds shall be quality level B and all fillet welds shall be the equivalent quality level, as defined in AS 1665.

3.1.4 Joint preparation The edge preparations necessary for different types of joints in the various thicknesses of material to be manually welded shall be in accordance with AS 1665 or other qualified procedure.

3.1.5 Cleaning and oxide removal All surfaces to be welded shall be smooth and free from oxide, paint, grease and moisture.

All surfaces to be welded shall be degreased either chemically or with a solvent.

After degreasing, the surfaces to be welded shall be scratch-brushed using stainless steel brushes only to ensure that all the oxide on the aluminium is removed. In multi-run welds, scratch-brushing shall be carried out between each run. Stainless steel brushes shall be kept exclusively for aluminium and be clean and free from rust.

The interval between cleaning and welding should be as short as possible. If accidental contamination with dirt or moisture occurs after cleaning and prior to welding, the surfaces shall be recleaned.

NOTES:

- 1 If the surfaces are not smooth, clean and free of moisture, weld porosity and oxide inclusions will result.
- 2 Where degreasing is achieved by swabbing with a solvent, chlorinated hydrocarbon degreasing agents should not be used because of their highly toxic properties. Solvents such as petroleum ether, industrial alcohol, acetone or white spirit are satisfactory but the flammability of these compounds should be recognized.

3.2 WELDED JOINTS AND CONNECTIONS

3.2.1 General Unless otherwise specified, welded joints and connections shall be in accordance with Appendix A.

3.2.2 Welds in areas of high cyclic stress Where high cyclic stress may be encountered in rudders and connections in the propeller region, double continuous fillet welds shall be used.

3.2.3 T-butt joints Where a butt meets a seam to form a tee junction, the welding of the seam should be interrupted well clear of the junction. The welding of the leg of the tee including any back run is to be completed first and then chipped back to remove crater cracks in the path of the seam to enable the seam to be welded straight through.

3.2.4 Plug welds Where plug welds are used to transmit shear in a lap joint or to prevent the buckling or separation of lapped parts, they shall—

- (a) be made with fillet welds and only filled in for joints not subject to fluctuating stress;
- (b) have a minimum diameter equal to the thickness of the part containing the plug weld plus 10 mm;

- (c) have a distance from the edge of the hole to the adjacent edge of the part not more than 10 times the thickness of the part containing the plug weld (see Figure 3.1); and
- (d) have a minimum centre-to-centre spacing equal to 4 times the diameter of the hole.

Plug welds are not recommended for areas subject to cyclic loading. The positions where plug welds are to be used shall be indicated on the construction drawings.

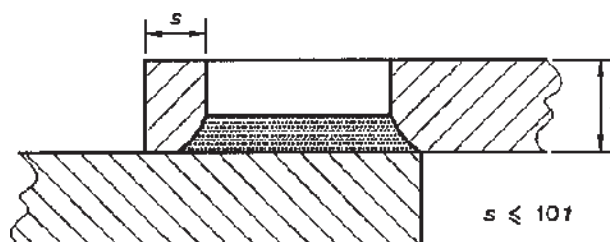


FIGURE 3.1 REQUIREMENTS FOR PLUG AND SLOT WELDS

3.2.5 Slot welds Where slot welds are used to transmit shear in a lap joint or to prevent the buckling or separation of lapped parts, they shall—

- (a) be made with fillet welds and not filled in except in areas not subject to fluctuating stress.
- (b) have a width of slot not less than the thickness of the part containing the slot weld plus 10 mm;
- (c) have a distance from the edge of the slot to the adjacent edge of the part not more than 10 times the thickness of the part containing the slot weld (see Figure 3.1);
- (d) have a minimum clear spacing in a longitudinal direction on any line not less than twice the length of the slot or 4 times the width of the slot, whichever is the greater;
- (e) have a length of slot not more than 10 times the width of the slot; and
- (f) have the ends of the slot rounded to a radius of not less than the thickness of the part containing the slot.

Slot welds are not recommended for areas subject to cyclic loading. The positions where slot welds are to be used shall be indicated on the construction drawings.

3.2.6 Distortion control When assembling and joining parts of a vessel, the procedure and sequence of welding shall be such that there will be minimal distortion and restraint. A complete program of welding sequences shall be established and the sequences shall be such that the parts may as far as possible contract freely to avoid cracks in runs of weld already deposited.

3.2.7 Misalignment Misalignment of structural elements except shell plating shall not be greater than half the thickness of the thinner member forming the stress path.

The tolerance for the alignment of shell plating subject to cyclic loading shall be not greater than 15 percent of the thinner plate.

3.3.1 General The design and method of fabrication of riveted and bolted joints should be in accordance with the relevant requirements of AS 1664. Rivets and bolts and their faying surfaces should be coated with a compatible anti-corrosive paint such as yellow zinc chromate.

3.3.2.1 Rivet diameter The diameter of rivets for single plate lap joints shall be not less than that calculated from the following equations:

- where

d = diameter of the shank of the rivets, in millimetres.

where

d = diameter of the shank of the rivets, in millimetres.

$$2.5d \leq e \leq 6d$$

- $$4d \leq e \leq 7d$$

and $3d \leq e_1 \leq 5d$

- $$e_2 \geq 2d$$

and $e_7 \geq 4t$

- $$e \leq 7d$$

and $e \leq 15t$

where

$t = t_i$ or $t = 2t_y$ (whichever is lesser) for double lap joints, in millimetres
(see Figure 3.2)

d = diameter of the shank of the rivets, in millimetres

e = spacing between rivet centres, in millimetres

e_1 = distance between rows, in millimetres (see Figure 3.2)

e_1 = distance between rivet and edge of plate, in millimetres (see Figure 3.2).

3.3.2.3 Rivet holes The difference in diameter between the rivet and hole shall not be greater than that shown in Figure 3.3. The holes shall be deburred.

3.3.2.4 Riveting practice Riveting shall be carried out in such a way that the surfaces make good contact.

NOTE: An example of recommended tacking and riveting sequence is shown in Figure 3.4.

3.3.2.5 Blind rivets Blind rivets shall not be used in shell plating or in stressed joints. Where blind rivets are used the grip lengths and rivet hole tolerance shall be as recommended by the manufacturer.

3.3.2.6 Hollow-end rivets Where hollow-end rivets with solid cross-sections for a portion of the length are used, the strength of these rivets shall be taken as equal to the strength of solid rivets of the same material, provided that the bottom of the cavity is not less than 25 percent of the rivet diameter from the plane of shear, as measured toward the hollow-end (see Figure 3.5), and further provided that they are used in locations where they will not be subjected to appreciable tensile stresses.

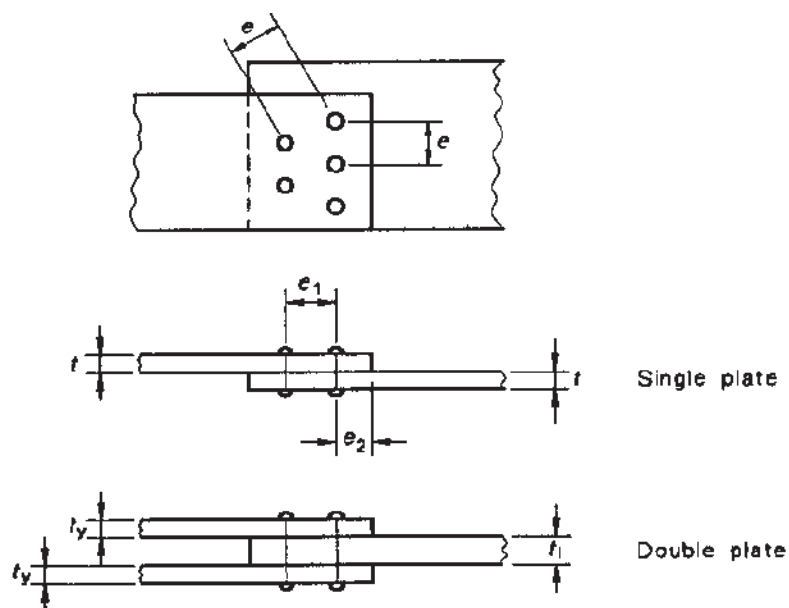


FIGURE 3.2 RIVET SPACING AND SIZING

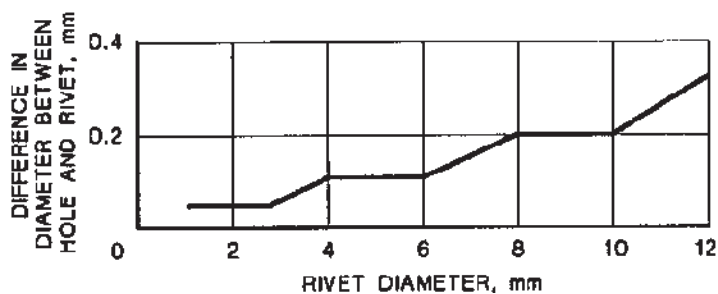


FIGURE 3.3 SIZING OF RIVET HOLES

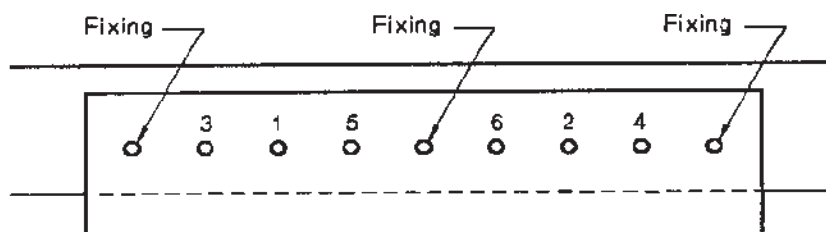


FIGURE 3.4 RECOMMENDED RIVETING PRACTICE

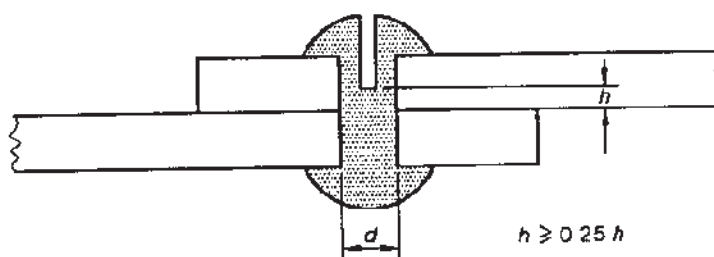


FIGURE 3.5 REQUIREMENTS FOR HOLLOW-END RIVETS

3.3.3 Bolting

3.3.3.1 Design Through-bolted joints shall be designed in the same manner as riveted joints (see Clause 3.3.2).

3.3.3.2 Bolting materials Nuts, bolts and washers in joints below the waterline shall be of aluminium alloy, Grade AS 2837/304 stainless steel or Grade AS 2837/316 stainless steel. Above the waterline aluminium alloy, Grade AS 2837/304 stainless steel, Grade AS 2837/316 stainless steel or zinc-plated steel fasteners shall be used.

3.3.3.3 Isolation of bolts Stainless steel fasteners in joints below the waterline shall be electrically insulated from the shell plating by non-conducting, non-hygroscopic material. In joints above the waterline, painting of the fasteners in accordance with Clause 3.5.6 should be carried out.

3.4 ALTERNATIVE FASTENERS

3.4.1 Lockbolts Lockbolts may be used when installed in compliance with the lockbolt manufacturer's recommended practices and provided that the body diameter and bearing areas under the head and nut, or their equivalent, are not less than those of a conventional nut and bolt.

3.4.2 Thread-forming (tapping) screws and metal stitching staples Where load carrying joints are made with thread-forming screws or metal stitching staples, permissible strength values for these connections shall be established on the basis of specific acceptance tests.

NOTE: Thread-forming (tapping) screws and metal stitching staples are being used increasingly to join thin metal structures. In view of the wide variance of joint strength obtainable with these fastening methods, no standard or uniform permissible forces are recommended.