

Australian/New Zealand Standard™

Buried corrugated metal structures

Part 6: Bolted plate structures



AS/NZS 2041.6:2010

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee CE-025, Corrugated Metal Drainage Pipes and Arches. It was approved on behalf of the Council of Standards Australia on 9 September 2010 and on behalf of the Council of Standards New Zealand on 24 September 2010. This Standard was published on 17 November 2010.

The following are represented on Committee CE-025:

AUSTROADS

Australasian Railway Association
Australian Chamber of Commerce and Industry
Australian Industry Group
Galvanizers Association of Australia
Main Roads Department, Queensland
New Zealand Heavy Engineering Research Association
University of Queensland

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.saiglobal.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR 10018.

Australian/New Zealand Standard™

Buried corrugated metal structures

Part 6: Bolted plate structures

Originated in Australia as AS A128—1962.
Previous editions AS 2041—1984 and AS 2042—1984.
AS 2041—1984 and AS 2042—1984 jointly revised, amalgamated and designated AS/NZS 2041:1998.
AS/NZS 2041:1998 jointly revised and designated, in part as AS/NZS 2041.6:2010.

COPYRIGHT

© Standards Australia Limited/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Australia) or the Copyright Act 1994 (New Zealand).

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, Private Bag 2439, Wellington 6140

ISBN 978 0 7337 9704 0

PREFACE

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee CE-025, Corrugated Metal Drainage Pipes and Arches, to supersede, in part, AS/NZS 2041:1998, *Buried corrugated metal structures*.

The objective of this Standard is to provide designers, manufacturers and installers of buried bolted plate structures with requirements for manufacture of such structures for use in earthworks primarily as culverts or access ways.

This Standard is Part 6 of the AS/NZS 2041 series, *Buried corrugated metal structures*, which comprises the following parts:

AS/NZS

- 2041 Buried corrugated metal structures
- 2041.1 Part 1: Design methods
- 2041.2 Part 2: Installation
- 2041.4 Part 4: Helically formed sinusoidal pipes
- 2041.6 Part 6: Bolted plate structures

Other parts of the series currently being drafted include the following:

- Part 3: Assessment of existing structures
- Part 5: Helically formed ribbed pipes
- Part 7: Bolted plate structures with transverse stiffeners
- Part 8: Metal box structures

This Edition includes the following changes:

- (a) Design requirements have been moved to AS/NZS 2041.1, which includes new limit states design methods.
- (b) Installation requirements are referred to AS/NZS 2041.2.
- (c) Notation has been based on ISO 3898.
- (d) Materials and fabrication requirements (remaining in this Standard) have been updated.
- (e) Class 1 and class 2 are now termed B68 and B200 profiles.
- (f) New profile sizes, B152, B230 and B381, included.
- (g) Reference tables for cover limits have been taken out.

In this document, the words ‘this Standard’ indicate AS/NZS 2041.6, which is regarded as Part 6 of the AS/NZS 2041 series of Standards.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	5
1.2 DESIGN AND INSTALLATION	6
1.3 NORMATIVE REFERENCES	6
1.4 DEFINITIONS	7
1.5 NOTATIONS	8
SECTION 2 SPECIFICATION	
2.1 GENERAL	11
2.2 MARKING OF STRUCTURES	11
SECTION 3 MATERIALS AND FABRICATION FOR B68 STRUCTURES	
3.1 SCOPE OF SECTION	12
3.2 MATERIALS	12
3.3 FABRICATION	17
3.4 REPAIR OF DEFECTS AND COATINGS	19
SECTION 4 MATERIALS AND FABRICATION FOR B152 STRUCTURES	
4.1 MATERIALS	22
4.2 FABRICATION	24
4.3 REPAIR OF DEFECTS AND COATINGS	27
SECTION 5 MATERIALS AND FABRICATION FOR B200 STRUCTURES	
5.1 MATERIALS	30
5.2 FABRICATION	32
5.3 REPAIR OF DEFECTS AND COATINGS	34
SECTION 6 MATERIALS AND FABRICATION FOR B230 STRUCTURES	
6.1 MATERIALS	37
6.2 FABRICATION	38
6.3 REPAIR OF DEFECTS	40
SECTION 7 MATERIALS AND FABRICATION FOR B381 STRUCTURES	
7.1 MATERIALS	42
7.2 FABRICATION	44
7.3 REPAIR OF DEFECTS AND COATINGS	46
SECTION 8 SECTION PROPERTIES FOR DESIGN	
8.1 SCOPE OF SECTION	48
8.2 DIMENSIONS AND TOLERANCES	48
8.3 MATERIAL AND SECTION PROPERTIES	48
SECTION 9 SHAPE LIMITATIONS	57

APPENDICES

A	GUIDELINES FOR DESIGN INFORMATION FOR SUPPLY AND INSTALLATION	58
B	MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD	62

BIBLIOGRAPHY	64
--------------------	----

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard Buried corrugated metal structures

Part 6: Bolted plate structures

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies minimum requirements for the materials and manufacture of buried corrugated metal structures formed by bolting together plates with sinusoidal profile.

Sinusoidal profiles covered include the following:

- (a) B68 (pitch 68 mm).....manufactured with either lapped joints or flanged joints.
- (b) B152 (pitch 152 mm).....lapped joints only.
- (c) B200 (pitch 200 mm).....lapped joints only.
- (d) B230 (pitch 229 mm).....lapped joints only.
- (e) B381 (pitch 381 mm).....lapped joints only.

The structure shapes are as follows (see Figure 1.1):

- (i) Pipe.
- (ii) Pipe-arch or underpass.
- (iii) Horseshoe arch or elliptical arch.
- (iv) Arch (one, two or three radius).
- (v) Vertical ellipse.
- (vi) Horizontal ellipse.
- (vii) Metal box.

These structures are intended for use in stormwater drainage and as access tunnels to support roadway and railway and other loadings.

Bolted plate structures are constructed of corrugated section shapes buried in an embankment or in a trench, with correct installation in a soil envelope being essential to the performance of the structure.

This Standard does not consider the additional design requirements for internally pressurized applications.

NOTES:

- 1 Guidelines on requirements that may need to be specified at the time of calling for tenders or quotations, and information to be supplied by the manufacturer, are detailed in Appendix A.
- 2 Information on means of demonstrating compliance with this Standard is given in Appendix B.
- 3 When intended for use in internally pressurized applications, specialist advice should be obtained.

1.2 DESIGN AND INSTALLATION

Design shall be carried out in accordance with AS/NZS 2041.1 using the section properties given in Section 8 of this Standard. Installation shall be carried out in accordance with AS/NZS 2041.2.

NOTE: This Standard includes the product requirements and design properties. AS/NZS 2041.1 gives information on design issues and requirements for structural design of the metal structure. Performance of the structure depends on correct installation (particularly adequate compaction of appropriate fill material around the metal structure) for which AS/NZS 2041.2 gives the requirements.

1.3 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard:

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

1110	ISO metric hexagon bolts and screws
1111	ISO metric hexagon commercial bolts and screws (All parts)
1112	ISO metric hexagon nuts including thin nuts, slotted nuts and castle nuts (ISO 4032:1986, ISO 4033:1979, ISO 4034:1986 and ISO 4035:1986) (All parts)
1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
1252–1983	High strength steel bolts with associated nuts and washers for structural engineering (Incorporating Amdt 1.)
1275	Metric screw threads for fasteners
1397	Steel sheet and strip—Hot-dip zinc-coated or aluminium/zinc-coated
4100	Steel structures
4100 Supp 1	Supplement 1: Steel structures—Commentary

AS/NZS

1252	High strength steel bolts with associated nuts and washers for structural engineering
1365	Tolerances for flat-rolled steel products
1594	Hot-rolled steel flat products
1734	Aluminium and aluminium alloys—Flat sheet, coiled sheet and plate
2041	Buried corrugated metal structures
2041.1	Part 1: Design methods
2041.2	Part 2: Installation
4680	Hot-dipped galvanized (zinc) coatings on fabricated ferrous articles

ISO

3898	Bases for design of structures—Notations—General symbols
------	--

ASTM

A449	Standard specification for hex cap screws, bolts and studs, steel, heat treated, 120/105/90 ksi minimum tensile strength, general use
A563	Standard specification for carbon and alloy steel nuts
A742	Standard specification for steel sheet, metallic coated and polymer precoated for corrugated steel pipe

A761	Standard specification for corrugated steel structural plate, zinc-coated, for field-bolted pipe, pipe arches and arches
A929	Standard specification for steel sheet, metallic-coated by the hot-dip process for corrugated steel pipe
B209	Standard specification for aluminium and aluminium alloy sheet and plate
B695	Standard specification for coatings of zinc mechanically deposited on iron and steel
B746	Standards specification for corrugated aluminium alloy structural plate for field bolted pipe, pipe arches and arches
B744	Standard specification for aluminum alloy sheet for corrugated aluminum pipe

1.4 DEFINITIONS

For the purpose of this Standard, the definitions in AS/NZS 2041.1 and AS/NZS 2041.2 and those below apply.

1.4.1 Bedding

A prepared layer of uncompacted, non-cohesive material placed over the foundation, below the structure invert.

1.4.2 Camber

A variation to the bedding grade along the structure invert to compensate for differential settlement.

1.4.3 Compaction

The process of soil densification, at a specified moisture content, through the application of load by rolling, tamping, rodding or vibration with mechanical or manual equipment.

1.4.4 Corrugation

Sinusoidal shapes consisting of a curve and tangent profile as shown in this Standard.

1.4.5 Cover

The vertical distance between the neutral axis of the structure's corrugation profile at the top of the structure and the—

- (a) pavement surface of road;
- (b) base of sleepers for railway traffic loads, and surface of track formation for heavy vehicles or equipment running on the track formation;
- (c) top of trench or embankment where Items (a) and (b) are not applicable; or
- (d) base of a stockpile.

1.4.6 Depth of corrugation

Measured as the vertical distance from a straight edge resting on the corrugation crests parallel to the axis of the structure to the bottom of the intervening valley.

1.4.7 Diameter, internal

The minimum clear dimension measured from internal crest to internal crest.

1.4.8 Flexibility factor

A measure of wall flexibility of the corrugated metal structure for the purpose of handling and installation without permanent deformation of the metal structure.

1.4.9 Foundation

Naturally occurring or prepared soil or rock underlying the installation and embankment.

1.4.10 Pitch of corrugation

The distance measured from crest to crest of corrugations, at 90° to the direction of the corrugation.

1.4.11 Protective coating

A coating designed to isolate the substrate from the environment.

NOTE: Types of protective coating include aluminized, galvanized, polymer, bituminized and painted coatings.

1.4.12 Skew number

A number denoting the angle between the centre-line of the road, railway or other embankment and the centre-line of the pipe, measured in a clockwise direction.

1.5 NOTATIONS

NOTE: Critical dimensions of buried corrugated metal structures are shown in Figure 1.1.

The notations in this Standard are based on the notations and principles given in ISO 3898 and AS/NZS 2041.1. The notations used are as follows:

A	= cross-sectional area of wall of the metal structure per unit length (based on structural base metal thickness), in millimetres squared per millimetre
d_c	= depth of sinusoidal corrugation, in millimetres
d_h	= effective horizontal geometrical dimension of structure (to the neutral axis of the corrugation), in millimetres
d_v	= effective vertical geometrical dimension of structure (to the neutral axis of the corrugation), in millimetres
$F_{f,max}$	= maximum flexibility factor, in millimetres per newton
f_u	= minimum ultimate tensile strength, in megapascals
f_y	= minimum yield strength, in megapascals
I	= second moment of area of the corrugated section (based on structural base metal thickness), in millimetres to the fourth power per millimetre
i	= radius of gyration of corrugated section (based on structural base metal thickness), in millimetres
p	= pitch of corrugation, in millimetres
R_{bs}	= seam strength (characteristic) in compression of bolted longitudinal seams, in kilonewtons per metre run of seam
R_s	= effective rise of pipe-arch, arch and special shape or effective diameter of pipe, measured to neutral axis of corrugation profile, in millimetres
R_c	= inside radius of sinusoidal corrugation, in millimetres
r_b	= bottom radius (neutral axis of corrugation), in millimetres
r_c	= corner radius, sometimes called the shoulder (neutral axis of corrugation), in millimetres
r_h	= haunch radius (neutral axis of corrugation), in millimetres
r_s	= side radius (neutral axis of corrugation), in millimetres

- r_t = top radius (neutral axis of corrugation), in millimetres
 S_b = clear internal bottom span of arch, in millimetres
 S_s = clear internal span of pipe-arch, arch and special shapes or internal diameter of pipe, measured to internal crests, in millimetres
 t = structural base metal thickness without coatings, in millimetres; ie (nominal base metal thickness minus base metal tolerance)/0.95 but not greater than the nominal base metal thickness. For ASTM A761 material, the nominal base metal thickness equals total specified thickness minus the coating thickness
 W_{el} = elastic section modulus of the corrugated section (based on structural base metal thickness), in millimetres to the third power per millimetre
 W_{pl} = plastic section modulus of the corrugated section (based on structural base metal thickness), in millimetres to the third power per millimetre
 θ_{bs} = angle between the horizontal and the bottom of the side arc (below) in elliptical arches, horseshoe arches and two and three radius arches, in degrees; *or* angle between the horizontal and the bottom of the side arc (above) in single radius arches with rise $\leq$ radius and metal box shapes, in degrees
 θ_c = angle subtended by corner arc (full arc) sometimes called the shoulder, in degrees

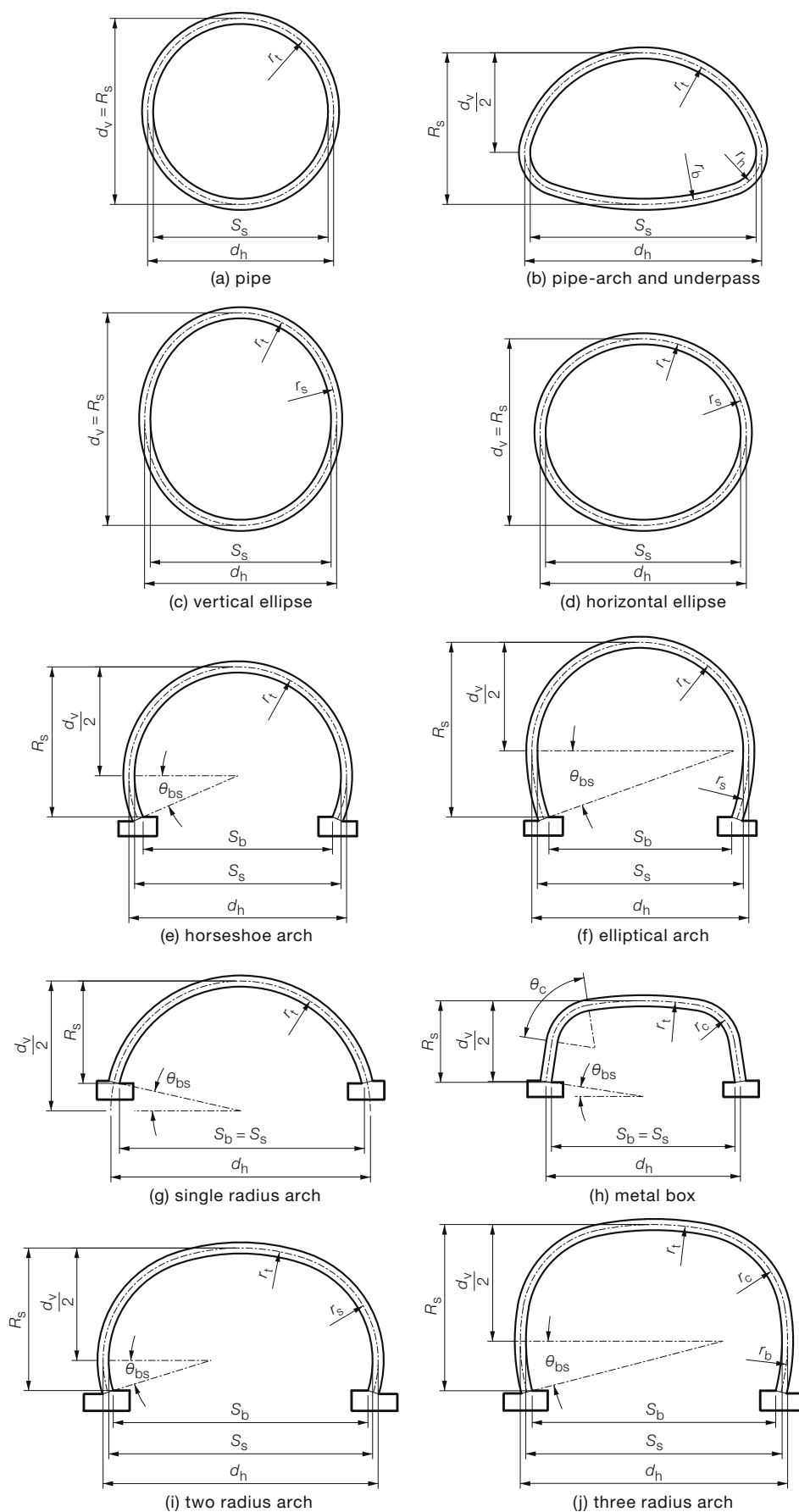


FIGURE 1.1 CRITICAL DIMENSIONS OF BURIED CORRUGATED METAL STRUCTURES

SECTION 2 SPECIFICATION

2.1 GENERAL

Corrugated bolted metal plate structures shall comply with the following:

- (a) Shape designation as given by the manufacturer shall include the corrugation pitch as a prefix.

NOTE: For example, a vertical ellipse shape in 200×55 corrugation would be 200-VE-XX where XX is the manufacturer's shape designation.

- (b) Materials and fabrication shall be in accordance with Sections 3, 4, 5, 6 and 7 (B68: 68×13 , B152: 152×51 , B200: 200×55 , B230: 229×64 , B381: 381×140 , sinusoidal section).

NOTE: Section properties for design are given in Section 8.

- (c) For the shapes described in this Standard, structures shall have the geometric limitations given in Section 9.

NOTE: Structural design shall be in accordance with AS/NZS 2041.1.

- (d) Structures shall be manufactured to provide the assembled tolerances given in AS/NZS 2041.2.

- (e) Marking shall be in accordance with Clause 2.2.

NOTE: For dimensions of special shapes, specialist advice should be sought.

2.2 MARKING OF STRUCTURES

Each structure shall be legibly and permanently marked in a conspicuous place agreed by the purchaser. The marking shall include the following:

- (a) Name of the manufacturer.
- (b) Date of manufacture including the month and year.
- (c) A unique number identifying the structure, which shall include the thickness and profile, the structure identifier and a number for traceability of the details of the particular installation, such as 5.0-200-30HE21-001.

NOTE: Manufacturers making a statement of compliance with this Australian Standard on product, packaging or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

SECTION 3 MATERIALS AND FABRICATION FOR B68 STRUCTURES

3.1 SCOPE OF SECTION

This Section specifies the materials to be used, method of manufacture, and dimensional requirements to be observed in the manufacture of B68 bolted plate structures.

3.2 MATERIALS

3.2.1 Base material

The base material consisting of the base metal and a protective coating shall be—

- (a) galvanized metal strip complying with the requirements of AS 1397 for steel base grade G250 and galvanized to Z600;
- (b) clad aluminium alloy strip with substrate metal classification 3004—H34 and cladding metal classification 7072 in accordance with AS 1734 or ASTM B744;
- (c) steel of grade G230 minimum with an aluminized (Type II) coating in accordance with ASTM A929; or
- (d) steel of grade G230 minimum with a polymer coating in accordance with ASTM A742.

The materials specified in Items (a) to (d) are appropriate for the design methods specified in AS/NZS 2041.1

3.2.2 Steel sheet

3.2.2.1 Material properties

The base steel shall be as shown in Table 3.2.2(A).

TABLE 3.2.2(A)
MATERIAL PROPERTIES FOR B68 STEEL SHEET

Standard	Metal grade	Minimum yield strength (f_y) MPa	Minimum tensile strength (f_u) MPa	Minimum elongation % over 50 mm
AS 1397	G250 steel	250	320	25
ASTM A929 ASTM A742	G230 steel	227.5	310.3	20

3.2.2.2 Base metal thickness

Tolerances on base metal thickness shall be in accordance with Table 3.2.2(B), Table 3.2.2(C) and Table 3.2.2(D).

TABLE 3.2.2(B)
STRUCTURAL BASE METAL WALL THICKNESS—AS 1397
G250 Z600 GALVANIZED STEEL

Specified (uncoated) wall thickness	Nominal coated wall thickness	Minimum coated wall thickness	Structural base metal wall thickness (<i>t</i>)
mm	mm	mm	mm
1.20	1.29	1.24 (1.13)	1.20 (1.09)
1.60	1.69	1.63 (1.53)	1.60 (1.52)
2.00	2.09	2.02 (1.91)	2.00 (1.92)
2.50	2.60	2.52 (2.41)	2.50 (2.43)
3.00	3.10	3.01 (2.89)	3.00 (2.94)
3.50	3.60	3.50 (3.37)	3.50 (3.44)
4.00	4.10	4.00 (3.87)	4.00 (3.97)

NOTE: Specified AS 1397 wall thickness is uncoated. AS/NZS 1365 strip tolerance assumes cold rolled. Section properties in Section 8 also assumes cold rolled strip tolerances. Hot rolled values are shown in brackets and their section properties can be calculated using Note 1 of Tables in Section 8.

TABLE 3.2.2(C)
STRUCTURAL BASE METAL WALL THICKNESS—ASTM A929
G230 Al TYPE 2 AND ASTM A929 G230 ZINC 610 g/m²
ALUMINIZED STEEL AND GALVANIZED STEEL

Specified (coated) wall thickness	Nominal uncoated wall thickness	Minimum coated wall thickness	Structural base metal wall thickness (<i>t</i>)
mm	mm	mm	mm
1.02	0.92	0.91	0.92
1.32	1.22	1.17	1.22
1.63	1.53	1.45	1.52
2.01	1.91	1.83	1.91
2.77	2.67	2.57	2.67
3.51	3.42	3.28	3.42
4.27	4.18	4.04	4.18

NOTE: Specified ASTM A929 wall thickness is coated.

TABLE 3.2.2(D)
STRUCTURAL BASE METAL WALL THICKNESS—ASTM A742
POLYMER-COATED STEEL

Base galvanized steel specification	Specified wall thickness mm	Nominal coated wall thickness including polymer mm	Minimum coated wall thickness including polymer mm	Structural base metal wall thickness (t) mm
AS 1397 G250 Z600	1.60 (uncoated)	2.20	2.14	1.60
ASTM A929 G230 Zinc 610 g/m ²	1.02 (zinc coated)	1.51	1.42	0.92
	1.32 (zinc coated)	1.82	1.68	1.22
	1.63 (zinc coated)	2.12	1.96	1.52
	2.01 (zinc coated)	2.50	2.34	1.91
	2.77 (zinc coated)	3.26	3.07	2.67
	3.51 (zinc coated)	4.02	3.78	3.42
	4.27 (zinc coated)	4.78	4.55	4.18

NOTE: Polymer coating thickness 254 microns per side.

3.2.2.3 Coating

The base steel shall have a coating in accordance with AS 1397, ASTM A929 or ASTM A742.

3.2.2.4 Alternative coatings

Where an alternative coating to that referred to in Clause 3.2.2.3 is used, it shall comply with the following:

- (a) *Heavy galvanized coating* The base steel shall be hot-dip galvanized in accordance with the requirements for general articles in AS/NZS 4680.
- (b) *Coating other than heavy galvanized* The base metal and application of the coating shall be in accordance with the coating manufacturer's specification.
- (c) *Duplex coatings* To protect the structure in abnormally corrosive or abrasive conditions a secondary coating shall be applied over the primary coating (nominated in Clauses 3.2.2.3, 3.2.2.4(a) or 3.2.2.4(b)), in accordance with the coating manufacturer's specification.

NOTE: Information on durability of suitable materials and coatings for various environmental conditions is given in AS/NZS 2041.1.

3.2.3 Steel bolts and nuts

3.2.3.1 Diameter

The bolts for the field assembly of bolted steel B68 structures shall be 12 mm in diameter for lapped structures and 10 mm in diameter for flanged structures.

3.2.3.2 Dimensions

The width across the flats of bolt heads and nuts shall be within the limits specified in AS 1111.

The form of thread and pitch of the bolt threads shall be ISO coarse pitch series in accordance with AS 1275. The threads shall comply with M12 8g tolerance in accordance with AS 1275, with thread tolerance class 8g before zinc coating. Threads for nuts shall be in accordance with AS 1214.

3.2.3.3 *Mechanical properties*

For all structures, the bolts shall comply with the material and mechanical properties specified in AS 1110 for property class 8.8.

The galvanized nuts shall pass a proof load test carried out in accordance with AS 1112 for property class 8.

For fluming and flanged structures, the property class shall be class 4.6 for bolts (in accordance with AS 1110) and class 5 for nuts (in accordance with AS 1112).

3.2.3.4 *Coating*

Bolts and nuts shall be zinc-coated by hot-dip galvanizing in accordance with AS 1214.

The bolts shall be centrifuged to remove surplus zinc from the threads after galvanizing.

The nuts shall be galvanized as blanks, and tapped after galvanizing using the oversize allowance specified in AS 1214 so that they can be assembled on the galvanized bolts by hand.

3.2.4 Aluminium sheet

3.2.4.1 *General*

The aluminium sheet shall be clad aluminium alloy with substrate metal classification 3004—H34 or 3004—H32 in accordance with AS/NZS 1734 or ASTM B744.

3.2.4.2 *Cladding thickness*

The nominal cladding thickness on each side shall be 5% of the total composite thickness. When determined by metallurgical microscope, the average cladding thickness shall be not less than 4% of the total composite thickness.

NOTE: Thickness examination should average ten separate measurements on each side of not less than three polished material samples.

3.2.4.3 *Chemical composition*

The chemical composition of the substrate and cladding shall be as given for alloys 3004 and 7072 respectively in AS/NZS 1734 or ASTM B744.

3.2.4.4 Material properties

The material properties of the clad aluminium alloy 3004—H34 or 3004—H32 shall be as specified in Table 3.2.4(A).

TABLE 3.2.4(A)
MATERIAL PROPERTIES FOR ALUMINIUM SHEET

Standard	Metal grade	Minimum yield strength (0.2% offset) min. (f_y) MPa	Minimum tensile strength (MPa) (f_u)		Minimum elongation % over 50 mm
			Min.	Max.	
AS/NZS 1734	Alclad 3004—H34	165	215	255	4% where $t > 1.3$ mm $t \leq 3.0$ mm 5% where $t > 3.0$ mm $t \leq 6.0$ mm
ASTM B744	Alclad 3004—H32	137.9	186.2	234.4	5% where $t \leq 2.8$ mm 6% where $t > 2.8$ mm
	Alclad 3004—H34	165.5	213.7	255.1	4% where $t \leq 2.8$ mm 5% where $t > 2.8$ mm

NOTE: The thickness given in this Table includes both the substrate and the cladding and can be considered to act together as the structural base metal thickness for the purpose of design, as outlined in AS/NZS 2041.1.

3.2.4.5 Base metal thickness

For structural base metal wall thickness, refer to Table 3.2.4(B) below.

TABLE 3.2.4(B)
STRUCTURAL BASE METAL WALL THICKNESS—
AS/NZS 1734 AND ASTM B744 ALCLAD 3004—H32 G140
AND ALCLAD 3004—H34 G165 ALUMINIUM

Specified wall thickness mm	Minimum wall thickness mm	Structural base metal wall thickness (t) mm
0.91	0.86	0.91
1.22	1.14	1.20
1.52	1.45	1.52
1.91	1.83	1.91
2.67	2.57	2.67
3.43	3.30	3.43
4.17	4.01	4.17

3.2.5 Aluminium bolts and nuts

Aluminium bolts and nuts for Class 1 (B68) structures shall be alloy 6061—T6 with proof stress (0.2%) of 240 MPa, ultimate tensile strength of 260 MPa and elongation 8%. Other alloys with equal or higher proof stress are permissible substitutes.

NOTE: Stainless steel bolts (SS303) and nuts (SS313) or galvanized steel bolts and nuts may be substituted for aluminium bolts and nuts, as specified in this Clause.

3.3 FABRICATION

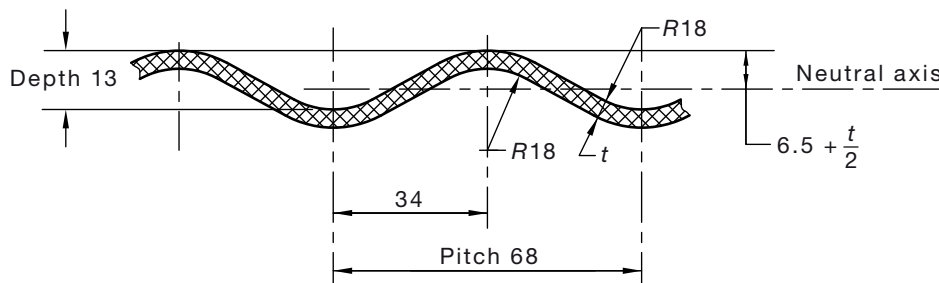
3.3.1 General

B68 structures shall be fabricated from material as specified in Clause 3.2.2 or 3.2.4 and shall be corrugated, hole-punched and curved in accordance with Clauses 3.3.2, 3.3.3 and 3.3.4. B68 structures are assembled on site with lapped seams or flanged seams.

3.3.2 Sinusoidal corrugations

Corrugations shall comply with the following (see Figure 3.3.2):

- The pitch of the sinusoidal corrugations (p) shall be 67.73 ± 5.29 mm.
- The depth of the sinusoidal corrugations (d_c) shall be 12.70 ± 0.51 mm.
- The radius of sinusoidal corrugations (R_c) shall be 17.46 ± 4.76 mm.
- The corrugations shall form smooth continuous curves and tangents.



DIMENSIONS IN MILLIMETRES

FIGURE 3.3.2 CORRUGATIONS FOR B68 STRUCTURES

3.3.3 Sheet tolerances

3.3.3.1 Sheet width

The actual net width of sheets measured along the corrugation shall differ from the specified net width by not more than ± 3 mm (as shown in Figure 3.3.3).

NOTE: Typically, the periphery of B68 structures is comprised of two semi-circular sheets.

3.3.3.2 Sheet length

The actual net length of sheets measured across the corrugations shall be $610 \text{ mm} \pm 3 \text{ mm}$, or $305 \pm 3 \text{ mm}$ for closure panels, where continuous longitudinal seams are specified (see Figure 3.3.3).

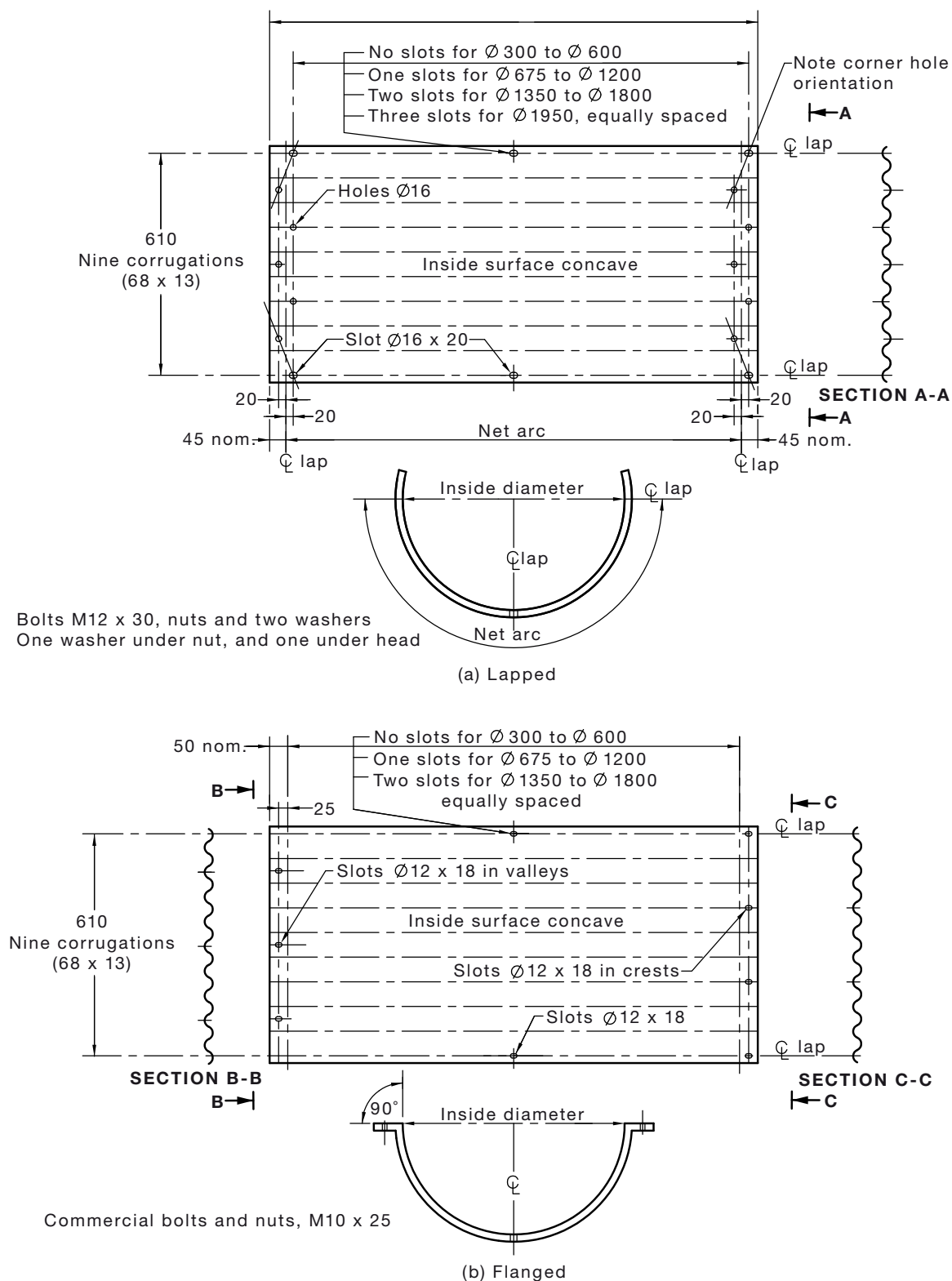
3.3.3.3 Sheet curvature

The tolerance on the measured rise, when compared to the calculated shop curvature, shall be ± 6 mm (see Figure 4.2.3). The length of the straight edge used shall not be less than 75% of the chord length.

3.3.3.4 Structure end finishing sheets

B68 structures shall have either a stepped end or a vertical end specified. Vertical end structures shall be supplied with special top closure panels for this purpose.

NOTE: For an illustration of a stepped end, see Figure A2, Appendix A.



DIMENSIONS IN MILLIMETRES

FIGURE 3.3.3 SHEET LAYOUT FOR B68 STRUCTURES

3.3.4 Bolt-holes and slots

3.3.4.1 General

Bolt-holes and slots shall be provided to allow interchangeability of sheets and field assembly with the prescribed fasteners to achieve the specified structure shape.

3.3.4.2 Longitudinal seams

Bolt-holes for lapped sheet longitudinal seams, as shown in Figure 3.3.4(A), shall be 16 mm in diameter prior to sheet curving, located at 102 mm centres on alternate crests and valleys of corrugations, and offset on opposite sides of the plate lap centre-line by 20 mm. Bolt-holes for flanged steel longitudinal seams, as shown in Figure 3.3.4(A), shall be 12 mm in diameter prior to steel fabrication, located at 204 mm centres and on the plate lap centre-line.

NOTE: Alternative seam bolting configurations are not precluded, provided the allowable seam strength used in design calculations is determined by full scale bolted seam compression testing.

3.3.4.3 Circumferential seams

Bolt-holes for lapped sheet circumferential seams as shown in Figure 3.3.4(A) shall be 16 mm × 20 mm slots, prior to sheet curving, located centrally on the corrugation crest nearest the sheet edges. Bolt-holes for flanged steel circumferential as shown in Figure 3.3.4(B) shall be 12 mm × 18 mm slots prior to sheet curving, located centrally on the corrugated crest nearest the sheet edges.

Circumferential seam bolt-holes shall be equally spaced along the sheet edge with centre-to-centre spacing of no more than 1000 mm.

3.3.4.4 Hole alignment

Prior to sheet curving, the diagonal dimensions measured between bolt slots at opposite sheet corners shall not differ by more than 5 mm.

3.3.4.5 Edge distance

Bolt-holes and slots shall be no closer to the sheet edge than 1.75 times their diameter.

3.3.4.6 Hole and slot defects

Holes and slots shall be free of cracks, and free of ragged edges and burrs in excess of 1.5 mm.

3.4 REPAIR OF DEFECTS AND COATINGS

3.4.1 General

The manufactured structure shall be free of the following defects:

- (a) Permanent deformation of the sheets that could impair assembly or the structural performance.
- (b) Burrs that are likely to cause injury to installers.

3.4.2 Assessment and repairs of damaged coatings

Where coatings have been damaged or are missing, they shall be repaired in accordance with AS/NZS 2041.2.

Cut ends shall be protected following cutting by application of appropriate coatings.