

Australian/New Zealand Standard™

Structural steel welding

Part 3: Welding of reinforcing steel



AS/NZS 1554.3:2014

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WD-003, Welding of Structures. It was approved on behalf of the Council of Standards Australia on 24 September 2014 and on behalf of the Council of Standards New Zealand on 12 September 2014.
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Australian/New Zealand Standard™

Structural steel welding

Part 3: Welding of reinforcing steel

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WD-003, Welding of Structures, to supersede AS/NZS 1554.3:2008.

This Standard incorporates Amendment No. 1 (November 2017). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide a code for the welding of reinforcing steel.

This edition takes cognizance of the ISO Standards for the welding of reinforcing steels, ISO 17660-1, *Welding—Welding of reinforcing steel, Part 1: Load-bearing welded joints* and ISO 17660-2, *Welding—Welding of reinforcing steel, Part 2: Non load-bearing welded joints* and, where deemed relevant by the Committee, appropriate requirements have been incorporated or adopted with modification. Changes associated with Australia and New Zealand adopting the ISO welding consumable Standards have also been included in this edition, as have changes to maintain consistency with other parts of the AS/NZS 1554 series of Standards.

The differences from the 2008 edition of AS/NZS 1554.3 are as follows:

- (a) Clarification of general requirements: Clauses 1.1, 1.4.13, 1.4.15.1, 1.6.2, 4.11, Table 4.11(A) and Figure 3.1.3.
- (b) Changes associated with alignment with AS/NZS 1554.1: Clauses 1.3, 1.7, 3.1.8, 4.1, 4.2, 4.3, 4.4, 4.6.2, 5.3, 6.2.2, 6.5, 6.7, 7.2, Tables 4.7.1(A), 4.7.1(B), 5.3, and Figure 3.3.2(A).
- (c) Changes to welding consumable classification Standards: Clauses 2.3.1, G4, and Tables 3.2, 4.6(A), 4.6(B).
- (d) Clarification of requirements for the welding of non-loadbearing welding joints: Clause 3.3, 5.6, Tables 3.3 (new), 4.7.1(B) and 4.12.2(A) and Figure 3.3.2(B).
- (e) Correction of errors and other amendments: Clauses 1.4.16, 1.9.3, 4.12.1, 4.12.2, 5.7.3, G4, Tables 4.1.2(B), 4.12.2(B), 5.3 (Title only) and Table F3.
- (f) New Appendix G.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard Structural steel welding

Part 3: Welding of reinforcing steel

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for the welding of reinforcing steel used in concrete structures that are designed and constructed in accordance with AS 3600 or NZS 3101.1, as well as other Standards that may be appropriate, by the following processes:

- (a) Manual metal-arc welding (MMAW).
- (b) Gas metal-arc welding (GMAW).
- (c) Flux-cored arc welding (FCAW).
- (d) Flash butt welding.
- (e) Flame-pressure welding.
- (f) Other processes approved by the principal.

Provision for the MMAW, GMAW and FCAW processes is contained within the body of the Standard. Additional and specific requirements applicable to flash butt welding and flame pressure welding are set out in Appendix B and Appendix C respectively.

The Standard applies specifically to the welding of reinforcing steels complying with AS/NZS 4671, but other steels may be used as provided for in Clause 2.1. It also applies to the welding of steel connection devices, inserts, anchors and anchor details, including prefabricated assemblies required in reinforced and precast concrete constructions.

NOTES:

- 1 Further information is given in WTIA Technical Note 11.
- 2 GMAW includes waveform controlled welding such as 'synergic', 'programmable', and 'microprocessor controlled' processes' e.g. pulsed spray transfer, controlled short circuit transfer.

1.2 INNOVATION

Any alternative materials, welding processes, consumables, methods of construction or testing that give equivalent results to those specified, but do not comply with the specific requirement of this Standard or are not mentioned in it, are not necessarily prohibited.

1.3 NORMATIVE REFERENCES

The documents referenced for normative purposes are listed in Appendix A.

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

1.4 DEFINITIONS

For the purpose of this Standard, the symbols and definitions given in AS 1101.3, AS 2812 and those below apply.

1.4.1 Approved

Except as may be otherwise stated, approved by the principal or the designer as appropriate.

1.4.2 Designer

The person, persons or organization responsible for the design of a structure.

1.4.3 Fabricator

The person, persons or organization responsible for executing work.

1.4.4 Inspecting authority

The authority having statutory powers to control the design and erection of buildings or structures.

NOTE: Where the structure is not subject to statutory jurisdiction, the principal is deemed to be the inspecting authority.

1.4.5 Inspector

A person employed by or acceptable to the inspecting authority or the principal for the purpose of inspecting welding in accordance with this Standard.

1.4.6 Loadbearing welded joints

See Clause 1.4.15.1.

1.4.7 May

Indicates the existence of an option.

1.4.8 Non-loadbearing welded joints

See Clause 1.4.15.2.

1.4.9 Principal

The purchaser or owner of a structure being fabricated or erected, or a nominated representative.

NOTE: Any nominated representative should be suitably qualified to deal with the technical issues of this Standard.

1.4.10 Reinforcing steel

Material complying with AS/NZS 4671 or material otherwise approved in accordance with Clause 2.1.

1.4.11 Shall

Indicates that a statement is mandatory.

1.4.12 Should

Indicates a recommendation.

1.4.13 Tack welds

See AS 2812 and Clause 5.6.

1.4.14 Types of splice**1.4.14.1 *Transverse end plate splice***

A joint between a bar and a baseplate, which is for anchoring purposes.

A1 |

1.4.14.2 *Direct butt splice*

A splice between two bars of reinforcing steel, with approximately collinear axes, with complete penetration and fusion of weld metal and base metal throughout the depth of the splice, the bars having been joined by a butt weld made from both sides, or from one side with permanent or temporary backing.

1.4.14.3 *Double-lap splice*

A joint consisting of two welds, deposited in the two grooves formed between two overlapping parallel bars in contact.

1.4.14.4 *Indirect butt splice*

A splice between two reinforcing steel bars, whose axes are approximately collinear, with the bars welded to either a single or double common splice member by either single or double-lap splices, the cross-section of the bars where they butt together remaining unwelded.

NOTE: The splice member may be a plate, an angle, a bar or other-shaped component.

1.4.14.5 *Single-lap splice*

A joint consisting of a single weld, deposited in a groove formed between two overlapping parallel bars in contact.

1.4.15 **Welded joints**

1.4.15.1 *Loadbearing welded joints*

A1 | Welded joint used for transmission of specified loads between reinforcing steel bars or between reinforcing steel bars and other steel product.

NOTE: The strength of loadbearing welded joints is taken into account during the design of the structure.

A1 | 1.4.15.2 *Non-loadbearing welded joints*

Welded joints for which the strength is not taken into account during the design of the reinforced concrete structure.

A1 | NOTE: Normally, the purpose of non-loadbearing welded joints is to keep reinforcing components in their correct position during handling, transport and lifting.

1.4.16 **Welding operator**

A person qualified (see Clause 4.12.2.3) to use the applicable welding procedure using fully mechanized or automatic welding.

1.5 **WELD CATEGORY**

Weld quality requirements of this Standard have equivalent requirements to weld Category SP (structural purpose) as specified in AS/NZS 1554.1.

1.6 **WELDING OF REINFORCING STEEL**

1.6.1 **Approval**

Reinforcing steel shall not be welded, unless it is shown on the drawings, or in other appropriate documents, or is otherwise approved [see Appendix E, Item (b)].

1.6.2 **Limitations**

The following limitations on welding, bending and rebending apply:

- (a) Welds that are not shown on drawings, but required to maintain reinforcing steel in its correct position, shall comply with the requirements of Clause 3.3.

- (b) Bending shall only be permitted on portions of the bar containing direct butt splice welds. The limits on bending diameters and angles shall be as specified in Clause 4.7.4.
- (c) Rebending shall not be permitted on any welded part of a bar.

NOTE: Bends should be made prior to welding and the distance from the weld to the start of the bend should be not less than twice the size of the bar being bent (that is, $2d_b$, where d_b is as shown in Figure 3.1.3). Where the design requires a loadbearing weld within a previously bent portion of a bar, a special test piece (see Clause 4.2(c)) replicating the proposed weld conditions should be subjected to suitable qualification tests as agreed between the principal and the fabricator.

1.6.3 Welding different grades

Different grades and types of reinforcing steel may be welded together, provided the appropriate requirements herein are complied with for each grade.

1.7 MANAGEMENT OF QUALITY

1.7.1 Quality management

Fabricators shall ensure that all welding and related activities prescribed within Clause 1.7.2 and this Standard are managed under a suitable quality management system.

Such a system should generally comply with the requirements of AS/NZS ISO 3834 and its parts, particularly where fabrication activities require the approval of the principal or inspecting authority, or where the fabrication of large, complex or critical structures is being undertaken.

1.7.2 Basic welding requirements

The basis of this Standard is that a weld shall—

- (a) be made in accordance with a qualified welding procedure;
- (b) be carried out by a welder suitably qualified to carry out such a procedure;
- (c) be carried out under the supervision of a welding supervisor who is employed by or contracted to the fabricator; and
- (d) comply with the appropriate requirements of this Standard.

For certain conditions prescribed herein, the welding procedure is deemed to be prequalified and may not require full qualification testing (see Clauses 4.3 and 4.7).

1.8 JOINING REINFORCING STEEL TO STRUCTURES

Where reinforcing steel is to be joined to steel plate, rolled sections or hollow sections, any butt or fillet welds outside the prequalified range listed in Tables F1, F2 and F3 of Appendix F, shall comply with AS/NZS 1554.1. See Appendix E, Item (d).

Interconnection of precast concrete members by way of reinforcing steel projecting from concrete shall not be made by fusion welds, unless the welds comply with this Standard.

1.9 SAFETY PRECAUTIONS

1.9.1 Welding safety

Welding shall be carried out in accordance with one or more of the following Standards: AS 1470, AS 1674.1, AS 1674.2, AS 2865, AS/NZS 1336, AS/NZS 1337 and AS/NZS 1338.1.

1.9.2 Welding equipment

Welding plant and equipment shall comply with all relevant sections of appropriate regulations and one or more of the following Standards: AS 2799, AS/NZS 1995 and AS 60974 1.

1.9.3 Other hazards

The fabricator shall identify and manage any other risks and hazards from welding that are not covered by Clauses 1.9.1 and 1.9.2. In particular, due consideration shall be given to the control of emitted fumes, especially when welding through surface coatings.

NOTES:

- 1 Guidance on the management of risk is given in AS/NZS ISO 31000.
- 2 Further guidance on safety precautions is given in WTIA Technical Notes 7 and 22.

SECTION 2 MATERIALS OF CONSTRUCTION

2.1 PARENT MATERIAL

Parent material shall include reinforcing steel complying with AS/NZS 4671 and steel plates, rolled sections and hollow sections that are listed in AS/NZS 1554.1.

Other steels may be used, provided the welding procedures followed have been established and approved in accordance with Appendix E, for the materials involved, and the mechanical properties and freedom from strain ageing of the unwelded reinforcing bar meet the requirements of AS/NZS 4671.

NOTES:

- 1 In addition to new works, this Standard also applies to repairs and alterations to existing buildings. Care should be taken to identify the steel in existing structures to be welded, taking special care to ensure the welding procedures selected are appropriate to the parent material to be welded.
- 2 For New Zealand, NZS 3101.1 does not permit the welding of reinforcing steel manufactured using the quenched and self-tempered process.

Reinforcing steel manufactured from stainless steel may also be used, provided welding consumables are matched with the parent material, and consideration is given to weld procedure qualification requirements, welder qualifications, quality of welds, levels of imperfection, and finishing requirements in accordance with AS/NZS 1554.6. These requirements shall be agreed with the principal prior to the commencement of welding [see Appendix E, Item (e)].

NOTE: Further guidance is given in Welding Technology Institute of Australia (WTIA) Technical Note 16.

2.2 BACKING MATERIAL

Steel backing material to be fused in the welding process shall have weldability properties of not less than that of the parent material (see Clause 2.1).

2.3 WELDING CONSUMABLES

2.3.1 Electrodes

Electrodes for the welding of parent material (see Clause 2.1) shall comply with—

- (a) for manual metal arc welding, AS/NZS 4855 or AS/NZS 4857; and
- (b) for processes other than manual metal arc welding, AS/NZS 14341, AS/NZS 16834, AS/NZS ISO 17632 or AS/NZS ISO 18276.

Other electrodes may be used, provided they are qualified in accordance with the requirements of Clause 4.6.2, and approved for use [see Appendix E, Item (f)].

2.3.2 Storage of welding consumables

Electrodes shall be stored in their original packets or cartons in a dry place, adequately protected from the effects of weather. Where special protection during storage and use is recommended by the manufacturer, electrodes shall be stored in accordance with the recommended conditions. Filler metals shall be dry, smooth and free from corrosion and any matter deleterious to satisfactory operation or to the weld metal. Any coating on electrodes or filler metals shall be continuous and firmly adherent. Where the manufacturer makes specific recommendations covering conditioning and pre-treatment of electrodes, prior to their use, such recommendations shall be followed.

NOTE: WTIA Technical Note 3 contains recommendations for the storage and conditioning of electrodes.

2.3.3 Shielding gas

A gas or gas mixture used for shielding during arc welding shall be of a welding grade complying with the requirements of AS 4882, and shall be suitable for the intended application.

SECTION 3 DETAILS OF FUSION - WELDED CONNECTIONS

3.1 GENERAL

3.1.1 Permissible weld types

Fusion-welded connections may be made by butt splices, indirect butt splices, lap splices, transverse end plate splices or tack welds.

3.1.2 Non symmetric connections

Non-symmetric connections, such as indirect butt splices and welds, other than Joint BI-1d in Table F2, Appendix F, and lap splice welds shall not be used for seismic-resistant design applications, unless specifically assessed for seismic performance by the designer.

3.1.3 Size of welds

The size of welds (S) shall be as shown in Figure 3.1.3 or as set out in Appendix F and shall comply with the following requirements:

- (a) For direct butt splices, the size of the smaller bar.
- (b) For indirect butt splices and lap splices, not less than 0.25 times the size of the smaller bar.
- (c) For transverse end plate splices, consisting of—
 - (i) an indirect lap splice, not less than 0.25 times the size of the smaller bar; and
 - (ii) a T-joint, as indicated in Table F3, Appendix F.

3.1.4 Design throat thickness

The design throat thickness of welds shall be the size of the weld as set out in Clause 3.1.3.

3.1.5 Effective length

The effective length of indirect butt splices and lap splices shall be the length of the weld that is of the specified size throughout, as shown in Figure 3.1.3.

3.1.6 Effective area

The effective area of direct butt splices shall be the area of the smaller bar.

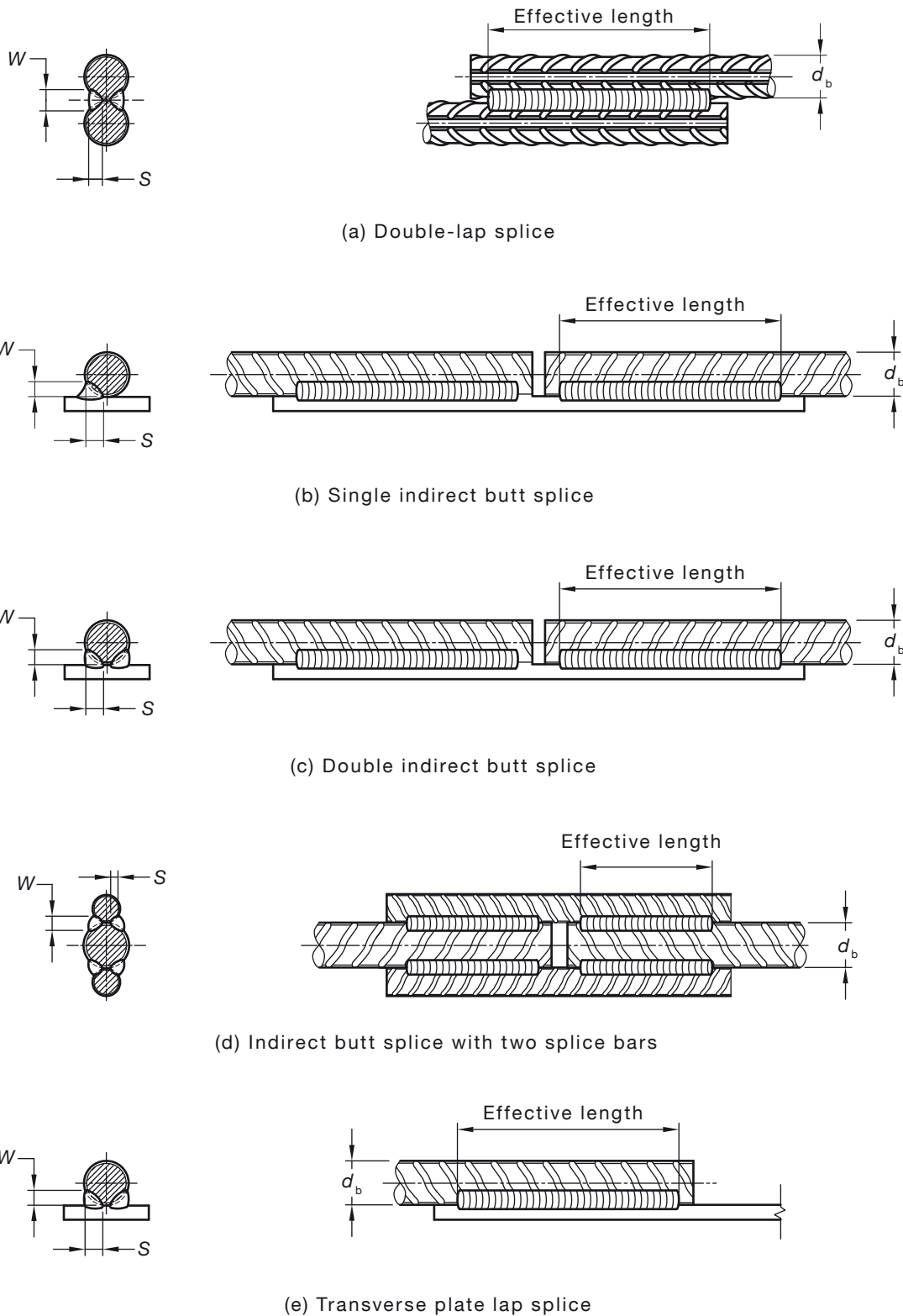
The effective area of indirect butt splices and lap splices shall be the sum of the products of the effective length and the applicable design throat thickness.

3.1.7 Finished width

The width (W), as shown in Figure 3.1.3, of a finished weld for indirect butt splices and lap splices shall be not less than 0.45 times the size of the smaller bar.

3.1.8 Welding consumable strength

Drawings or other documents that give details of welded connections shall specify the nominal tensile strength of the weld metal [see Appendix E, Item (h)] and comply with Clause 4.6.



LEGEND:

S = Size of weld
 W = Width of weld

NOTES:

- 1 The effective lengths are marked for only one of the welds in each of the above drawings, for clarity.
- 2 The effective length of each of the welds is required to be not less than that specified in Table 3.2.
- 3 The size of weld (S) in Figures 3.1.3(a) to (e) is the lesser of the effective throat thickness [see Figure 3.1.3(a) or effective leg length [see Figure 3.1.3(b)] of the weld.

FIGURE 3.1.3 DIMENSIONS OF WELDS

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3.2 LOADBEARING WELDED JOINTS

3.2.1 Butt splices

3.2.1.1 *Direct butt splices*

Direct butt splices shall comply with Table F1, Appendix F. Double-V and double bevel butt splices may have preparations that are unequal in depth.

3.2.1.2 *Indirect butt splices*

Indirect butt splices shall comply with Table F2, Appendix F and the following:

- (a) Any welding of reinforcement to splice bars, plates or angles shall be by means of fillet welds.
- (b) Any welding of reinforcement to splice sleeves shall be by means of end-fillet welds.
- (c) As applicable, splice-bar, plate, angle, sleeve and attaching welds shall have sections of sufficient strength to meet the requirements of AS 3600 or NZS 3101.1.
- (d) The welding consumables and minimum effective lengths of welds shall comply with the requirements of Table 3.2, unless shown otherwise on drawings or in specifications.

3.2.2 Lap splices

Lap splices shall comply with Table F4, Appendix F. The minimum effective length of each weld shall comply with the requirements of Table 3.2.

Where access is not available to weld the second side of bars in a lap splice connection, a single-sided lap splice may be used in lieu of a double-lap splice, provided the minimum effective weld length is increased, to comply with Table 3.2.

3.2.3 Transverse end plate splices

Transverse end plate splices shall comply with Table F3, Appendix F. End plates and attaching welds shall have sections of sufficient strength to meet the requirements of AS 3600 or NZS 3101.1. The size and strength of welds shall comply with the design drawings.

The base material and size shall be approved by the designer. See Appendix E, Item (i).

TABLE 3.2
MINIMUM EFFECTIVE LENGTH OF WELD
FOR LOADBEARING WELDED JOINTS

A1

AS/NZS 4671 reinforcing steel grade	Welding consumable (see Note 1)			Minimum effective length of weld (see Note 2)		
	MMAW AS/NZS 4855, AS/NZS 4857	GMAW AS/NZS 14341 AS/NZS 16834	FCAW AS/NZS ISO 17632, AS/NZS ISO 18276	Type of splice (see Note 3)		
				S1	S2 and S3	S4
250N, 300E	B-E43, B-E49	B-G43, B-G49	B-T43, B-T49	3 d_b	5 d_b	8 d_b
500L, 500N, 500E	B-E43	B-G43	B-T43	3 d_b	5 d_b	10 d_b
—	B-E49	B-G49	B-T49	3 d_b	5 d_b	9 d_b
—	B-E55, B-E57, B-E59	B-G55, B-G57, B-G59	B-T55, B-T57, B-T59	3 d_b	5 d_b	8 d_b
—	B-E62	B-G62	B-T62	3 d_b	5 d_b	7 d_b

NOTES:

- 1 Consumables classified by yield strength with similar tensile strength may also be used in lieu of those classified by tensile strength without additional qualification.
- 2 Minimum effective weld lengths are described in terms of multiples of the size d_b of the smaller bar being joined.
- 3 Legend for types of splice:
 S1 = indirect butt splice with two splice bars (joint BI-1d)
 S2 = other indirect butt splices (joints BI-1a, BI-1b and BI-1e)
 S3 = double-lap splice (joints L-a, L-b and L-c)
 S4 = single-lap splice (joints L-d, L-e and L-f)

3.3 NON-LOADBEARING WELDED JOINTS [see Appendix E, Item (j)]

3.3.1 General

Welds used for the preassembly of reinforcing elements, the temporary positioning of reinforcing steel or the location of steel during transport and placement shall comply with the following:

- (a) Be of sufficient size and strength to retain the reinforcing components in their correct position and be capable of withstanding handling, transport and lifting stresses.
- (b) The number of welds used to locate the reinforcing steel whilst welding or during erection and placement of concrete shall be kept to a practical minimum.
- (c) The welds shall have their minimum size and location shown on drawings or be specified in other suitable documents, and not have any quantifiable structural performance in the structure.
- (d) The welding operation shall be conducted so as to comply with the requirements of this Standard.
- (e) The welding procedure shall not cause embrittlement of the parent material.
- (f) The nominal carbon equivalent of the designated grade of any wires, rods and bars that the reinforcing steel is to be welded to shall not exceed that of the designated grade of the reinforcing steel to which they are to be joined.
- (g) Safe lifting points for fabricated cages and other assemblies shall be clearly marked on the drawings and on the fabricated cages.

- (h) Welds used to locate reinforcing steel shall comply with the requirements of Clauses 3.3.2 and 3.3.3, as appropriate. All welding parameters used to produce these welds shall be recorded (see Clause 4.1).

A summary of recommended diameters for non-loadbearing welded joints is given in Table 3.3.

3.3.2 Cross-joints

Welds used for the preassembly of reinforcing elements, the temporary positioning of reinforcing steel or the location of steel during transport and placement [see Figures 3.3.2(A) and 3.3.2(B)] shall comply with all of the following:

- (a) The welds shall have a width of more than 0.45 times the size of the smaller bar but not less than 6 mm, and, a minimum effective length of not less than half the size of the smaller bar or 12 mm which-ever is the lesser. Qualification testing shall comply with Clause 4.7.
- (b) Have the shear strength of three test specimens assessed in accordance with Clause 4.7.5.

Details of welds made using non-mechanized processes suitable for assembling and erecting reinforcing steel and not being incorporated into another weld are shown in Figure 3.3.2(A).

3.3.3 Lap joints

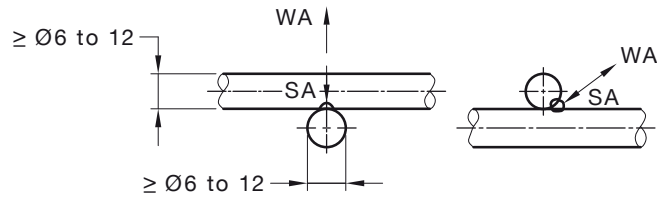
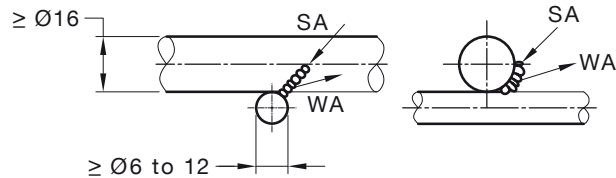
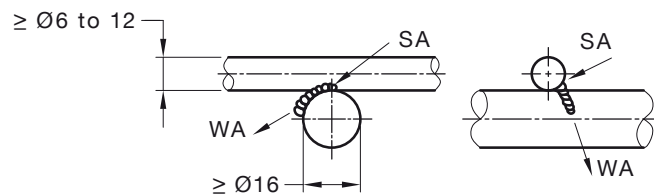
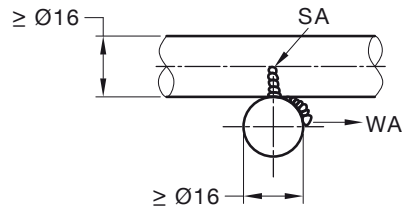
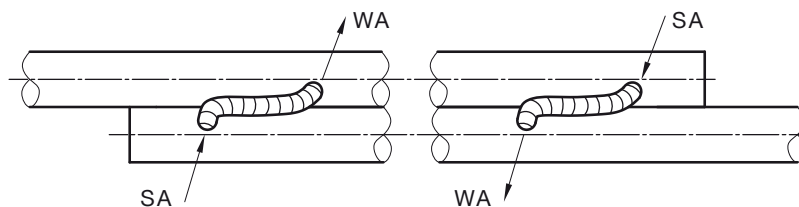
Welds that combine or locate reinforcing members or components not subject to design stresses that lie in the same plane e.g. ligatures whose ends overlap and meet the requirements of AS 3600, or bars parallel to each other and lapped in accordance with AS 3600, shall:

- (a) Have a width (W) and size (S) complying with Clause 3.1 and Table F4.
- (b) The minimum length of splice shall be at least twice the size of the smaller bar being joined and may be made up of a number of welds. Each weld shall have a minimum effective length of not less than the size of the smaller bar.
- (c) Have one test specimen assessed by macro examination in accordance with Clause 4.7.

TABLE 3.3
RECOMMENDED RANGE OF BAR DIAMETER FOR
NON-LOADBEARING WELDING JOINTS

millimetres	
Type welded joint	Range of bar diameter for non-loadbearing welded joints
Cross-joint	6–50
Lap-joint	6–40

NOTE: For cross-joints $d_{\min}/d_{\max}$ should be ≥ 0.4 .

(a) Joining crossed same sized ≥ 6 mm to 12 mm bars(b) Joining crossed ≥ 16 mm bars to lower < 16 mm bars(c) Joining crossed < 16 mm bars to lower ≥ 16 mm bars(d) Joining crossed ≥ 16 mm bars

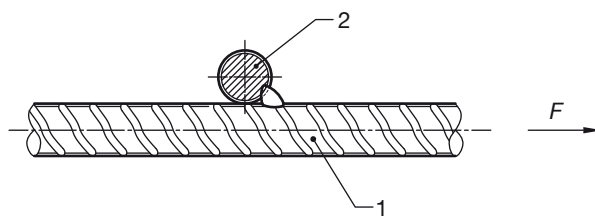
NOTE: Arcs struck on free end of bars.

(e) Joining lapped bars

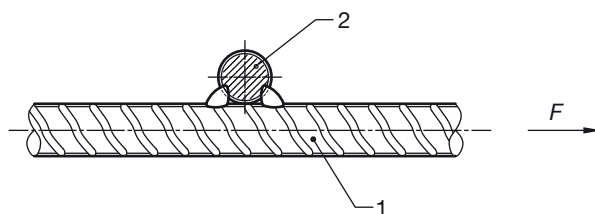
LEGEND:
 SA = Direction for striking arc
 WA = Direction for withdrawing arc

NOTE: Reinforcing ribs not shown for clarity.

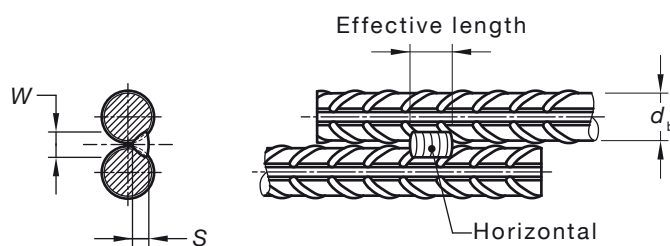
FIGURE 3.3.2(A) DETAILS OF WELDS SUITABLE FOR LOCATIONAL PURPOSES



(a) Single-sided weld



(b) Double-sided weld



(c) Lapped joint for locational purposes

LEGEND:

1 = Longitudinal bar

2 = Transverse bar

 F = Force to be anchored by transverse bar when subject to shear testing in accordance with ISO 15630-2

FIGURE 3.3.2(B) CROSS-JOINTS SUITABLE FOR LOCATING REINFORCEMENT

SECTION 4 QUALIFICATION OF PROCEDURES AND PERSONNEL FOR FUSION WELDING

4.1 QUALIFICATION OF WELDING PROCEDURE

The welding procedure (i.e., the joint preparation, the welding consumables and the welding parameters) shall be qualified before welding commences. See Appendix E, Item (k).

The fabricator shall establish a welding procedure and list the applicable parameters in a document known as the 'welding procedure qualification record' (also known as a PQR or WPQR). Such a welding procedure shall be held by the fabricator as a record and be available for examination.

A welding procedure specification (WPS) shall be developed from the PQR, based on the limits of the essential variables of Clause 4.11, and be made available to the welder during fabrication.

NOTE: A typical welding procedure sheet suitable for use as a PQR and a WPS is shown in Appendix D.

4.2 METHODS FOR QUALIFICATION OF WELDING PROCEDURE

Each welding procedure shall be qualified [see Appendix E, Item (k)] by one of the following methods:

- (a) A procedure prequalified in accordance with Clause 4.3.
- (b) Production of documentary evidence of relevant prior experience by the fabricator. A completed welding procedure sheet such as that shown in Appendix C, together with records of tests carried out constitutes documentary evidence of prior experience. All WPS's shall meet the requirements of essential variables of this Standard. The following are deemed to comply with this requirement:
 - (i) Procedure qualifications establish in accordance with this and previous editions of this standard.
 - (ii) Qualifications and evidence of successful usage of procedures qualified in accordance with other application Standards (e.g. AS/NZS 3992) provided that the parent materials comply with Clause 2.1, were welded with consumables complying with Clause 2.3, and the level of imperfections complies with Clause 6.2 of this Standard.

NOTE: Due to changes in the welding consumables classifications systems used in Australia and New Zealand, reference should be made to Appendix G for guidance on the extension of weld procedure qualification. Weld procedures qualified, using consumables classified under the former systems, remain valid and may continue to be used without further qualification where consumable equivalence can be established.

- (c) Preparation of test splices that simulate as closely as practicable the weld preparation, grade, type and size of the reinforcement and the welding conditions to be used in production. The test splices shall be tested in accordance with the requirements of Clause 4.7.
- (d) A welding procedure qualified by another fabricator, see Clause 4.4.

4.3 PREQUALIFIED WELDING PROCEDURES

4.3.1 Complying conditions

Welding procedures shall not be deemed to be prequalified, unless all of the following apply:

- (a) The joint preparations are prequalified in accordance with Clause 4.4.
- (b) The consumables are prequalified in accordance with Clause 4.6.
- (c) The workmanship and welding techniques, including the preheat and inter-run temperature requirements, comply with the requirements of this Standard.
- (d) Where Clause 4.7 and Table 4.7.1(A) and/or 4.7.1(B) require the weld to be tested, documentary evidence is available of a satisfactory macro test or shear tests as appropriate in accordance with Clause 4.7.

4.3.2 Non-complying conditions

Welding procedures utilizing self-shielded flux-cored consumables in combination with other consumable types shall be deemed non-compliant with Clause 4.6 and require qualification (see Clause 4.7).

4.4 PORTABILITY OF QUALIFIED WELDING PROCEDURES

A welding procedure qualified by one fabricator shall be valid for use by a second fabricator, provided—

- (a) the original qualification tests were carried out in accordance with this Standard or other acceptable national or international Standards, and were fully documented;
- (b) the second fabricator has adequate equipment and facilities and demonstrates successful welding of welder qualification tests or a macro test using the procedure;
- (c) the application of the welding procedure is acceptable to both fabricators and the principal; and
- (d) the welding procedure identifies the original and second fabricator.

4.5 PREQUALIFIED JOINT PREPARATIONS

4.5.1 General

The joint preparations prescribed in Clauses 4.5.2, 4.5.3 and 4.5.4 shall be deemed to be prequalified, provided the welding processes and consumables used comply with the recommendations of the consumable manufacturer.

4.5.2 Prequalified butt splices

For butt splices, joint preparations conforming to the dimensions given for the processes indicated in Tables F1 and F2, Appendix F, shall be deemed to be prequalified.

Direct butt splices that are to be welded from both sides, using these prequalified preparations, shall have the back of the first run gouged out by suitable means to sound metal before welding is started on the second side, unless evidence is produced by macro etching that complete fusion can be obtained without such gouging.

4.5.3 Prequalified transverse end plate splices

Joint preparations complying with Table F3, Appendix F, shall be deemed to be prequalified for all processes indicated in the Table.

4.5.4 Prequalified lap splices

For lap splices, joint preparations complying with Table F4, Appendix F, shall be deemed to be prequalified for all processes indicated in the Table.

Lap splices welded on one side only, in accordance with Clause 3.2.2 using joint preparations complying with Table F4, Appendix F, are also deemed to comply with this Clause (4.5.4).

NOTE: It is permissible to split the welds of lap connections into two welds of approximately equal length on single-lap welds and on each side of double-lap welds. A gap between each weld run of at least two times the size of the smaller bar being joined, but no greater than the length of weld, may be left, provided the sum of each effective weld length for a given side complies with the requirements of Table 3.2. This will assist in minimizing the tendency for lap connections to rotate under load.

4.6 QUALIFICATION OF WELDING CONSUMABLES

4.6.1 Prequalified welding consumables

Welding consumables shall be deemed to be prequalified and shall not require qualification testing provided they comply with the following requirements:

- (a) They are matched with the steel type in accordance with the requirements of Tables 4.6(A) and 4.6(B).
- (b) They comply with the other relevant requirements of this Standard.
- (c) They are used within the parameters and the positions recommended by the manufacturer.

4.6.2 Qualification of welding consumables by testing

Where welding consumables are not prequalified in accordance with Clause 4.6.1, they may be qualified in conjunction with a welding procedure qualification test in accordance with Clause 4.7.

TABLE 4.6(A)

**PREQUALIFIED WELDING CONSUMABLES—DIRECT BUTT SPLICE WELDS
AND TRANSVERSE END PLATE SPLICE WELDS**

AS/NZS 4671 reinforcing steel grade	Manual metal arc (AS/NZS 4855, AS/NZS 4857)	Gas metal arc AS/NZS 14341 AS/NZS 16834)	Flux-cored arc (AS/NZS ISO 17632, AS/NZS ISO 18276)
250N, 300E	B-E43XX, B-E49XX	B-G43, B-G49	B-T43, B-T49
500L, 500N (see Note 2)	B-E6215, B-E6216 B-E6218	A-G55, B-G62	A-T55, B-T62

NOTES:

- 1 Where X is shown, any number appropriate to the classification Standard is acceptable.
- 2 For transverse end plate splice welds only, welding consumables deemed prequalified for grade 500N are deemed prequalified for grade 500E.
- 3 Consumables classified by yield strength with similar tensile strength may also be used in lieu of those classified by tensile strength without additional qualification.