

Australian/New Zealand Standard™

## Structural steel welding

### Part 2: Stud welding (steel studs to steel)



## **AS/NZS 1554.2:2003**

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 3 June 2003 and on behalf of the Council of Standards New Zealand on 4 June 2003. It was published on 5 August 2003.

---

The following are represented on Committee WD-003:

Australian Chamber of Commerce and Industry  
Australian Industry Group  
AUSTROADS  
Bureau of Steel Manufacturers of Australia  
Electricity Supply Association of Australia  
Institution of Engineers Australia  
New Zealand Heavy Engineering Research Association  
New Zealand Non-destructive Testing Association  
New Zealand Welding School  
Steel Reinforcement Institute of Australia  
University of Sydney  
Welding Technology Institute of Australia

---

### **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 Standards may also be withdrawn.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 Australia web site at [www.standards.com.au](http://www.standards.com.au) or Standards New Zealand web site at [www.standards.co.nz](http://www.standards.co.nz) and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. 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 International or Standards New Zealand at the address shown on the back cover.

---

*This Standard was issued in draft form for comment as DR 02616.*

# Australian/New Zealand Standard™

## Structural steel welding

### Part 2: Stud welding (steel studs to steel)

Originated as AS CA 8.2—1972.  
Previous edition AS 1554.2—1993.  
Jointly revised and designated AS/NZS 1554.2:2003.  
Reissued incorporating Amendment No. 1 (December 2003).

#### COPYRIGHT

© Standards Australia/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.

Jointly published by Standards Australia International Ltd, GPO Box 5420, Sydney, NSW 2001, and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 5382 5

## PREFACE

This Standard was prepared by the Standards Australia Committee WD-003, *Welding of Structures*, to supersede AS 1554.2—1993.

*This Standard incorporates Amendment No. 1 (December 2003). 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 requirements for the stud welding of steel studs to steel elements.

This edition includes requirements for the welding of coated steels, including—

- (a) reference to AS 3597, AS/NZS 4360 and IEC 60974-1 (see Appendix B); and
- (b) amending Item 3.1(b) and the second paragraph of Clause 5.5.

Following publication of this edition, the Committee also intends to commence a full revision of the Standard.

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

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

## CONTENTS

|                                                                                          | <i>Page</i> |
|------------------------------------------------------------------------------------------|-------------|
| <b>SECTION 1 SCOPE AND GENERAL</b>                                                       |             |
| 1.1 SCOPE.....                                                                           | 4           |
| 1.2 INNOVATION .....                                                                     | 4           |
| 1.3 REFERENCED DOCUMENTS.....                                                            | 4           |
| 1.4 DEFINITIONS.....                                                                     | 4           |
| 1.5 BASIC WELDING REQUIREMENTS .....                                                     | 5           |
| 1.6 SAFETY PRECAUTIONS .....                                                             | 6           |
| <b>SECTION 2 MATERIALS OF CONSTRUCTION</b>                                               |             |
| 2.1 GENERAL REQUIREMENTS FOR STUDS.....                                                  | 7           |
| 2.2 STUD MATERIAL.....                                                                   | 8           |
| 2.3 PARENT MATERIAL.....                                                                 | 10          |
| <b>SECTION 3 STUD APPLICATION QUALIFICATION</b>                                          |             |
| 3.1 GENERAL.....                                                                         | 11          |
| 3.2 PREPARATION OF TEST SPECIMENS .....                                                  | 11          |
| 3.3 TESTING.....                                                                         | 11          |
| 3.4 TEST DATA.....                                                                       | 13          |
| <b>SECTION 4 PROCEDURAL CONTROL</b>                                                      |             |
| 4.1 PREPRODUCTION TESTING .....                                                          | 14          |
| 4.2 PRODUCTION WELDING.....                                                              | 15          |
| 4.3 STUD-WELDING OPERATORS QUALIFICATION .....                                           | 15          |
| <b>SECTION 5 PRODUCTION TECHNIQUE AND WORKMANSHIP</b>                                    |             |
| 5.1 PREPARATION BEFORE WELDING .....                                                     | 16          |
| 5.2 WELDING.....                                                                         | 16          |
| 5.3 STUD SPACING .....                                                                   | 18          |
| 5.4 FINISHED WELDS.....                                                                  | 18          |
| 5.5 STUD WELDING THROUGH SHEET METAL .....                                               | 18          |
| 5.6 WORKMANSHIP .....                                                                    | 18          |
| <b>SECTION 6 TESTING OF FINISHED WELDS</b>                                               |             |
| 6.1 NON-THREADED STUDS SHEAR CONNECTORS AND HEADED<br>CONCRETE ANCHORS.....              | 20          |
| 6.2 THREADED STUDS.....                                                                  | 20          |
| 6.3 USE OF TESTED STUDS.....                                                             | 21          |
| 6.4 ADDITIONAL TESTING FOR STUDS WELDED TO BEAMS WITH<br>ADVERSE SURFACE CONDITIONS..... | 21          |
| 6.5 UNSATISFACTORY WELDS .....                                                           | 21          |
| <b>APPENDICES</b>                                                                        |             |
| A MATTERS FOR RESOLUTION.....                                                            | 22          |
| B LIST OF REFERENCED DOCUMENTS.....                                                      | 23          |
| C MANUFACTURER'S STUD BASE QUALIFICATION REQUIREMENTS .....                              | 25          |

## STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

**Australian/New Zealand Standard****Structural steel welding****Part 2: Stud welding (steel studs  
to steel)**

## SECTION 1 SCOPE AND GENERAL

**1.1 SCOPE**

This Standard prescribes requirements for the stud welding of steel studs to steel elements, such steel studs being used for the attachment of members and connection devices to concrete (as concrete anchors and as shear connectors in composite steel/concrete construction), and for the fastening of other members and appurtenances. It also applies to the stud welding of steel studs through light-gauge steel sheet either coated or not coated, and includes requirements for the stud material, the parent material, the qualification of stud bases, stud welding procedure and operators, and the workmanship and testing of the finished welds.

This Standard does not apply to the welding of studs to pressure vessels.

A list of matters for resolution between the principal and fabricator is given in Appendix A.

**1.2 INNOVATION**

Any novel materials, welding processes or consumables, or methods of construction that do not comply with a specific requirement of this Standard, or are not mentioned in it, but which give equivalent results to those specified, are not necessarily prohibited. The Standards Australia Committee on Welding of Structures can act in an advisory capacity concerning equivalent suitability, but specific approval remains the prerogative of the inspecting authority.

**1.3 REFERENCED DOCUMENTS**

A list of documents referred to in this Standard is given in Appendix B.

**1.4 DEFINITIONS**

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

**1.4.1 Fabricator**

The person or organization responsible for the welding of the structure during fabrication or erection.

**1.4.2 Inspecting authority**

The building 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.

### **1.4.3 Inspector**

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

### **1.4.43 May**

Indicates the existence of an option.

### **1.4.5 Principal**

The purchaser or owner of the structure being fabricated or erected or his/her nominated representative.

### **1.4.6 Ring test**

Tapping a stud with 3 kg (approximately) hammer in the direction of the beam—if the stud gives a ‘ring’ sound, it passes the test; if it gives a ‘dead’ sound it fails the test.

### **1.4.7 Shall**

Indicates a requirement.

### **1.4.8 Shear connector**

A stud to transmit shear between a steel member and a concrete element in a composite construction.

### **1.4.9 Should**

Indicates a recommendation.

### **1.4.10 Stud**

A short length of rod or bar, which may take a variety of shapes to suit the individual application.

### **1.4.11 Stud base**

The stud tip at the welding end, including flux and ferrule and 3 mm of the body of the stud adjacent to the tip.

### **1.4.12 Stud welding operator**

The person who performs the stud welding operation.

### **1.4.13 Wet weather capable**

A stud-welding machine designed to safely weld in damp or wet conditions (Category C environment, see AS 1674.2), incorporating a cycle that preheats the site to which a stud will be welded for sufficient time to dry the affected area prior to the welding of the stud.

## **1.5 BASIC WELDING REQUIREMENTS**

The basis of this Standard is that stud welds shall—

- (a) only use studs or shear connectors with qualified stud bases;
- (b) be made in accordance with a qualified stud-welding procedure;
- (c) be made by a welder suitably qualified to carry out such a procedure; and
- (d) comply with all the appropriate requirements of this Standard.

## **1.6 SAFETY PRECAUTIONS**

### **1.6.1 Welding safety**

Welding shall be carried out in accordance with the following Standards:

AS 1470, AS 1674.1, AS 1674.2, AS/NZS 1336, AS/NZS 1337, AS/NZS 1338.1, AS/NZS 2865.

### **1.6.2 Welding equipment**

Welding plant and equipment shall comply with all relevant sections of appropriate regulations, and the following Standards:

AS 1966.1, AS 1996.2, AS 2799, AS/NZS 1995, IEC 60974-1.

### **1.6.3 Other hazards**

The fabricator shall identify and manage other risks and hazards of welding not controlled by Clauses 1.6.1 and 1.6.2. In particular, due consideration shall be given to the control and dispersal of emitted fume, especially when welding through paints, primers and other surface coatings.

#### **NOTES:**

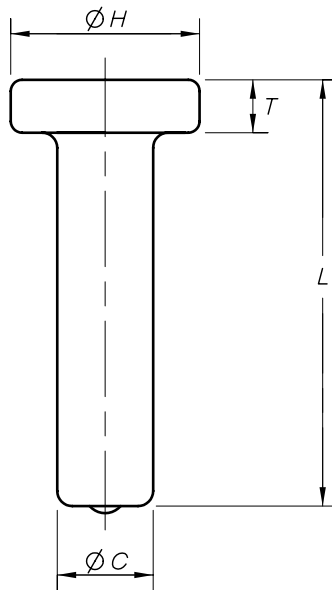
- 1 Guidance on the management of risk is given in AS/NZS 4360.
- 2 For further guidance on safety precautions, refer to WTIA Technical Notes 7 and 22.

## SECTION 2 MATERIALS OF CONSTRUCTION

### 2.1 GENERAL REQUIREMENTS FOR STUDS

#### 2.1.1 Stud design

Studs shall be of a design suitable for arc welding to steel members with automatically timed stud welding equipment. The type, size or diameter, and length of stud shall be as specified by the drawings, specifications, or special provisions, as approved by the principal. The dimensions and tolerances of standard-type headed shear connectors are given in Figure 2.1.



| Shank diameter<br>(C) | Length (L)<br>tolerance | Head diameter<br>(H) | Minimum head<br>height (T) |
|-----------------------|-------------------------|----------------------|----------------------------|
| 12.7 +0.00<br>-0.25   | ±1.6                    | 25.4 ±0.4            | 7.1                        |
| 15.9 +0.00<br>-0.25   | ±1.6                    | 31.7 ±0.4            | 7.1                        |
| 19.0 +0.00<br>-0.38   | ±1.6                    | 31.7 ±0.4            | 9.5                        |
| 22.2 +0.00<br>-0.38   | ±1.6                    | 34.9 ±0.4            | 9.5                        |

NOTE:  $L$  = manufactured length before welding.

DIMENSIONS IN MILLIMETRES

FIGURE 2.1 DIMENSIONS AND TOLERANCES FOR  
STANDARD-TYPE HEADED SHEAR CONNECTORS

#### 2.1.2 Ferrule

A ferrule of heat-resistant ceramic or other suitable material shall be furnished with each stud.

The type of ferrule used shall be appropriate to the application.

NOTE: Ferrules for clean beam welding are different to ferrules for through deck welding and the two must not be interchanged.

### **2.1.3 Flux**

A suitable deoxidizing and arc stabilizing flux for welding shall be furnished with each stud of 8.00 mm diameter or larger. Studs less than 8.00 mm in diameter may be supplied with or without flux.

### **2.1.4 Stud bases**

Only studs with qualified stud bases shall be used. A stud base, to be qualified, shall comply with the test requirements prescribed in Appendix C. The ferrule used in production shall be the same as used in stud base qualification tests or as recommended by the stud manufacturer. Qualification of stud bases in accordance with Appendix C shall be the responsibility of the stud manufacturer.

### **2.1.5 Manufacture**

Stud manufacture shall be by heading, rolling or machining techniques. Finished studs shall be of uniform quality and condition, free of injurious laps, fins, seams, cracks, twists, bends or other injurious discontinuities or defects.

Radial cracks or bursts in the head of a stud shall not be the cause for rejection, provided that the cracks or bursts do not extend more than half the distance from the head periphery to the shank as determined by visual examination.

When requested by the principal or the inspecting authority, the fabricator shall provide the following information:

- (a) A description of the stud and ferrule.
- (b) Certification from the stud manufacturer that the stud base is qualified as specified in Clause 2.1.4. Such certification shall include copies of certified results of laboratory tests required, as specified in Appendix C.

## **2.2 STUD MATERIAL**

### **2.2.1 Manufacture**

Studs shall be made from cold-drawn stock complying with the requirements of AS 1443, Grades 1010 through 1020, either semi-killed or fully killed steel.

### **2.2.2 Mechanical properties**

#### **2.2.2.1 General**

Mechanical properties of studs shall be determined by tensile testing either the steel after cold finishing or the full diameter finished studs, in accordance with AS 1391.

#### **2.2.2.2 Testing**

Tests shall be made on tensile test specimens obtained in accordance with AS 1391, or on finished studs welded to test plates of AS 3678 Grade 250 steel, using a test fixture similar to that shown in Figure 2.2, or a tensile machine that grips the ends of the studs in the jaws of the machine. Plates of adequate size may be fillet welded to the unwelded end for studs without heads. The rate of straining when approaching the yield point shall lie within the highest range of strain rate given in AS 1391.

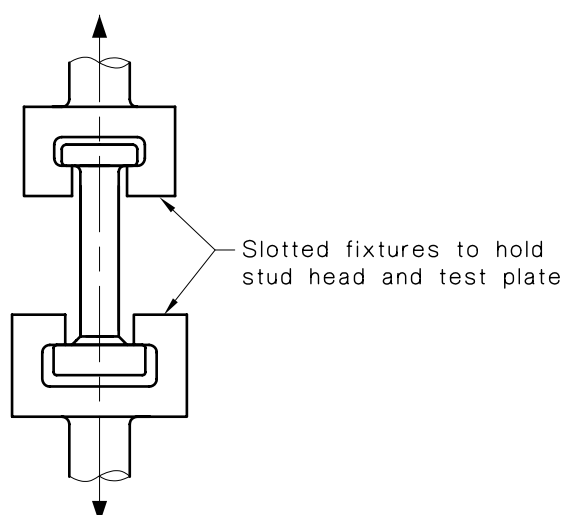


FIGURE 2.2 TYPICAL TENSILE TEST FIXTURE

**2.2.2.3 Requirements**

Unless otherwise specified by the principal or the inspecting authority in accordance with Appendix A, the mechanical properties of the studs shall comply with Table 2.1.

**TABLE 2.1**  
**MECHANICAL PROPERTIES OF STUDS**

| Property                                                                                                                      | Shear connectors<br>(Note 1) | Other than shear<br>connectors (Note 2) |
|-------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------------------------|
| Minimum tensile strength                                                                                                      | 410 MPa                      | 380 MPa                                 |
| Minimum yield strength (0.2% proof stress)                                                                                    | 345 MPa                      | Not applicable                          |
| Minimum elongation on $5.65 \sqrt{S_o}$<br>(where $S_o$ = the original cross-sectional area within the gauge length) (Note 3) | 12%                          | 10%                                     |
| Minimum reduction in area                                                                                                     | 50%                          | 50%                                     |

## NOTES:

- 1 Studs that are headed, bent or of other configuration in 12.7 mm, 15.9 mm, 19 mm, and 22.2 mm diameter are used as an essential component in composite beam design and construction.
- 2 General purpose studs of any type and size used for purposes other than shear transfer in composite beam design and construction.
- 3 If the elongation is measured on a 50 mm gauge length, it shall comply with the following values:

| Stud diameter<br>mm | Minimum elongation, % |                             |
|---------------------|-----------------------|-----------------------------|
|                     | Shear connectors      | Other than shear connectors |
| 12.7                | 13                    | 11                          |
| 15.9                | 14                    | 12                          |
| 19.0                | 16                    | 13                          |
| 22.2                | 17                    | 14                          |

#### **2.2.2.4** *Validity of tests*

The test result shall be regarded as valid, irrespective of the position of fracture, provided that the specified minimum elongation has been obtained. If the specified minimum elongation has not been obtained, the results of the test shall, unless otherwise agreed by the principal or the inspecting authority, be discounted if the distance between the fracture and the near gauge mark is less than one-third of the gauge length or if fracture occurs outside the gauge length.

#### **2.2.2.5** *Retests*

Should any test sample first selected fail to pass the requirements specified in Clause 2.2.2.3, then for each failed test sample two additional test samples shall be tested from the same steel or lot of studs in accordance with this Standard. Should all of these test specimens pass, the test results shall be deemed to comply with this Standard.

### **2.2.3 Certification**

Upon request by the principal or the inspecting authority (see Appendix A), the fabricator shall furnish the following documents:

- (a) The stud manufacturer's certification that the studs, as delivered, conform to the requirements of Clauses 2.1 and 2.2, as applicable.
- (b) Certified copies of the stud manufacturer's test reports on the last completed set of in-plant quality control mechanical tests required by Clause 2.2.2 for each stock size delivered.

### **2.3 PARENT MATERIAL**

The parent material, to which the stud is to be welded, shall—

- (a) be of a grade with a specified minimum yield strength not exceeding 800 MPa; and
- (b) comply with the following Standards, as appropriate:

AS 1163, AS 1450, AS 1548, AS 3597, AS/NZS 1594, AS/NZS 1595, AS/NZS 3678, AS/NZS 3679.1, AS/NZS 3679.2, ISO 4950-3, ASTM A514, ASTM A517.

Other weldable steels with a specified minimum yield strength not exceeding 800 MPa may be used after the establishment of welding procedures in accordance with this Standard.