

SECTION 611 - STEEL REINFORCEMENT

~~##This section cross-references Section 175. Section 175 must be included in the specification.:~~

611.01 GENERAL

This section covers the supply, handling and placing of steel reinforcing materials for concrete. Two types of reinforcing material are covered:

- (a) carbon steel reinforcement, as described in AS/NZS 4671
- (b) stainless steel reinforcement, as described in BS 6744.

611.02 STANDARDS

Australian Standards and other documents are referenced as stated in this clause.

Section 175 details the relevant references to these documents.

Reference	Title
(a) Australian Standards	
AS 1391	Metallic materials - Tensile testing at ambient temperature
AS 2062	Non-destructive testing - Penetrant testing of products and components
AS 2205.5.1	Methods for destructive testing of welds in metal - Macro metallographic test for cross-section examination
AS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS 5100	Bridge Design Set
AS 5100.5	Bridge Design – Part 5 - Concrete
AS/NZS 1554.1	Structural steel welding – Part 1 - Welding of steel structures
AS/NZS 1554.3	Structural steel welding – Part 3 - Welding of reinforcing steel
AS/NZS 1554.6	Structural steel welding – Part 6 - Welding stainless steels for structural purposes
AS/NZS 4671	Steel reinforcing materials
(b) Other Documents	
BS 6744	Stainless steel bars - Reinforcement of concrete - Requirements and test methods (2016)
EN 10088.1	Stainless Steels – List of Stainless Steels
VicRoads Bridge Technical Note – BTN 025	AS 5100 Part 5
VicRoads Technical Bulletin TB46	Guide to Surveillance of Structural Steelwork

611.03 GRADES OF STEEL REINFORCEMENT

Grades of steel reinforcement used shall comply with the following requirements.

- (a) Carbon Steel Reinforcing Material

Unless otherwise shown on the drawings, steel for reinforcing bars shall be Grade 500N, complying with the requirements of AS/NZS 4671. Steel for welded steel reinforcing mesh shall be Grade 500L, complying with the requirements of AS/NZS 4671.

(b) Stainless Steel Reinforcement

Where the use of stainless steel reinforcement is indicated on the drawings, stainless steel reinforcement shall consist of ribbed (deformed) bars or coil, deformed wire or welded mesh complying with the requirements of BS 6744 Grade 500. The chemical composition of stainless steel reinforcement shall conform to one of designations 1.4301, 1.4162, 1.4429, 1.4436 or 1.4462 to BS EN 10088.1 (as identified by BS 6744). Wire used to tie stainless steel shall conform to one of the designations 1.4301, 1.4162, 1.4429, 1.4436 or 1.4462 to BS EN 10088.1 (as identified by BS 6744).

611.04 STEEL REINFORCEMENT SUPPLY

The Contractor shall be responsible for the preparation of the steel reinforcement schedule for all steel reinforcement required for the ~~Contract~~ Works.

The Contractor shall make appropriate allowances when preparing the steel reinforcement schedule to achieve the specified tolerances on member dimensions, concrete cover and location of steel reinforcement and any post-tensioning sheathing or other fitments, taking into account the practical variations in the tolerances noted and other margins normally applied by steel reinforcement suppliers.

Steel reinforcement shall be supplied cut to length and bent to shape, as detailed on the drawings.

The surface condition of reinforcement shall be such as to not impair its bond to the concrete or its performance in the member.

Steel reinforcement shall not be coated unless specified, in which case the nature and type of the coating to be used and the conditions of application shall be separately specified. When carbon steel reinforcement is specified on the drawings to be hot-dip galvanised, the hot-dip galvanising shall be in accordance with AS 4680. Use of epoxy coated steel reinforcement shall not be permitted.

Stainless steel reinforcement shall be supplied, handled and stored separately from other steels. Tools used for cutting, bending and transport of stainless steel reinforcement shall not have been used for other materials.

611.05 CERTIFICATION AND TESTING

(a) Third Party Certification

Manufacturers and suppliers of steel reinforcement materials must be in possession of a current certificate of approval, issued by the Australian Certification Authority for Reinforcing Steel (ACRS), (<http://www.acrs.net.au/> or <http://steelcertification.com/>). Evidence of compliance with this clause shall be submitted to the Superintendent Council within 14 days prior to the commencement of Works. ~~of award of the Contract.~~

(b) No Third Party Certification

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Approval shall be obtained in writing from the Superintendent Council for the use of steel reinforcing materials that are not covered by the long-term quality level of AS/NZS 4671 at least 14 days prior to the intended first date of use of such steel. Steel reinforcing materials that are not covered by the long-term quality level of AS/NZS 4671 shall not be ordered or placed in the works without approval. The Contractor shall nominate the members in which the reinforcing steel is to be used and the country and mill of origin and the specification to which the steel is produced, and clearly demonstrate how it is equivalent to that specified by AS/NZS 4671.

Where use of steel reinforcement is not covered by the long-term quality level of AS/NZS 4671, testing shall be carried out in accordance with Clause B7 of AS/NZS 4671, including the frequency of sampling and testing, and to the appropriate Australian Standard, as listed in AS/NZS 4671.

Where the certification of the steel is incomplete, the Contractor shall arrange for testing to be carried out, as required in Clause 611.05(c), to demonstrate compliance of the material, at the rate of one test per 1000 lineal metres of material.

(c) Test Certificates and Laboratory Accreditation

Laboratories that perform tests required by this section shall meet the requirements of AS ISO/IEC 17025. All test reports shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. Testing laboratories shall comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025. (Test reports may be called test certificates.)

NOTE: Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories can offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA.

The appropriate logo or further details of the ILAC (MRA) signatory shall be noted on the test document, and all reporting requirements of the test method and material standard shall be included. All test reports shall be in English alphanumeric characters.

611.06 BENDING

Bending or re-bending of steel reinforcement shall be done in accordance with the requirements of AS 5100.5, Cl 17.4.3, and be read in conjunction with VicRoads Bridge Technical Note BTN 025 AS 5100 Part 5, Cl 2.2.

Steel reinforcement shall not be bent or straightened in a manner that will cause damage to the steel. Steel with kinks or bends not shown on the drawings or in the steel reinforcement schedule shall not be used.

Heating of Grade 500N steel reinforcement to a maximum of 450°C is permitted under controlled workshop conditions, subject to methods in accordance with the manufacturer's recommendations, provided:

- (a) the steel is heated uniformly through and beyond the portion to be bent
- (b) the temperature of the steel does not exceed 450°C
- (c) the bar is not cooled by quenching.

Hot bending of stainless steel reinforcement shall not be permitted.

Tools used for bending stainless steel reinforcement shall not have been used for fabricating other materials. Pins used in the bending of stainless steel shall be made from stainless steel.

611.07 RE-BENDING ON SITE

On-site heating of steel reinforcement will not be permitted.

Re-bending of steel reinforcement shall be by an approved means. Steel reinforcement that has been bent and subsequently straightened shall not be bent again within 20 bar diameters of the previous bend. Minimum internal diameter of re-bend bars shall be in accordance with AS 5100.5, Cl 17.4.3.

HP—Re-bending of steel reinforcement shall not commence until the procedure has been reviewed and approved by the Superintendent Council, and shall be witnessed by the Superintendent Council's representative.

611.08 IDENTIFICATION

Steel reinforcement and welded steel reinforcing mesh shall be bundled and tagged with a label identifying the bar reference number.

611.09 HANDLING, STORAGE AND SURFACE CONDITION

Steel reinforcement that has been damaged in any way shall not be incorporated into or used in the works.

Steel reinforcement shall be stored in conditions that minimise or prevent the formation of surface rust.

Steel reinforcement shall be kept free from rust, oil, grease, tar, paint, mud or any other deleterious substance which may reduce bond between the steel reinforcement and concrete.

The presence of mill scale or surface rust shall not be cause for rejection of reinforcement.

Steel reinforcement that has the surface pitted by corrosion, where the loss of cross-section is greater than the tolerance on mass per metre of bar (4.5%), shall not be used in the works.

Stainless steel reinforcement shall be supplied, handled and stored separately from other steels. Stainless steel reinforcement shall be stored so that it is not contaminated by debris from processing operations, grease, oil, iron or other steels.

611.10 PLACING

All steel reinforcement shall be securely held during placing and compacting of the concrete. Steel reinforcement supports shall be made of durable materials strong enough to withstand the imposed loads without movement of the steel reinforcement, shall be positively attached to the steel reinforcement, and of such size as to maintain the specified cover.

Wooden supports, metal supports and plastic-coated metal supports which extend to the surface of the concrete shall not be used. Placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted.

The specified minimum concrete cover shall be maintained at tie-wire positions.

The Contractor shall ensure that the method of placement of stainless steel reinforcement does not allow it to become contaminated by contact with other steel. In particular, welding or cutting of black steel reinforcement or any other structural steel shall not occur after any stainless steel has been placed.

Stainless steel embedment items shall be fixed in place by tying with stainless steel wire of the same grade, or by anchoring to the forms using stainless steel fixings of the same grade.

611.11 SPLICING

Steel reinforcement shall be supplied in the full lengths shown on the drawings. Alternatively, and where directed by the Superintendent Council, the Contractor shall splice the bars by lapping. In lapped splices, the reinforcements shall be placed in contact and the specified cover shall be maintained. The lap shall be long enough to develop the full strength of the reinforcement and unless shown on the drawings shall be not less than the tensile or compressive development length determined in accordance with AS 5100.5, CI 13.1.

Splicing of steel reinforcement shall be in accordance with AS 5100.5, CI 13.1.

611.12 PROJECTING STEEL REINFORCEMENT

Where shown on the drawings, projecting steel reinforcement shall be provided for the purpose of splicing to the adjacent sections of reinforced concrete. Care shall be taken to avoid damage to the projecting steel reinforcements after they have been set and any damage to the bars or their setting shall be repaired by the Contractor. Projecting steel reinforcement in newly poured concrete shall remain undisturbed for a minimum period of 24 hours following the completion of placing concrete in order to avoid damage to the concrete surrounding the reinforcements.

611.13 TACK WELDING

(a) Carbon Steel Reinforcement

Tack welding of steel reinforcement will be permitted for Grade 250N and Grade 500N carbon steel reinforcement bars provided welding is not within 50 mm of the tangent point of a bend in the steel.

All tack welding shall comply with the requirements of AS/NZS 1554.3. In cases where the application of AS/NZS 1554.3 indicates that welding procedure testing is required for tack welding, the tack welding procedure shall be qualified in accordance with Appendix C of AS/NZS 1554.3.

(b) Stainless Steel Reinforcement

Tack welding of stainless steel reinforcement is not recommended.

611.14 WELDED SPLICES IN CARBON STEEL REINFORCEMENT

(a) General

Welding of carbon steel reinforcement shall be in accordance with AS/NZS 1554.3.

Steel reinforcement shall be spliced by welding only at the locations shown on the drawings.

The steel reinforcement projecting from the ends of beams shall be spliced as shown on the drawings.

Pairs of bars with misalignments less than 8 mm may be realigned prior to welding. Splices for pairs of bars with misalignments greater than 8 mm shall be packed prior to welding.

Care shall be taken during welding to avoid excessive heating of the reinforcing bar.

The earth lead shall be attached to the steelwork being welded at all times to prevent leakage of currents.

(b) Welding Procedure Qualification

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Welding of splices in steel reinforcement, including to other steelwork and to continuity bar reinforcement, shall not commence until the welding procedure has been qualified and reviewed by the Superintendent Council.

The qualification process shall be in accordance with AS/NZS 1554.3 and with the following additional requirements:

- (i) production of a weld test plate, witnessed by either a Structural Steelwork Surveillance Officer, accredited to VicRoads Technical Bulletin TB46, or the Contractor's Welding Supervisor
- (ii) submission to the Superintendent Council of test certificates demonstrating compliance of the procedure with AS/NZS 1554.3 including a photograph of the weld section, prepared and etched to AS 2205.5.1, at a magnification of x1 or greater.

The welding procedure shall provide a weld with the specified throat thickness, free from inclusions and imperfections, and with satisfactory fusion and surface appearance.

(c) Inspection and Quality of Welds

(i) Direct Butt Splices

The Contractor shall carry out non-destructive inspection processes at a frequency sufficient to ensure that welding of direct butt weld splices complies with the specified requirements but shall not be less than that shown in Table 611.141.

Table 611.141 Inspection and Quality of Direct Butt Splice Welds

Inspection process	Minimum extent of inspection (% of welds, as no.)	Detail of inspection of direct butt splice welds	Quality requirements
Visual inspection	100	Each full weld circumference	AS/NZS 1554.3, Table 6.2
Non-destructive internal inspection by Radiography	First two inspection lots		
	20	with a minimum of 12 bars inspected per lot, and at least 6 of these 12 bars to be examined at two directions, at least 60 degrees apart	AS/NZS 1554.1, Table 6.2.1
	Subsequent inspection lots after first two		
	10	If more than one weld in an inspection lot does not comply with the quality requirements, revert to extent of inspection as for the first two inspection lots	AS/NZS 1554.1, Table 6.2.1
Non-destructive surface inspection by Magnetic particle, or Liquid penetrant	5	Each full weld circumference	AS/NZS 1554.3, Table 6.2

(ii) All other welds

Inspection of the welding of steel reinforcement shall be in accordance with AS/NZS 1554.3.

The quality of welds shall conform to AS/NZS 1554.3, and any imperfections shall be assessed in accordance with AS/NZS 1554.3, Table 6.2.

611.15 WELDING STAINLESS STEEL REINFORCEMENT

(a) General

Welding of stainless steel reinforcement shall be in accordance with AS/NZS 1554.3 and AS/NZS 1554.6.

Stainless steel reinforcement shall be welded only in a welding workshop specifically set up for the purpose. Such facility shall maintain conditions preventing any contamination of the stainless steel and consumables used in the proper performance of the welding for the full duration of the ~~Contract~~ Works. All consumables shall be stored, conditioned and handled in accordance with the manufacturer's recommendations.

HP Prior to the commencement of works, the Contractor shall submit to the Superintendent Council the results of an independent assessment that the purpose-specific welding shop has been established.

Reports of re-assessment shall be submitted to the Superintendent Council at 3 month intervals until welding and fabrication works are completed.

Welding procedures and consumables shall comply with the bar manufacturer's recommendations. Weld preparations shall be clean and free of any contamination prior to welding.

(b) Welding Procedure Qualification

HP Welding of splices in stainless steel reinforcement, including to other steelwork and to continuity bar reinforcement, shall not commence until the welding procedure has been qualified and reviewed by the Superintendent Council.

The qualification process shall be in accordance with AS/NZS 1554.3 and AS/NZS 1554.6 and with the following additional requirements:

- (i) production of a weld test plate, witnessed either a Structural Steelwork Surveillance Officer, accredited to VicRoads Technical Bulletin TB46, or the Contractor's Welding Supervisor; and
- (ii) submission to ~~the Superintendent~~ Council of –
 - test certificates demonstrating compliance of the procedure with AS/NZS 1554.3 and AS/NZS 1554.6, including a photograph of the weld section, prepared and etched to AS 2205.5.1, at a magnification of x1 or greater, and
 - test certificates demonstrating that the weld procedure does not result in the loss of ductility and corrosion resistance as specified in sub-paragraph (e) below.

(c) Inspection and Quality of Welds

Welds shall be examined by liquid penetrant methods, to AS 2062, at a frequency of 5% of the welds manufactured.

Inspection of the welding of stainless steel reinforcement shall be in accordance with AS/NZS 1554.6. The quality of welds shall conform to Category 1B to AS/NZS 1554.6, Table 6.1, and any imperfections shall be assessed in accordance with AS 1554.6, Table 6.3.2.

All arc strikes shall be treated as welds, and inspected 100% by liquid penetrant methods, to AS 2062, and shall be assessed in accordance with AS 1554.6, Table 6.3.2.

(d) Cleaning of Welds

Unless otherwise specified, any welds in stainless steel reinforcement covered by concrete shall be acceptable as surface condition III, after removal of slag or wire brushing to AS/NZS 1554.6, Table 6.2.1. Any pickling compounds used shall be chloride free.

(e) Corrosion Resistance of Welds

When specified, welds on stainless steel reinforcement shall be tested for corrosion resistance against pitting and inter-granular corrosion in accordance with AS/NZS 1554.6, Appendix E. Corrosion resistance testing shall be carried out on test specimens sampled from the weld procedure qualification tests and on three product samples, each prepared and tested at equally spaced quantity intervals during the works.

611.16 MECHANICAL SPLICES

If mechanical splices are proposed or required in the drawings, the Contractor shall submit full details of tests that demonstrate compliance of the proposed mechanical splice with the requirements of VicRoads Bridge Technical Note BTN 025 AS 5100 Part 5 to the Superintendent Council. The tests shall be conducted in accordance with the appropriate Australian Standard, for example AS 1391, in a laboratory accredited as required by CI 611.05(c).

Details of the type and location of mechanical splices together with the supporting test data shall be submitted to the Superintendent Council not less than 14 days before their proposed use in the works. Mechanical splices shall not be incorporated in the works until the Superintendent Council has accepted their proposed use.

Mechanical splices for stainless steel reinforcement shall be manufactured from stainless steel that conforms to one of the designations 1.4301, 1.4162, 1.4429, 1.4436 or 1.4462 to BS EN 10088 (as identified by BS 6744).

611.17 CONTACT BETWEEN DISSIMILAR METALS EMBEDDED IN CONCRETE

Contact between carbon steel and galvanised steel reinforcement or carbon steel and stainless steel reinforcement or other similar metal embedments shall not be allowed.

Where contact between such dissimilar metals embedded in concrete is unavoidable, the two different metals shall be electrically isolated to prevent galvanic or bimetallic corrosion.

Electrical isolation may be effected by using PVC conduit sleeves, suitable soft plastic wrapping or tapes or by other approved means.

Steel reinforcement and other metal embedment items shall only be fixed in place with tie wire made of the same metal and same grade.