
SECTION 611 - STEEL REINFORCEMENT

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 reinforcing material, as described in AS/NZS 4671; and
- (b) stainless steel reinforcement, as described in BS 6744.

611.02 STANDARDS

Standards, Codes of Practice, Test Methods, Technical Bulletins and other documents applicable to the works covered by this specification are detailed in VicRoads Standard Specification Section 175.

611.03 GRADES OF REINFORCEMENT

Grades of reinforcement used shall comply with the following requirements:

(a) Carbon Steel Reinforcing Material

Unless shown otherwise on the drawings, steel reinforcing materials shall consist of deformed high strength carbon steel reinforcing bars or welded mesh of Grades 250N, 300E, 500E, 500L and 500N, complying with the requirements of AS/NZS 4671. Unless otherwise shown on the drawings, steel for reinforcing bars shall be Grade 500N. Steel for welded steel reinforcing mesh shall be Grade 500L.

(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 1.4429, 1.4436 or 1.4462 to BS EN 10088 (as identified by Table 5, BS 6744:2001). Wire used to tie stainless steel shall conform to one of the designations 1.4429, 1.4436 or 1.4462 to BS EN 10088 (as identified by BS 6744:2001).

611.04 REINFORCEMENT SUPPLY

Unless otherwise specified, the Contractor shall be responsible for the preparation of the reinforcement schedule for all reinforcement required for the Contract.

The Contractor shall make appropriate allowances when preparing the reinforcement schedule to achieve the specified tolerances on member dimensions, concrete cover and location of 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 reinforcement suppliers.

Steel reinforcement shall be supplied cut to length, bent to shape, free from loose millscale, free from loose or thick rust, or any other surface contamination that adversely affects the steel and its intended use.

All operations to process and fabricate steel reinforcement, such as cutting, bending, shaping, placing, joining and similar tasks, shall be in accordance with AS 5100 Part 5.

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 galvanized, the hot-dip galvanizing shall be in accordance with AS 4680. Use of epoxy coated 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). Evidence of compliance with this clause shall be submitted to the Superintendent within 14 days of award of the Contract.

(b) No Third Party Certification

HP Approval shall be obtained in writing from the Superintendent 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 such approval. In seeking this approval, the Contractor shall nominate the members in which the reinforcing steel is to be used and shall also state 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.

Testing of steel reinforcement shall be carried out in accordance with the appropriate Australian Standard, as listed in AS/NZS 4671, by officers experienced in the test methods described in the Contract, in a laboratory accredited by the National Association of Testing Authorities (NATA) for those test methods. All test reports shall be endorsed in accordance with the NATA terms of accreditation for that laboratory, for chemical composition and physical properties. All testing shall be in accordance with Clause B7 of AS/NZS 4671-2001, including the frequency of sampling and testing.

611.06 BENDING

Bending or re-bending of reinforcement shall be done in accordance with the requirements of AS 5100 Part 5, and be read in conjunction with VicRoads BTN2007/016 Bending, Splicing and Welding of Grade 500 Reinforcement.

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

Heating of Grade 500N bars to a maximum of 450°C is permitted under controlled workshop conditions, subject to methods in accordance with the manufacturer's recommendations. The bars shall be heated uniformly through their cross-section and beyond the portion to be bent in each direction for a distance at least equal to the bar diameter. The internal bend diameter of any hot-bent bar shall meet the requirements of AS 5100 Part 5. Heated bars shall not be cooled by quenching. If during heating, the temperature of the bar exceeds 450°C, the design yield strength of the steel after bending shall be taken as 250 MPa.

On-site heating of reinforcement will not be permitted.

Hot bending of stainless steel reinforcement shall be in accordance with methods recommended by the manufacturer. Tools used for bending stainless steel reinforcement shall not have been used for fabricating other materials. Pins used for bending stainless steel shall be made from stainless steel.

611.07 RE-BENDING ON SITE

Re-bending of reinforcement shall be by approved means. 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 Part 5.

HP Re-bending of steel reinforcement shall not commence until the procedure has been reviewed and approved by the Superintendent.

611.08 IDENTIFICATION

Reinforcement and fabric components shall be bundled and tagged with a label identifying the bar reference number.

611.09 HANDLING, STORAGE AND SURFACE CONDITION

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.

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

Thin powdery rust and tightly adhering rust are not considered detrimental, and need not be removed. Mill scale, which flakes off when the reinforcement is struck by a hammer, or which can be readily dislodged by hand wire brushing, shall be removed.

Reinforcement that has 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 reinforcement shall be securely held during placing and compacting of the concrete. Reinforcement supports shall be made of durable materials strong enough to withstand the imposed loads without movement of the reinforcement, shall be positively attached to the 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 and wooden supports 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 bars 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

Reinforcement shall be supplied in the full lengths shown on the drawings. Alternatively, and where directed by the Superintendent, the Contractor shall splice the bars by lapping. In lapped splices, the bars 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 bar and unless shown on the drawings shall be not less than the tensile or compressive development length determined in accordance with AS 5100 Part 5.

Splicing of reinforcement shall be in accordance with AS 5100 Part 5.

611.12 PROJECTING 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 bars after they have been set and any damage to the bars or their setting shall be repaired by the Contractor. Projecting 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 bars.

611.13 TACK WELDING

(a) Carbon Steel Reinforcement

Tack welding of 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 Part 3. In cases where the application of AS/NZS 1554 Part 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 Part 3.

(b) Stainless Steel Reinforcement

Tack welding of stainless steel reinforcement is not permitted.

611.14 WELDED SPLICES IN CARBON STEEL REINFORCEMENT

(a) General

Welding of carbon steel reinforcement shall be in accordance with AS/NZS 1554 Part 3.

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

The 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

HP Welding of splices in 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.

The qualification process shall be in accordance with AS/NZS 1554, Part 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 Guide to Surveillance of Structural Steelwork, or the Contractor's Welding Supervisor;
- (ii) submission to the Superintendent of test certificates demonstrating compliance of the procedure with AS/NZS 1554, Part 3 including a photograph of the weld section, prepared and etched to AS 2205.5.1 Methods for destructive testing of welds in metal – Macro metallographic test for cross-section examination, at a magnification of at least x1.

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

Inspection of the welding of steel reinforcement shall be in accordance with AS/NZS 1554 Part 3.

The quality of welds shall conform to AS/NZS 1554 Part 3, and any imperfections shall be assessed in accordance with AS/NZS 1554 Part 3, Sections 9 and 10.

611.15 WELDING STAINLESS STEEL REINFORCEMENT

(a) General

Welding of stainless steel reinforcement shall be in accordance with AS/NZS 1554 Part 3 and Part 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. 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 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 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.

Tack welding of stainless steel reinforcement is not permitted.

(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.

The qualification process shall be in accordance with AS/NZS 1554, Part 3 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 Guide to Surveillance of Structural Steelwork, or the Contractor's Welding Supervisor;
- (ii) submission to the Superintendent of test certificates demonstrating compliance of the procedure with AS/NZS 1554, Part 3 including a photograph of the weld section, prepared and etched to AS 2205.5.1 Methods for destructive testing of welds in metal – Macro metallographic test for cross-section examination, at a magnification of at least x1.

(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 Part 6. The quality of welds shall conform to Category 1B to AS/NZS 1554 Part 6, Table 6.1.1, and any imperfections shall be assessed in accordance with AS 1554 Part 3, Sections 9 and 10.

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 Part 3, Sections 9 and 10.

(d) Cleaning and Corrosion Resistance of Welds

When specified, completed welds shall be cleaned and passivated by wire brushing and pickling to finish Category II to AS/NZS 1554 Part 6, Table 6.2.1. Pickling compounds shall be chloride free.

The Contractor shall demonstrate that the weld procedure does not result in the loss of ductility and corrosion resistance. Welds on stainless steel reinforcement shall be tested for corrosion resistance against pitting and intergranular corrosion in accordance with AS/NZS 1554 Part 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. Testing of steel reinforcement for corrosion resistance shall be carried out in accordance with the appropriate Australian Standard, by officers experienced in the test methods described in the Contract, in a laboratory accredited by the National Association of Testing Authorities (NATA) for those test methods. All test reports shall be endorsed in accordance with the NATA terms of accreditation for that laboratory.

611.16 MECHANICAL SPLICES

Mechanical splices shall not be permitted at critically loaded sections of the structure. Preference shall be given to lapped or welded splices. However, a mechanical splice may be permitted where the designer considers on the basis of engineering considerations that a lapped or welded splice is unsuitable. In this case the mechanical splice shall be designed in accordance with Bridge Technical Note BTN2007-016 Bending, Splicing and Welding of Grade 500 Reinforcement.

The Contractor shall submit full details of tests that demonstrate compliance of the proposed mechanical splice with the requirements of Bridge Technical Note BTN2007-016 to the Superintendent. The tests shall be conducted in accordance with the appropriate Australian Standard in a NATA accredited laboratory. When tested in accordance with AS 1391, mechanical bar splices shall develop at least the nominal ultimate tensile or compressive strength of the smaller of the bars being tested.

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

Mechanical splices for stainless steel reinforcement shall be manufactured from stainless steel that conforms to one of the designations 1.4429, 1.4436 or 1.4462 to BS EN 10088 (as identified by Table 5, BS6744:2001). The strength of the mechanical splice shall not be less than the strength of the smaller bar to be joined by the splice.