

Main Roads Technical Standard

MRTS71

Reinforcing Steel

June 09

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Reinforcing Steel

1 INTRODUCTION

This Standard applies to the supply, fabrication and placing of reinforcing bar and welded reinforcing mesh used in concrete road and bridge structures, concrete pavements and incidental concrete construction.

This Technical Standard shall be read in conjunction with MRTS01 *Introduction to Technical Standards*, MRS50 *Specific Quality System Requirements* and other Technical Standards as appropriate.

This Standard forms part of the Main Roads Specification and Technical Standards Manual.

The requirements for supply, fabrication and placing of reinforcing bar and welded reinforcing mesh used in concrete road and bridge structures, concrete pavements and incidental concrete construction includes the use of suppliers and products for the items listed in Table 1 that are registered by Transport and Main Roads.

Table 1 - Items Requiring Use of Registered Suppliers and Products

Clause	Category of Work
5.1	Steel reinforcing.
5.3	Bar grip screwed couplers.
9	Bar chairs and spacers.

For information regarding registered suppliers and products for the above items refer to –

Queensland Department of Transport and Main Roads
 Concrete Technology
 GPO Box 1412
 Brisbane Qld 4001

2 DEFINITION OF TERMS

The terms used in this Standard shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Standards*.

3 REFERENCED DOCUMENTS

Table 3 lists documents referenced in this Technical Standard

Table 3 – Referenced Documents

Reference	Title
AS/NZS 1553.1	Covered electrodes for welding – Low carbon steel electrodes for manual metal-arc welding of carbon steels and carbon-manganese steels
AS/NZS 1554.3	Structural steel welding – Welding of reinforcing steel
AS 2203.1	Cored electrodes for arc-welding – Ferritic steel electrodes
AS/NZS 2717.1	Welding – Electrodes – Gas metal arc – Ferritic steel electrodes
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

3.1 Standard Drawings

Table 3.1 lists Standard Drawings referenced in this Technical Standard.

Table 3.1 – Standard Drawings

Drawing Number	Title
1043	Reinforcing Steel – Standard Bar Shapes Drawing 1 of 2 and Drawing 2 of 2
1044	Reinforcing Steel – Standard Hook, Lap and Bend Details and General Steel Reinforcement Information

4 QUALITY SYSTEM REQUIREMENTS

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Standards*.

The Hold Points, Witness Points and Milestones applicable to this Standard are summarised in Table 4.1.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
5.1	1. Acceptance of supplier.		Submission of proposed supplier of steel reinforcing (7 days).
5.2	2. Steel Reinforcing compliance		
5.3	3. Acceptance of alternative bar grip screwed couplers		Submission of alternative bar grip screwed couplers (14 days).
7	4. Hot bending of steel reinforcing. 5. Overheating bar on Site.		
9	6. Approval of reinforcement placement.		
10		Installation of bar grip screwed couplers.	
13.2.2		Welding of test pieces.	
13.3	7. Approval of welding process and consumables. 8. Verifying welded splices.		
14	9. Substitution of reinforcement.		Proposal to substitute alternative reinforcement (4 weeks)

5 MATERIALS

5.1 Supply of Steel Reinforcing

Steel reinforcing shall be manufactured, processed and supplied only by a registered steel reinforcing supplier (refer clause 1) who is also a member of the independent product certification body for steel reinforcing ACRS (Australian Certification Authority for Reinforcing Steel).

At least 7 days before steel reinforcing is supplied, the Contractor shall submit to the Administrator the identity and address of the proposed supplier and evidence of conformance with this Clause. **Milestone**

Steel reinforcing shall not be delivered to the Site until written acceptance of the proposed supplier has been obtained from the Administrator. **Hold Point 1**

5.2 Steel Reinforcing

Steel reinforcing materials shall comply with AS/NZS 4671.

The Contractor shall supply to the Administrator certified copies of the manufacturer's test certificates identifiable with the reinforcement supplied or provide documentary evidence that all products meet the requirements of AS/NZS 4671 and that the supplier has a system in place to prevent non conforming material from being supplied **Hold Point 2**

Where such certificates cannot be supplied, the Contractor shall arrange testing of reinforcement for tension, bending and ductility to AS/NZS 4671.

The number of bars to be tested shall be determined on the basis of one bar length for each 5 tonnes of reinforcement or part thereof for each size and grade of reinforcing bar used, with a minimum of 2 bar lengths per size and grade. Test results shall be made available to the Administrator.

Where shown in the Drawings, steel reinforcing shall be galvanised to AS/NZS 4680. Galvanised reinforcing bars shall be passivated in a 0.2% sodium dichromate solution applied by the galvaniser.

5.3 Bar Grip Screwed Couplers

Bar grip screwed couplers shall be registered proprietary products used for splicing steel reinforcing bar (refer Clause 1).

The coupler shall be designed or shown by testing to be capable of developing a stress, in tension or compression, not less than 1.5 times the nominal yield stress of the weaker bar at the splice.

Unless supplied with a threaded coupling rod installed, the coupler shall be fitted with a plastic plug to protect the thread. Couplers shall connect two reinforcing bars on a single axis.

Couplers may be of 2 types, either –

- a) swaged to the end of a steel reinforcing bar; or
- b) connected to a steel reinforcing bar with a tapered thread.

Registered products are listed in Clause 1 of Annexure MRTS71.1.

Alternative products may be submitted to the Administrator for approval provided that full technical data sheets are supplied at least 14 days prior to proposed use. **Milestone**

Alternative bar grip screwed couplers shall not be used without the prior approval of the Administrator. **Hold Point 3**

6 PROTECTION

Steel reinforcing shall be protected from damage at all times. During storage it shall be stacked in racks or on timber above ground and shall be kept clear of any contamination. Should accidental contamination occur, the steel reinforcing shall be cleaned as specified in Clause 8.

7 CUTTING AND BENDING

Steel reinforcing bar shall be free of kinks or other unwanted deformations, and shall be cut to length, and bent in accordance with the Drawings. Welded reinforcing mesh shipped in rolls shall be straightened into flat sheets before use.

Steel reinforcing bar shall be cold bent by the application of a consistent force around a circular pin.

All bends shall be made in accordance with the shapes and dimensions shown on Standard Drawing Numbers 1043 and 1044, unless otherwise shown in the Drawings.

If a reinforcing bar has been bent and subsequently bent in the reverse direction or straightened, it shall not be bent again within 20 bar diameters of the previous bend.

After cutting and bending, bars shall be bundled or stored in a manner which permits clear identification of their bending schedule mark.

Where specifically authorised by the Administrator, **Hold Point 4** steel reinforcing bars may be bent hot on the Site provided that –

- a) the steel is heated uniformly through and beyond the portion to be bent (5 bar diameters is suitable for a 90° bend);
- b) the temperature does not exceed 450°C;
- c) suitable temperature indicating crayons or equivalent are used to determine the temperature; and
- d) the bar is not cooled by quenching or compressed air blast.

If the temperature of the bar exceeds 450°C during heating, construction of that lot shall not proceed until the approval of the Administrator has been obtained. **Hold Point 5**

Steel reinforcing bar and welded reinforcing mesh shall be fabricated to the shape and dimensions shown in the Drawings and within the following tolerances –

- a) On any overall dimension for bars and mesh except where used as a fitment –
 - i) Length up to 600 mm - 25 mm, + 0; and
 - ii) Length over 600 mm - 40 mm, + 0,
- b) On any overall dimension of bars or mesh used as a fitment –
 - i) For deformed bars and mesh –
 - for deck and kerb units and girders ± 5 mm; and
 - for other areas - 15 mm, + 0,
 - ii) For plain round bars –
 - for deck and kerb units ± 5 mm; and
 - for other areas - 10 mm, + 0,
- c) On the overall offset dimension of a cranked column bar - 0, + 10 mm; and
- d) For the sawn or machined end of a straight bar intended for use as an end-bearing splice, the angular deviation from square measured in relation to the end 300 mm shall be within 2°.

8 SURFACE CONDITION OF STEEL REINFORCING

The surface condition of steel reinforcing shall comply with the following requirements –

- a) At the time concrete is placed, steel reinforcing shall be free from mud, oil, grease and other non-metallic coatings and loose rust which would reduce the bond between the concrete and the steel reinforcing;
- b) For the purpose of this Standard, rust shall not be deemed to be loose if, on rubbing with the thumb, it leaves only a stain thereon;
- c) Nevertheless, a deformed bar or welded reinforcing mesh complying with AS/NZS 4671 and having mill scale or rust or both shall be deemed to comply with this Standard if, for a specimen which has been wire-brushed by hand –
 - i) the dimensions of the cross-section, including height of deformations; and
 - ii) the mass,are not less than the dimensions and mass required by the Australian Standard;
- d) Any steel reinforcing projecting from a previous concreting operation shall be cleaned free of adhering concrete or loose slurry prior to any further embedment;
- e) Any steel reinforcing installed within 1 km of the coastline shall be thoroughly washed with a high pressure fresh water jet immediately prior to pouring concrete to remove any salts deposited during storage and placement; and
- f) Steel reinforcing which has been submerged by tidal or flood waters shall be cleaned with a high pressure fresh water jet prior to pouring concrete.

9 PLACING AND FIXING

Steel reinforcing shall be placed in position as shown in the Drawings. In the case of steel reinforcing bar, the bars shall be tied together by wiring each intersection, using annealed wire not less than 1.25 mm in diameter. Where the bar spacing is 300 mm or less, alternate intersections only need to be tied.

Clearance from forms shall be maintained by use of registered bar chairs (refer to Clause 1). The shape of the chair shall be such that minimum obstruction is offered to the formation of the homogeneous concrete both within and around the chair. Tubular or cylindrical types shall not be used. Some bar chairs are suitable for soffit use only and these shall not be used against side forms. Bar chairs shall have sufficient structural strength to support the weight of steel reinforcing bars and workmen at temperatures experienced on the Site.

Plastic tipped metal chairs shall not be used for any locations other than those where there is no possibility of the tips of the feet of the chairs becoming exposed.

Precast mortar blocks shall not be used unless approved by the Administrator. Blocks manufactured from vibrated concrete of strength equivalent to that of the main concrete, and to a size and shape approved by the Administrator may be used. Such blocks shall have suitable fixing wires cast in.

Layers of bars shall be separated by means of registered bar spacers (refer to Clause 1). Stirrups and ligatures shall pass around the main reinforcement and shall be securely tied to it.

The system of fixing shall be such as to form a rigid cage which maintains dimensional tolerances under loads experienced during handling and transport of cages and placement of concrete. Welding of steel reinforcing to form a rigid cage shall comply with the following requirements –

- a) Welding shall be in accordance with the requirements of AS/NZS 1554.3. In particular, tack welds shall not substantially reduce the cross-section of the steel reinforcing bar nor adversely affect its strength. Tack welding on bent portions of bars is permitted subject to the requirements of AS/NZS 1554.3 Clause 3.3;

Tack welds shall –

- i) have a throat thickness not less than 4 mm;
- ii) have a length not less than the diameter of the smaller bar;
- iii) be made using controlled hydrogen consumables; and
- iv) Non-hydrogen controlled consumables may be used provided their use is qualified in accordance with AS/NZS 1554.3.

Qualification of tack welding is required on a 6 monthly basis for all staff undertaking tack welding;

- b) Splice welding shall not be carried out within a distance equal to two bar diameters of any portion of a bar which has been or will be bent;
- c) Not more than one-third of the main steel reinforcing bars at any cross-section shall be so welded; and
- d) Hard-drawn steel bars and welded reinforcing mesh shall not be welded or heated.

All steel reinforcing in position shall be inspected and approved before placement of concrete is commenced. **Hold Point 6**

Welding adjacent to or above any prestressing bar or strand (stressed or unstressed) shall not be permitted without special precautions to protect all prestressing from welding splatter. Protection arrangements shall be verified by the Administrator. **[Refer to Hold Point 7]**

10 INSTALLING BAR GRIP SCREWED COUPLERS

Bar grip screw couplers shall be installed where shown in the Drawings. Prior to screwing bars into a coupler, all threads shall be thoroughly cleaned. Threads shall be completely engaged and the joint tightened. **Witness Point**

As-constructed drawings shall be marked up to show the type of coupler used.

11 TOLERANCE ON POSITION OF STEEL REINFORCING

The deviation from the specified position of steel reinforcing shall not exceed the following stated tolerances.

- a) For positions controlled by cover –
- | | |
|---|-----------------------|
| i) in girders, beams, slabs, and deck and kerb units | - 5 mm, + 10 mm; |
| ii) in slabs, columns and walls | - 5 mm, + 10 mm; |
| iii) in slabs-on-ground including footings of walls and culverts | - 10 mm, + 20 mm; and |
| iv) in footings cast in the ground where the depth of the footing is 500 mm or more | - 20 mm, + 40 mm. |

where a positive value indicates the amount the cover increases and a negative value indicates the amount the cover decreases; and

- b) For positions not controlled by cover –
- | | |
|--|--------|
| i) the location of steel reinforcing on a profile | 10 mm; |
| ii) the position of the ends of steel reinforcing along the line of the bar | 50 mm; |
| iii) the spacing of bars in walls and slabs and of fitments in beams and columns – | |
| • 10% of the specified spacing; or | |
| • 15 mm. | |
- whichever is greater.

12 WELDING PROCEDURE SHEETS

No welding shall be carried out until a Welding Procedure Specification Sheet, in accordance with Section 4 of AS 1554.3 has been completed and a copy submitted to the Administrator. Welding shall not be carried out until the appropriate Welding Procedure Specification Sheet has been verified by the Administrator. **[Refer to Hold Point 7]**

13 SPLICING

13.1 General

Splicing of steel reinforcing shall occur only in the locations shown in the Drawings, unless otherwise approved by the Administrator. Where practical, splices in steel reinforcing bar shall be staggered.

Steel reinforcing bar shall be spliced by lapping or, where shown in the Drawings, by welding (refer to Clause 13.3).

The length of lap splices in steel reinforcing bar shall be as shown in the Drawings. Where an unscheduled splice occurs or where the length is not shown in the Drawings, the length of the lap slice shall be as shown on Standard Drawing Number 1044. All steel reinforcing shall be spliced in such a manner as to maintain specified clear cover to the surface of the concrete.

Welded reinforcing mesh shall be lap spliced only. Splicing of welded reinforcing mesh shall be achieved so that the two outermost transverse bars of one sheet of mesh overlap the outermost transverse bar of the sheet being lapped.

13.2 Qualification of Welders

13.2.1 General

Welding personnel shall be qualified by one of the methods given below –

- a) The provisions of AS/NZS 1554.3. Clause 4.10.2, or
- b) Qualification by the Contractor in accordance with Clause 13.2.2.

13.2.2 Qualification by the Contractor

The Contractor shall arrange for testing of two test pieces for each welder proposed to be employed on the work. Each test piece shall be 300 mm long with a joint of the type proposed to be used at the centre.

Test pieces shall be prepared from the same size and grade of steel reinforcing as that to be welded on the job. Welding of test pieces shall be carried out on the job, using the equipment and consumables to be used on the job, and using the least advantageous welding position likely to be experienced in the Works. The Contractor shall provide all information regarding the welding of test pieces requested by the Administrator.

The welding of all test pieces shall be carried out in the presence of the Administrator. **Witness Point**

One test piece shall be tested in tension. The tensile test piece when ruptured under tensile load shall have an ultimate strength at least equal to that of the parent metal. The other test piece shall be tested in bending as described in AS/NZS 1554.3 and shall pass the requirements of this test.

Testing shall be conducted by a laboratory registered by NATA for the test.

In the event of failure of any of the test pieces to meet the above requirements, four further test pieces shall be made and tested. Two of the test pieces shall be tested in tension and the remaining two in bending. Should any of the re-tests fail, the welder shall be deemed to have failed the test and shall not be eligible for Qualification under this clause.

13.3 Splicing by Welding

Splicing of steel reinforcing bar by welding shall be permitted only where shown in the Drawings or where approved by the Administrator. The process and consumables shall be approved by the Administrator **Hold Point 7** and shall comply with the following –

- a) All welding of steel reinforcing bar shall be carried out in accordance with AS/NZS 1554.3;
- b) Welding Consumables to be used shall comply with AS/NZS 1553.1 or AS 2203.1 or AS/NZS 2717.1;
- c) Splices shall be made by butt or by fillet welding. Butt welds shall be qualified complete penetration butt joints in accordance with AS/NZS 1554.3; and
- d) Only welders who are proved competent by tests, as described Clause 13.2 shall be used.

Welding adjacent to or above any prestressing bar or strand (stressed or unstressed) shall not be permitted without special precautions to protect all prestressing from welding splatter. Protection arrangements shall be verified by the Administrator. **[Refer to Hold Point 7]**

Placement of the reinforcement within the concrete formwork shall not proceed until the Administrator has verified all splice welds. **Hold Point 8**

14 SUBSTITUTIONS

Substitution of different sizes of steel reinforcing shall not be made unless approved in writing by the designer and the Administrator. The application shall be forwarded at least 4 weeks prior to the date on which the steel reinforcing is required to be placed **Milestone**. Substitution shall be permitted only if the structure is not adversely affected by the change. Substitution shall not proceed until the Administrator has approved the change. **Hold Point 9** No additional payment shall be made on account of any approved substitution.

Details of all substitutions shall be included in the as-constructed drawings.

15 SUPPLEMENTARY REQUIREMENTS

The requirements of MRTS71 *Reinforcing Steel* are varied by the Supplementary requirements given in Clause 2 of Annexure MRTS71.1.