

Technical Specification

**Transport and Main Roads Specifications
MRTS72 Manufacture of Precast Concrete Elements**

July 2019

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1 Introduction

This Technical Specification applies to the manufacture of precast reinforced concrete elements other than box culverts, machine manufactured pipes and pre tensioned prestressed concrete members. It includes wet cast steel reinforced concrete pipes.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the *Transport and Main Roads Specifications Manual*.

1.1 Registered Products and Suppliers

The requirements for the construction of precast concrete elements include the use of registered products and suppliers. For information regarding these products and suppliers refer to the department's website, www.tmr.qld.gov.au, or email TMRStructuralMaterials@tmr.qld.gov.au.

2 Definition of terms

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

In addition, terms listed in Table 2 are applicable to this Technical Specification.

Table 2 – Definition of terms

Term	Definition
Applied load per anchor	The dead weight of the precast concrete element multiplied by the sling angle factor and the dynamic factor and divided by the number of effective lifting points used in the lift
Design Criteria	Departmental requirements for design details and methodology, found in different documents depending on application. For example, <i>Design Criteria for Bridges and Other Structures</i>
Designer	RPEQ Engineer responsible for the design of the element
Dynamic factor	A multiplying factor to account for dynamic effects during lifting
Factor of safety	The ultimate capacity (lower characteristic strength) of the lifting anchor divided by the applied load per anchor
Lifting anchor	A cast in, bolted on or otherwise attached device anchored to the unit, at the lifting point, which is provided exclusively for lifting the precast concrete element
Lifting attachment	Lifting device used to attach a lifting anchor to the hoisting equipment
Lifting point	The designed location of a lifting device to be used for lifting a precast concrete element
Registered	Pre-qualified product or supplier in accordance with departmental registration schemes: <ul style="list-style-type: none"> • <i>Registration Scheme: Suppliers and Products for Bridges and Other Structures</i> • <i>Product Index for Bridges and Other Structures</i> Registration for certain products and suppliers is a pre-requisite for approval, not a substitute

Term	Definition
Rigging diagram	Diagram showing the method for attaching hoisting equipment to the precast concrete element, the required sling angles and load sharing requirements
Sling angle factor	The factor by which the tension in a sling increases according to the included angle between the slings
Working load limit	The maximum load which may be applied to a lifting anchor, device or attachment

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 3600	<i>Concrete Structures</i>
AS 3610.1 (2018)	<i>Formwork for Concrete Part 1: Specifications</i>
AS 3850.1	<i>Prefabricated concrete elements Part 1: General requirements</i>
AS 5100.5	<i>Bridge Design Part 5 Concrete</i>
AS/NZS 4680 (2006)	<i>Hot dip galvanized (zinc) coatings on fabricated ferrous articles</i>
AS/NZS ISO 9001	<i>Quality Management Systems - Requirements</i>
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS06	<i>Reinforced Soil Structures</i>
MRTS15	<i>Noise Fences</i>
MRTS50	<i>Specific Quality System Requirements</i>
MRTS70	<i>Concrete</i>
MRTS71	<i>Reinforcing Steel</i>
MRTS71A	<i>Stainless Steel Reinforcing</i>
MRTS78	<i>Fabrication of Structural Steelwork</i>
MRTS78A	<i>Fabrication of Structural Stainless Steelwork</i>
SCM-P-015	<i>Registration Scheme: Suppliers and Products for Bridges and Other Structures</i>

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 Specifications*.

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

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
5.3	1. Approval of a new manufacturing procedure.		Submission of manufacturing procedure. (28 days)
5.4	2. Approval to commence manufacture		Submission of details of supply and manufacture. (14 days)
5.4.1	3. Approval of sample panel		
9.2		1. Placing of concrete	
11	4. Acceptance	2. Inspection	

4.2 Conformance requirements

The conformance requirements which apply to lots of work covered by this Technical Specification are summarised in Table 4.2

Table 4.2 – Conformance requirements

Clause	Item
9.8	Dimensions
11	Acceptance

4.3 Testing frequency

The minimum testing frequency for work covered by this Technical Specification is each precast concrete element manufactured with the exception of testing for concrete slump and strength. Testing frequencies for concrete slump and strength are as defined in MRTS70 *Concrete*.

5 Conditions for manufacture of precast concrete elements

5.1 Standard

All precast concrete elements shall be manufactured in accordance with the details shown on the Drawings and in accordance with this Technical Specification.

5.2 Manufacture by registered suppliers

Precast concrete members shall be manufactured only by a registered supplier. Registered suppliers shall comply with the *Registration Scheme: Suppliers and Products for Bridges and Other Structures*.

5.3 New manufacturing procedure

Where a new or innovative procedure is proposed to manufacture precast concrete elements, this shall be submitted to the department, giving details of materials and processes not less than 28 days prior to establishment of the process. **Milestone**

Manufacture using the new procedures shall not occur until approval of the new procedure has been granted. **Hold Point 1**

Where innovative manufacturing processes are proposed, it should be noted that the department has a strategy document on engineering innovation, which can be found on the Transport and Main Roads website.

With respect to intellectual property, the department has and always will respect manufacturers' intellectual property. However, it is considered necessary for all details of products and processes purchased by the department to be provided. These details shall not be provided to any third party.

Note: Any confidentiality document or formal agreement required would need to be negotiated between Transport and Main Roads' Legal Services and the manufacturer.

5.4 Manufacture of precast concrete elements

At least 14 days before manufacture is due to commence, the Contractor shall provide to the Administrator the following information: **Milestone**

- a) drawings showing the profile dimensions of the element, grade of concrete, cover to reinforcement and exposure classification
- b) the calculated mass of element
- c) nominated precast supplier, the precast supplier registration certificate and the place of manufacture
- d) casting program
- e) a quality plan, consisting at a minimum of:
 - i. an Inspection and Test Plan (ITP)
 - ii. nominated acceptance testing laboratory
 - iii. nominated method of concrete delivery, placement and compaction
 - iv. nominated method of concrete curing
 - v. method of product identification and marking.
- f) where the design is an alternative product design, a copy of the design approval (refer to Clause 6), and
- g) any pre-production submissions required by other Technical Specifications (e.g. MRTS70 *Concrete*, MRTS71 *Reinforcing Steel*).

Other pre-production submissions include, for example, the nomination of a concrete mix design and submission of its approval certificate (MRTS70 *Concrete*), and nomination of reinforcing steel supplier (MRTS71 *Reinforcing Steel*). These would form part of the quality plan.

The submitted quality plan is not the "quality manual" of ISO 9001, nor full work instructions. It may be a brief statement with some attachments.

Manufacture of precast concrete products shall not commence until the above submission has been approved by the Administrator. **Hold Point 2**

Note that Clause 5.4.2 can move this Hold Point from pre-manufacture to pre-delivery

5.4.1 Sample Panels

Sample elements shall be manufactured for inspection for precast elements either:

- a) manufactured from coloured concrete (that is, other than grey),
- b) cast with an inlaid pattern, or
- c) specified with a non-standard finish, including boat ramps (that is, not a class 2 finish to AS 3610.1).

Sample panels shall be manufactured and evaluated in accordance with AS 3610.1 Clause 3.7.

Production of further elements shall not begin prior to acceptance of the sample element by the Administrator. **Hold Point 3**

The accepted sample shall be preserved as a quality benchmark until completion of the production run.

MRTS06 *Reinforced Soil Structures* includes additional requirements for RSS facing panels.

5.4.2 Stock Items

Where a product is manufactured to a Transport and Main Roads Standard Drawing, or approved equivalent, with a 50 year design life, product which has been already been manufactured by a registered supplier, may be accepted at the sole discretion of the Administrator subject to:

- a) submission and approval of full production records and all other information in accordance with this Technical Specification, including Clause 5.4, demonstrating that the product is compliant with this Technical Specification prior to the product being delivered to site, and
- b) inspection of the product before delivery to site in accordance with the requirements of Clause 11 of this Technical Specification.

Where drawings for standard items have been approved by Engineering and Technology Branch in accordance with Clause 6.1, reinforcement details do not need to be included on the drawings for submission under this item. However, drawings indicating reinforcement details shall be available at the place of manufacture for inspection purposes.

Acceptance of product already manufactured is limited to standard low risk products, such as concrete lintels, gully inlets, drainage grate surrounds and lids.

6 Product design

6.1 Design requirements

Alternative product designs which do not comply with the department's Standard Drawings or the Issued-for-Construction Project Drawings shall not be used without approval from the department. Alternative product designs must comply with the Design Criteria, this Technical Specification and other relevant Technical Specifications. Supply of product to alternative designs shall not occur without approval of the Administrator.

Alternative product designs for products covered by Standard Drawings or other innovative products shall be submitted to the relevant section of the department's Engineering and Technology Branch for consideration and approval by the relevant Deputy Chief Engineer. All product details, including reinforcement details, shall be provided.

The department has a strategy document on engineering innovation, which can be found on the Transport and Main Roads website.

Note that approval of an alternate (proprietary) design by Engineering and Technology, and approval to supply an alternative product by the Administrator are separate processes. The former is however, a prerequisite of the latter.

6.2 Design life

The design life of precast concrete elements manufactured under this Technical Specification shall be as stated in the relevant design criteria, Standard Drawing or Technical Specification.

6.3 Exposure classifications, and cover to reinforcement

Exposure classifications, cover to reinforcement and minimum concrete strength shall be as per AS 3600 (for design life 50 years or less) or AS 5100 (for design life greater than 50 years) unless specified otherwise in the relevant design criteria, Standard Drawing or Technical Specification.

Elements with a design life of 50 years or more shall be designed for a minimum exposure classification of B2.

6.4 Provision for lifting

Each precast concrete element shall be provided with certified lifting points and these lift points shall be shown on the drawing. Approved lifting points shall comply with the following:

- a) the designer shall be responsible for certification of the lifting anchors. A rigging diagram shall be shown on the drawing. The rigging diagram shall include details of the required load sharing to equalise loads between lifting points and the included angle between the slings
- b) the minimum factor of safety for the design of the lifting points for both lifting anchor and concrete pull out capacity shall be 4.0
- c) the allowance for dynamic effects (dynamic factor) shall be as per Table 6.4. Elements requiring repeated lifts throughout the service life (e.g. traffic barriers) shall have a minimum dynamic factor of 2

- d) cast in lifting anchors shall comply with Clause 9 and shall fail in a ductile manner as evidenced by visible distortion prior to failure
- e) cover to reinforcement at the lifting anchor recess, if required, shall be maintained in accordance with this Technical Specification
- f) cover to the lifting anchor is not required provided any recess is filled with an approved cementitious repair grout, and:
 - i. stainless steel lifting anchors are used for Exposure Classification C2, and
 - ii. lifting anchor is hot dip galvanised to AS/NZS 4680 for all other exposure classifications
- g) all lifting anchors shall be permanently marked or tagged by the manufacturer with the working load limit, which shall be clearly visible when installed and in use
- h) the number of lifting points and the location of these points shall be designed to provide stability at all stages of lifting, handling and installation, including the requirement to land the product at the required level during installation
- i) with the exception of small symmetrical products less than 100 kg, a minimum of two lifting points shall be provided on all products and no product shall be lifted with less than two points; lifting of product shall be in accordance with the rigging diagram, and
- j) lifting anchors which are damaged shall not be used without inspection and certification by an RPEQ Engineer.

Table 6.4 – Dynamic factors for lifting

Means of Transportation	Factor
Gantry crane on steel rails (in precast yard)	≥ 1.2
Stationary hydraulic crane standing on outriggers	≥ 1.2
Tracked mobile lifting equipment travelling with the suspended load on a prepared even surface	≥ 1.7
Non-tracked mobile lifting equipment (including rubber tyred) travelling with the suspended load on a prepared even surface	≥ 2.0
All mobile equipment travelling with the load suspended on unprepared uneven surfaces	≥ 5.0
Any other case not listed above	≥ 1.5

In addition to the requirements of MRTS72, the following should also be considered:

- a) details of any temporary bracing or support requirements during transport or erection should also be included by the designer
- b) for some products, a generic lifting design may cover a range of variations to a product where there are only small variations in design, such as minor changes which decrease product mass or inclusion of additional ferrules or cast in items
- c) for design purposes, it should be assumed that products that are designed for repeat portable use, such as traffic barriers, are lifted 200 times, and all other products are lifted 20 times, and
- d) it should also be noted that the Working Load Limit shown on the lifting anchor may not correspond to a Factor of Safety of 4.0 as required by MRTS72. The manufacturer's specifications and the certified lifting design should always be consulted before installation of lifting anchors.

7 Reinforcing Steel

Reinforcing steel shall comply with MRTS71 *Reinforcing Steel* or MRTS71A *Stainless Steel Reinforcing* as appropriate.

The tolerance for cover to steel reinforcing in all elements shall be ± 5 mm.

8 Cast-in items

Cast in items, including, but not limited to, ferrules, formwork anchors, lifting devices, cast in bolts, anchor points, lintels and drainage grate surrounds, shall be either:

- a) fabricated by a registered steel fabricator in accordance with MRTS78 *Fabrication of Structural Steelwork* or MRTS78A *Fabrication of Structural Stainless Steelwork*, or
- b) proprietary items as specified in the Drawings or approved equivalent. Proprietary cast in items shall be a registered product.

Lifting devices shall comply with AS 3850.1, noting the additional safety factor required by Clause 6.4 when designing the lifting points.

9 Concrete

9.1 General

In addition to the requirements of MRTS70 *Concrete*, Clauses 9.2 to 9.8 shall apply to the manufacture of precast concrete elements.

9.2 Placing concrete

Placing of concrete shall be a mandatory Hold Point in the manufacturer's Quality Management System. The manufacturer shall also advise the Administrator of the intention to place concrete.

Witness Point 1 For product with a 50-year design life (or less) and manufactured to a Transport and Main Roads Standard Drawing or approved equivalent, refer to alternative requirements in Clause 5.4.2.

9.3 Formwork

Formwork shall comply with MRTS70 *Concrete*.

9.3.1 Formwork for precast concrete boat ramp planks

Precast concrete boat ramp planks shall be cast inverted in formwork supported on a flat, level and firm surface. The chevron pattern shall be incorporated into the base of the formwork. The formwork shall be designed so that the product can be stripped without damage.

The base of the formwork shall be metal or 19 mm formply that is sufficiently braced to resist deformation and remains flat during placement of concrete. The chevron pattern shall be created using milled HDPE or steel securely attached to the formwork base. Blockouts (if required for reduced gap planks) shall be HDPE or an integral part of the formwork front side.

Edge formwork shall be metal and have sufficient rigidity to resist deformation during placement of concrete. The stainless-steel link bars shall be fixed to the formwork to positively locate the link bars in both dimensions.

9.4 Fillets

Internal corners and external edges of all precast concrete elements shall be finished with curved or straight fillets appropriate to the application. Fillets are not required for external edges in products installed underground.

Specified cover also includes cover to fillets.

9.5 Installation of lifting devices

Lifting anchors shall be fixed securely in place before placement and compaction of concrete. Where the lifting anchor has a recess, cover shall be maintained to the recess.

Puddling in of lifting anchors into wet concrete is not permitted.

9.6 Removal of formwork

Formwork shall not be removed from the concrete or the product lifted until the concrete has attained a strength not less than 60% of the specified 28-day characteristic strength. Curing shall continue as soon as practical, but no later than one hour after removal of formwork.

Permission for early stripping or lifting of the product may be granted by the Administrator to a minimum of 40% of the specified 28-day strength, but not less than 16 MPa subject to satisfactory performance. Where a minimum lifting strength is shown on the drawings which is higher than these requirements, the drawing requirements shall apply.

Permission for early stripping or lifting will generally be granted, provided it can be demonstrated by calculations that the stresses in the product are not sufficient to cause cracking or damage.

9.7 Finish

9.7.1 Surface condition

The concrete shall be dense, hard and substantially free from chipped edges, fins, protrusions and surface roughness.

Any lifting recesses shall be filled with a registered cementitious repair grout or mortar to achieve the required surface finish in accordance with AS 3610.1 after installation of the product. Lifting ferrules shall be kept clean and fitted with a removeable cap.

Elements shall not be coated with cement wash or any other preparation not specified or otherwise approved by the Administrator.

9.7.2 Cracks, dents and bulges

Precast elements in Exposure Classifications B1 or less shall have:

- no crack or fissure wider than 0.3 mm
- no individual crack longer than 300 mm, and
- a cumulative crack length of no more than 500 mm.

Precast elements in Exposure Classifications B2 or higher shall have:

- no crack or fissure wider than 0.15 mm
- no individual crack longer than 300 mm, and
- a cumulative crack length of no more than 500 mm.

Dents not exceeding 3 mm in depth and bulges not exceeding 3 mm in height shall be permitted provided these do not extend over the surface for a distance of more than 180 mm and the specified cover is maintained.

The intention of this Technical Specification is that precast units are produced crack free.

9.7.3 Air holes

Air holes exceeding 12 mm in lateral dimension or having a depth greater than 3 mm shall be filled in accordance with MRTS70 *Concrete*.

The intention of this Technical Specification is that precast units are produced with very few air holes. Excessive air holes are a strong indication that suitable manufacturing processes are not being observed in the production process and are not acceptable.

9.8 Tolerances

Completed precast concrete elements shall comply with the tolerances set out in Table 9.8. In addition, the following tolerances apply:

- a) position of lifting attachments ± 5 mm
- b) position of ferrules and other cast-in items ± 5 mm: where a ferrule group or other cast in items are required to be attached to the same element, the relative tolerance between these ferrules or cast-in items shall be ± 2 mm or as specified by the Designer, and
- c) horizontal and vertical alignment of link bars in precast concrete boat ramp planks ± 3 mm.

Table 9.8 – Tolerances for precast concrete elements

Precast concrete element	Tolerance (mm)				
	Thickness of any section	Length or width	Internal dimensions	Straightness†	Squareness
Slabs and panels, including RSS wall panels	± 3	± 3	–	3	± 3 in 2000 mm
Pits, gullies and manholes	+ 5, - 3	± 5	± 5	–	± 5 in 2000 mm
Kerbs, channels and blocks	+ 5, - 3	± 5	–	5	± 3 in 2000 mm
Retaining walls	± 5	± 10	–	3	± 5 in 2000 mm
Traffic barriers	± 5	± 10	–	5	± 5 in 2000 mm
Piles	+ 10, - 5	± 20	–	10	–
Boat ramp planks	± 3	± 3	–	5	± 3 in 2000 mm
All other products	+ 5, - 3	± 5	± 5	3	± 5 in 2000 mm

† Deviation from a 1 metre long straight-edge except for piles the deviation is over the length of the pile.

10 Marking, handling, storing and transporting

10.1 Marking

On each precast concrete element, the following information shall be clearly and permanently marked on a surface which shall not be on permanent display when erected:

- a) date of manufacture
- b) identification number
- c) manufacturer's name or registered mark, and
- d) maximum mass of the element.

10.2 Handling

Precast concrete elements shall be handled in a manner which shall avoid damage to the element and shall be lifted using the lifting points provided. Lifting of product shall be in accordance with the rigging diagram.

10.3 Transporting

Precast concrete elements shall not be transported from the place of manufacture until the greater of seven days has elapsed since casting and the time when concrete has attained 70% of the specified 28 day characteristic strength.

Adequate packers or supports shall be provided to support and firmly hold precast concrete elements during transport. The packers or supports shall not damage or stain the product in any way.

10.4 Storing

Precast concrete elements shall be stored clear of the ground on adequate supports placed on a plane surface in a manner that shall avoid damage, twisting or warping. The ground shall not be subject to subsidence under the weight of the elements.

Slabs and panels may be stacked up to six layers high, provided that supports are provided to separate each layer. Supports for upper layers shall be placed directly above the supports of the layer below.

Material used for supports shall not damage or stain the product in any way.

11 Acceptance

Precast concrete elements shall remain available for inspection for a minimum of seven days from the date of manufacture. **Witness Point 2**

The acceptability of precast concrete elements in accordance with this Technical Specification shall be determined by inspection on the basis of visual inspection, geometric measurement, measurement of clear cover to reinforcement, reinforcement spacing and location, and specified 28 day concrete strength. **Hold Point 4**

Precast concrete elements may be rejected should the products fail to meet any of the requirements of this Technical Specification.

Any damage to the product during handling or transporting to site shall be assessed in accordance with Clause 9.7 of this Technical Specification.

MRTS72 states that 'Precast concrete elements may be rejected should the products fail to meet any of the requirements of this Technical Specification'. It should be noted that manufacture of defect free product in accordance with MRTS72 is always the preferred outcome. However, where issues exist, early submission of non-conformances in accordance with the contract to the Administrator may assist with resolving issues. Acceptance of non-conforming or defective product is always at the discretion of the Administrator.

11.1 Records to be submitted

For release of **Hold Point 4**, the following records shall be submitted:

- a) Lot register enabling traceability between records and physical units
- b) As-constructed dimensions of units
- c) Concrete strength test reports and summary (as per MRTS70 *Concrete*)
- d) Heat-accelerated curing charts (as per MRTS70 *Concrete*), if applicable
- e) Other documentation required by Technical Specifications

Item (e) may be triggered when another Technical Specification calls up MRTS72 for manufacture. For example, precast concrete electrical pits to MRTS91 *Conduits and Pits* require a load test and subsequent batch release certificate.

