

Superseded

Technical Specification

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

October 2017

Superseded

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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.

The requirements for the manufacture of precast concrete elements include 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 approved products

Clause	Category of Work
5.2	Precast Concrete Manufacturer
9	Proprietary Cast-in items
6.5 and 10.9.1	Cementitious Repair Grout

For information regarding approved suppliers and products for the above items, refer to <https://www.tmr.qld.gov.au/business-industry/Business-with-us/Approved-products-and-suppliers/Bridges-and-other-structures-approved-products-and-suppliers.or>:

Department of Transport and Main Roads
 Bridge Construction Maintenance and Asset Management (BCMAM)
 GPO Box 1412
 Brisbane Qld 4001.

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 applicable to MRTS72

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
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

Term	Definition
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
Sling angle factor	The factor by which the tension in a sling increases according to the included angle between the slings
Rigging diagram	Diagram showing the method for attaching hoisting equipment to the precast concrete element, the required sling angles and load sharing requirements
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 1012.20 (1992)	<i>Methods of Testing Concrete Method 20: Determination of Chloride and Sulfate in Hardened Concrete and Concrete Aggregates</i>
AS 1379 (2007)	<i>Specification and Supply of Concrete</i>
AS 3600 (2009)	<i>Concrete Structures</i>
AS 5100.5 (2004)	<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 (2008)	<i>Quality Management System Requirements</i>
Design Criteria	<i>Design Criteria for Bridges and Other Structures</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>
MRTS72	<i>Manufacture of Precast Concrete Elements</i>
MRTS78	<i>Fabrication of Structural Steelwork</i>
SMP-PC01	<i>Procedures Manual: Registration of Approved Suppliers of Precast Concrete Products</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
5.4	1. Approval of drawings by the Administrator 2. Approval of sample panel	1. First cast of each member type.	Submission of details of process of manufacture (28 days).
5.5	3. Approval of a new manufacturing procedure.		Submission of details of process of manufacture (28 days).
5.6	4. Approval to manufacture precast concrete boat ramp planks		Submission of information to manufacture precast concrete boat ramp planks
10.2		2. Placing of concrete.	
12		3. 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
10	MRTS70 Concrete
10.10	Tolerances
12	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 elements shall be manufactured only by a Registered Supplier. The requirements for registration are outlined in the document SMP-PC01. For a copy of this document, refer to contact details in Clause 1.

To be eligible for registration as a Registered Supplier, a supplier shall:

- a) operate a quality management system certified to a minimum of AS/NZS ISO 9001. Certification shall be by a JAS / ANZ accredited certifier
- b) establish procedures for manufacture of precast concrete elements, and
- c) have an inspection and test plan, including Hold Points acceptable to the department for manufacturing precast concrete elements which demonstrates compliance with this Technical Specification. The inspection and test plan shall address supply of materials.

Registration as a Registered Supplier of precast concrete elements shall be reviewed at intervals varying from six months to three years, depending on registration level or earlier if unsatisfactory performance is noted.

5.3 Registration status

Information regarding registration status can be obtained from Transport and Main Roads. Refer to Clause 1.

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, reinforcement details, grade of concrete, cover to reinforcement and exposure classification
- b) the calculated mass of element
- c) the place of manufacture
- d) an outline of the procedure of manufacture, Quality Plan and casting program, and
- e) where the design is an alternative product design, a copy of the design approved by the Administrator shall also be submitted (refer to Clause 6).

Manufacture of precast concrete products shall not commence until approval of drawings has been granted by the Administrator. **Hold Point 1**

The manufacturer shall advise the Administrator when the first cast of each member type is to occur.

Witness Point 1

Sample panels for RSS wall panels shall be as per MRTS06 *Reinforced Soil Structures*. For other precast elements manufactured from either coloured concrete, or which have a pattern cast into the surface, or precast concrete recreational boat ramp planks (refer Clause 5.6(h) for sample requirements), the manufacturer shall make available a sample element for inspection. Production of further panels or boat ramp planks shall not occur prior to acceptance of the sample element by the administrator. **Hold Point 2**

Requirements for inspection of sample panels for RSS wall panels are included in MRTS06 *Reinforced Soil Structures*. Coloured concrete refers to colours other than grey.

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 12 of this Technical Specification.

Where drawings for standard items have been previously approved by Transport and Main Roads in accordance with Section 6 of MRTS72 *Manufacture of Precast Concrete Elements*, reinforcement details do not need to be included on the drawings for submission under this item. However, drawings indicating reinforcement details must 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.

5.5 New manufacturing procedure

Where a new or innovative procedure is proposed to manufacture precast concrete elements, this procedure will need to be included in the registration (refer Clause 5.2). The manufacturer shall submit the procedure for manufacture to the department (refer Clause 1), giving details of materials and processes not less than 28 days prior to establishment of the process. **Milestone**

Manufacture shall not occur until approval and registration of the new procedure has been granted by Transport and Main Roads (refer Clause 1). **Hold Point 3**

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.

5.6 Manufacture of precast concrete recreational boat ramp planks

For manufacture of the standard precast concrete recreational boat ramp planks only, where the precaster cannot satisfy Clause 5.2, the precaster may be granted permission to manufacture planks subject to submission and acceptance of the following information, not less than 14 days prior to commencement of manufacture. **Milestone** Manufacture shall not commence until approval has been granted by the Director (Bridge and Marine Engineering). **Hold Point 4**

- a) Place of manufacture
- b) details of formwork (number of forms, materials, method of assembly, fixing of link bars and conformance with dimensional accuracy)
- c) proposed concrete mix
- d) production rate and proposed program of pouring, curing stripping and handling
- e) curing and handling procedure
- f) method of achieving non-slip surface
- g) inspection and test plan (ITP), including Hold Points acceptable to the department for manufacturing precast concrete boat ramp planks which demonstrates compliance with this Technical Specification and the drawing – the ITP shall also address the supply of materials and the identification of non-conforming product, and
- h) production of a sample element for approval using the proposed design concrete mix and method of applying the non-slip finish. The sample element shall be 400 x 400 x 150 mm and include the chamfered edge and at least two full depth non-slip chevrons at the skew angle of the full size element. A new sample will be made if the design mix or the method of applying the non-slip finish changes.

6 Product design

6.1 Design requirements

Alternative product designs which do not comply with the department's Standard Drawings or the Certified For Construction Project Drawings shall not be used without approval from Transport and Main Roads. 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 must 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, must be provided.

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

Changes or modifications to project drawings must be addressed through an appropriate contractual process with the Administrator. Approval to supply alternative products to a project instead of standard specified products must also be obtained using the same method.

6.2 Design life

The design life of precast concrete elements manufactured under this Technical Specification shall be one of the following as defined in the Design Criteria:

- a) 100 years as defined in this Technical Specification
- b) 50 years as defined in this Technical Specification

- c) noise fences as defined in MRTS15 *Noise Fences*, and
- d) RSS wall panels as specified in MRTS06 *Reinforced Soil Structures*, 100 years in accordance with this Technical Specification.

6.3 Exposure classifications and cover to reinforcement

6.3.1 100 year design life

6.3.1.1 Exposure classifications (100 year design life)

The minimum exposure classification for products with a 100 year design life, including all bridge components, shall be B2 in accordance with AS 5100.5. Exposure classifications shall be in accordance with AS 5100.5, with the exception of the following environments:

- a) brackish, saltwater and marine applications in accordance with Table 6.3.1.1(a), and
- b) potential acid sulfate soil (PASS) and / or acid sulfate soil (ASS) environments in accordance with Table 6.3.1.1(b).

Table 6.3.1.1(a) – Concrete exposure classifications for precast elements in brackish, saltwater and marine applications

Location	Chloride content of water	Exposure classification
Brackish water permanently submerged or zones subject to repeated wetting or drying	2000 ppm to 8000 ppm	B2
Permanently submerged in marine or saltwater	Above 8000 ppm	C
Spray zones in marine or saltwater	Above 8000 ppm	C
Tidal splash zones or zones subject to repeated wetting and drying in marine or saltwater	Above 8000 ppm	C2

1. Tidal splash zone is the zone 1 m below lowest astronomical tide (LAT) to 1 m above highest astronomical tide (HAT).
2. Spray zone is the zone from 1 m above HAT where the structure is exposed permanently to salt spray or built over the sea.
3. Soffits of bridges and other structures which are in occasional contact with saltwater shall be Exposure Classification C.

Table 6.3.1.1(b) – Concrete exposure classifications for precast elements in (PASS / ASS)

SO ₄ in groundwater (mg/l or ppm)	Acidity (pH)			
	< 3.5	≥ 3.5 to < 4.5	≥ 4.5 to < 5.5	≥ 5.5
< 1500	C2	C1	C	B2
≥ 1500 to < 3000	C2	C1	C	B2
≥ 3000 to < 6000	C2	C2	C	B2
≥ 6000	C2	C2	C2	C

1. Full isolation of the concrete surface exposed to the environment by either protective coating, membrane or use of controlled backfill is also required for Exposure Classification C2.

Additional information is provided in this section of MRTS72 *Manufacture of Precast Concrete Elements* as AS 5100.5 (2004) does not adequately address exposure classifications for aggressive environments, including salt water environments, and acid sulfate soils (ASS) and potential acid sulfate soils (PASS).

6.3.1.2 Cover to reinforcement (100-year design life)

Cover to reinforcement shall be as defined in AS 5100.5 except for the following exceptions:

- a) Exposure Classification C2 in salt water or marine applications as defined in Table 6.3.1.1(a) – 70 mm with rigid forms and intense vibration, and
- b) Exposure Classifications C, C1 and C2 for PASS / ASS as per exposure classification C in AS 5100.5.

Additional information is provided in this section of MRTS72 *Manufacture of Precast Concrete Elements* as AS 5100.5 (2004) does not adequately address cover to reinforcement for aggressive environments, including salt water environments, and acid sulfate soils (ASS) and potential acid sulfate soils (PASS).

6.3.2 50-year design life

Exposure classifications and cover to reinforcement for products with a 50-year design life shall be as defined in AS 3600. The minimum exposure classification shall be A2.

6.3.3 Noise fences

Exposure Classifications and cover to reinforcement are as defined in MRTS15 *Noise Fences*.

6.4 Concrete

Concrete shall be as defined in Clause 10 of this Technical Specification.

6.5 Provision for lifting

Each precast concrete element shall be provided with approved 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 minimum allowance for dynamic effects (dynamic factor) shall be 1.5. Higher values shall be used in the following cases:
 - lifting with a crawler crane travelling with the load suspended on an even surface (1.7)
 - lifting with a rubber-tyred mobile crane either stationary or travelling with the load suspended on an even surface (2.0)
 - all traffic barriers or other products designed for repeat portable use (2.0), and

- lifting while travelling with the load suspended over very rough ground (5.0)
- d) cast-in lifting points 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:
 - stainless steel lifting anchors are used for Exposure Classification C2, and
 - 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.

In addition to the requirements of MRTS72 *Manufacture of Precast Concrete Elements*, 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 *Manufacture of Precast Concrete Elements*. The manufacturer's specifications and the certified lifting design should always be consulted before installation of lifting anchors.

7 Materials

Steel reinforcing shall comply with the requirements of MRTS71 *Reinforcing Steel* except as amended by this Technical Specification (refer Clause 8).

Cast-in items shall comply with Clause 9 of this Technical Specification.

Concrete shall comply with the requirements of MRTS70 *Concrete*, except as amended by this Technical Specification (refer Clause 10).

8 Modifications to MRTS71 Reinforcing Steel

8.1 General

Notwithstanding any requirements to the contrary in MRTS71 *Reinforcing Steel*, Clauses 8.2 to 8.3 shall apply to the manufacture of precast concrete elements.

8.2 Cover

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

8.3 Bar chairs

Bar chairs and spacers between the formwork and reinforcement shall comply with MRTS70 *Concrete*. Steel spacers can be used for internal spacing of individual reinforcing mats where the spacer does not intrude on the cover zone in any way.

9 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 an approved steel fabricator in accordance with MRTS78 *Fabrication of Structural Steelwork*, or
- b) proprietary items as specified in the Drawings or approved equivalent. Proprietary cast-in items shall be an approved product (refer Clause 1).

10 Modifications to MRTS70 Concrete

10.1 General

In addition to the requirements of MRTS70 *Concrete*, Clauses 10.2 to 10.10 shall apply to the manufacture of precast concrete elements.

10.2 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 2 For product with a 50-year design life and manufactured to a Transport and Main Roads Standard Drawing or approved equivalent, refer to alternative requirements in Clause 5.4.

10.3 Concrete strength grade and additional concrete mix design requirements

10.3.1 Minimum concrete strength grade and aggregate size

Precast concrete elements shall be manufactured from concrete with a characteristic 28-day strength of not less than:

- a) for Exposure Classification A2 and B1 to AS 3600, S32 to MRTS70 *Concrete*
- b) for Exposure Classification B2 to AS 3600 and AS 5100, S40 to MRTS70 *Concrete*, and

- c) for Exposure Classification C, C1, C2 and U (marine, tidal, saltwater or PASS / ASS conditions) to both AS 3600, AS 5100 and this Technical Specification, 50 MPa to MRTS70 Concrete.

The maximum aggregate size shall be 20 mm unless shown otherwise on the Drawings.

MRTS72 *Manufacture of Precast Concrete Elements* requires that 'The maximum aggregate size shall be 20 mm unless shown otherwise on the Drawings'. Changing to smaller maximum aggregate size concrete mixes is not permitted unless approved by the designer. There has been some history with increased shrinkage and cracking of product with 10 mm maximum aggregate mixes in larger products.

10.3.2 Additional requirements for S32, S40 and S50 concrete mixes for Exposure Classifications B2 or less

For exposure classifications A2, B1 and B2 to AS 3600 and B2 to AS 5100, the following requirements are in addition to MRTS70 Concrete:

- a) minimum total cementitious content and maximum water cementitious ratio to be as per MRTS70 Concrete
- b) cementitious material to be a blend compliant with either of the following criteria with the combined total adding to 100%. Blend tolerances to be as per AS 1379:
 - 65% to 75% GP Cement, 25% to 35% Fly Ash
 - 50% to 55% GP Cement, 20% to 25% Ground Granulated Blast Furnace Slag, and 25% to 30% Fly Ash, or
 - 65% to 71% GP Cement, 4% to 8% Amorphous Silica, and 25% to 31% Fly Ash, and
- c) maximum chloride ion content of hardened concrete to be 0.80 kg/m³.

10.3.3 Additional requirements for aggressive environments S50 concrete mixes

For Exposure Classifications C1, C2 in AS 3600 and C, C1, C2 in AS 5100, the following requirements are in addition to MRTS70 Concrete:

- a) maximum chloride ion content of hardened concrete to be 0.40 kg/m³
- b) minimum total cementitious content and maximum water cementitious ratio for C Exposure Classifications to be as per MRTS70 Concrete; for C1 and C2 Exposure Classifications minimum total cementitious content to be 500 kg/m³ and maximum water cementitious ratio to be 0.4, and
- c) cementitious material to be a blend compliant with either of the following criteria with the combined total adding to 100%. Blend tolerances to be as per AS 1379:
 - 50% to 55% GP Cement, 20% to 25% Ground Granulated Blast Furnace Slag, and 25% to 30% Fly Ash, or
 - 65% to 71% GP Cement, 4% to 8% Amorphous Silica, and 25% to 31% Fly Ash.

There is strong evidence to demonstrate that concrete mixes containing a ternary blend of cementitious materials provide significantly enhanced durability. This is particularly critical in aggressive environments. Use of supplementary cementitious materials, such as Fly Ash and Ground Granulated Blast Furnace Slag, also significantly decreases the environmental impacts associated with cement production and also controls Alkali Silica Reaction (ASR).

Under no circumstances in any environment will the use of only GP Cement be considered due to the risk of ASR. Thus, a blended cement is specified in all applications.

10.3.4 Determination of chloride content of hardened concrete

The following method shall be used to determine the chloride ion content by testing ground samples of hardened concrete in accordance with AS 1012.20.

Take the samples from a minimum 1.2 kg portion of the hardened concrete. Crush and grind the 1.2 kg of hardened concrete to a maximum size of 150 microns, and then oven dry at $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a minimum of one hour before taking the samples for analysis.

Analyse five randomly selected samples of 20 ± 0.1 grams of the ground concrete for chloride ion content.

Use the Volhard titration method calibrated against a concrete with known chloride content for the tests. Modify the procedure of AS 1012.20 and use standard solutions for the analysis that bracket the expected chloride ion concentration. Alternatively, use the AS 1012.20 XRF (X-Ray Fluorescence) Method in accordance with AS 1012.20.

Report the following:

- a) chloride ion content of each of the five samples
- b) the average chloride content, and
- c) standard deviation of the five samples.

The average mass of acid soluble chloride ion per unit volume of hardened concrete as placed must not exceed the values given in Clause 10.3.2c) or 10.3.3a) as appropriate.

Tests are to be undertaken by a NATA accredited laboratory, and be submitted with the mix design. Test is to be repeated annually.

10.4 Formwork

Formwork shall be constructed from metal – timber forms are not acceptable. Where rigid forms and intense vibration is specified, external formwork vibrators shall be used. Where a hole or void in the concrete is shown on the drawing, the formwork or void former shall be removed after casting. Permanent hole formers are not accepted unless shown on the drawing.

MRTS72 specifies metal formwork. The following exceptions are acceptable for flat panel work only:

- a) use of timber edge forms for custom panels
- b) use of proprietary form liners or other suitable material as a form liner for patterned panels
- c) polystyrene to form custom blockouts.

10.4.1 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.

10.5 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.

10.6 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.

10.7 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 form work. **Nonconformance**

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 15 MPa subject to the following conditions:

- a) product design approval
- b) certification of product lifting points, and
- c) satisfactory performance.

Under no circumstances shall the formwork be stripped or the product lifted before the concrete has attained a strength of 40% of the specified 28-day concrete strength. 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 in accordance with the requirements of MRTS72 *Manufacture of Precast Concrete Elements* 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.

10.8 Curing

Curing shall conform to the following requirements – combinations of curing methods are permitted.

Combinations of curing may involve steam curing until at least the specified concrete strength for removal of formwork and lifting of the product has been achieved followed by water or membrane curing. This allows maximum utilisation of formwork in precast applications. The requirements of MRTS72 *Manufacture of Precast Concrete Elements* must be followed in the transition between steam, and water or membrane curing. Care must be taken to avoid damage or cracking to the product due to thermal shock and to ensure that the product has cooled before application of a curing compound if this curing method is used.

10.8.1 Water or membrane curing

Curing shall continue until the lesser of seven days and the time when the concrete has attained 70% of the specified 28 day characteristic strength.

Acceptable methods are described in MRTS70 *Concrete*.

10.8.2 Steam curing

Steam curing processes shall be as per MRTS70 *Concrete*. Curing shall be deemed to be complete if 70% of the specified concrete strength and a minimum of 420°C hours in the enclosure has been achieved.

Where concrete is steam cured for a lesser time than these curing requirements, or 70% of the specified strength has not been achieved, the concrete shall be kept covered and saturated until the concrete surface cools to not more than 20°C above ambient temperature and alternative curing is commenced to achieve the Standard Curing Requirements, defined in Clause 10.8.1 of this Technical Specification.

10.9 Finish

10.9.1 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 an approved cementitious repair grout (refer Clause 1) to the satisfaction of the Administrator after installation of the product.

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

10.9.2 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 the MRTS72 *Manufacture of Precast Concrete Elements* is that precast units are produced crack free.

10.9.3 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.

The intention of MRTS72 *Manufacture of Precast Concrete Elements* 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.

10.10 Tolerances

Completed precast concrete elements shall comply with the tolerances set out in Table 10.10. 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 10.10 – 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.

11 Marking, handling, storing and transporting

11.1 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.

11.2 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.

11.3 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.

11.4 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.

12 Acceptance

Precast concrete elements shall remain available for inspection for a minimum of seven days from the date of manufacture. **Witness Point 3**

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.

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 10.9 of this Technical Specification.

MRTS72 *Manufacture of Precast Concrete Elements* 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 *Manufacture of Precast Concrete Elements* 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.

Superseded