

Technical Specification

MRTS274 Repair of New Concrete Construction

November 2024



Copyright

© The State of Queensland (Department of Transport and Main Roads) 2024.

Licence



This work is licensed by the State of Queensland (Department of Transport and Main Roads) under a Creative Commons Attribution (CC BY) 4.0 International licence.

CC BY licence summary statement

In essence, you are free to copy, communicate and adapt this work, as long as you attribute the work to the State of Queensland (Department of Transport and Main Roads). To view a copy of this licence, visit: <https://creativecommons.org/licenses/by/4.0/>

Translating and interpreting assistance



The Queensland Government is committed to providing accessible services to Queenslanders from all cultural and linguistic backgrounds. If you have difficulty understanding this publication and need a translator, please call the Translating and Interpreting Service (TIS National) on 13 14 50 and ask them to telephone the Queensland Department of Transport and Main Roads on 13 74 68.

Disclaimer

While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained within. To the best of our knowledge, the content was correct at the time of publishing.

Feedback

Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Contents

- 1 Introduction 1**
- 2 Definitions of terms 1**
- 3 Referenced documents 2**
- 4 Standard test methods 2**
- 5 Quality system requirements 3**
 - 5.1 Hold Points, Witness Points and Milestones 3
 - 5.2 Construction procedures 3
 - 5.3 Conformance requirements 4
- 6 Competency of personnel 4**
- 7 Nature and extent of defect 4**
- 8 Repair Approval 5**
 - 8.1 Nature and extent of repair 5
 - 8.1.1 *Pre-approved Repair Procedures* 5
 - 8.2 Withdrawal of Approval 5
- 9 Acceptance 6**
- 10 Materials 6**
 - 10.1 Registration 7
 - 10.2 Water 7
 - 10.3 Dowels 7
 - 10.4 Cast-in items 7
- 11 Repair of Cracks 7**
 - 11.1 Repair of fine cracking by means of coating 7
 - 11.1.1 *General* 7
 - 11.1.2 *Materials* 8
 - 11.1.3 *Surface preparation* 8
 - 11.1.4 *Coating application* 8
 - 11.1.5 *Acceptance* 9
 - 11.2 Crack repair by means of injection 9
 - 11.2.1 *General* 9
 - 11.2.2 *Materials* 9
 - 11.2.3 *Surface preparation* 10
 - 11.2.4 *Crack injection* 10
 - 11.2.5 *Acceptance* 11
 - 11.3 Repair of cracks by gravity feed 11
 - 11.3.1 *Materials* 11
 - 11.3.2 *Application* 11
 - 11.3.3 *Acceptance* 12
- 12 Repair of chips, spalls and honeycombed concrete 12**
 - 12.1 Materials 12
 - 12.2 Extent of repair 13
 - 12.3 Breaking out concrete 14
 - 12.3.1 *Fully exposed reinforcement or prestressing strand* 14

12.4 Cast in items 14

12.5 Installation of dowels 15

12.6 Surface preparation 15

12.7 Application of repair material 15

12.8 Curing 16

12.9 Acceptance 16

Appendix A: Example repair method matrix entries..... 17

1 Introduction

This Technical Specification applies to the repair of minor defects to new concrete structures under construction. Structural defects should be directed to the Designer for case-by-case assessment prior to selection from this document and subsequent approval.

Surface dressing, (i.e., the filling of air (bug) holes to achieve the required surface finish) in accordance with MRTS70 *Concrete*, is not considered repair.

Rectification of non-conformances through the use of this Technical Specification shall be at no cost to the Principal.

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 repair of concrete elements include the use of products that are registered by Transport and Main Roads. For information regarding these products refer to the Transport and Main Roads website (www.tmr.qld.gov.au) or email TMRStructuralMaterials@tmr.qld.gov.au.

2 Definitions 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 – Definitions of terms

| Term | Definition |
|---|---|
| Active crack | Live cracks, which are subject to further movement under applied load. |
| Characteristic strength (f _c) | The compressive strength of the concrete at age 28 days as specified in the Contract. |
| Crack width | The maximum measured width of the crack along its length. Crack width is determined at the surface of the concrete by use of a crack comparator gauge or card. |
| Designer | RPEQ engineer responsible for the design of the element. |
| Deterioration | The decrease in concrete properties/performance due to gradual processes. For example, corrosion of reinforcement. The decrease of performance itself may be sudden. |
| Registered | Pre-qualified product in accordance with departmental registration schemes: <ul style="list-style-type: none"> • <i>Product Index for Bridges and Other Structures</i> Registration for products and suppliers is a pre-requisite for Administration approval, not a substitute. |

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

| Reference | Title |
|-----------------|---|
| Design Criteria | <i>Design Criteria for Bridges and Other Structures</i> (Transport and Main Roads document) |
| AS 1478.2 | <i>Chemical admixtures for concrete, mortar and grout – Methods of sampling and testing admixtures for concrete, mortar and grout</i> |
| BS 6319-2 | <i>Testing of resin composites for use in construction</i> |
| EN 1504 | <i>Products and Systems for the Protection and repair of Concrete Structures</i> |
| ICRI 310.2R | <i>Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.</i> |
| MRTS01 | <i>Introduction to Technical Specifications</i> |
| MRTS50 | <i>Specific Quality System Requirements</i> |
| MRTS70 | <i>Concrete</i> |
| MRTS71 | <i>Steel Reinforcing</i> |
| SA HB 84 | <i>Guide to Concrete Repair and Protection</i> |
| AS 1580.408.5 | <i>Paints and related materials</i> |
| - | <i>Managing respirable crystalline silica dust exposure in construction and manufacturing of construction elements: Code of Practice (WHSQ, 2022)</i> |

4 Standard test methods

The standard test methods stated in Table 4 shall be used in this Technical Specification.

For testing of proprietary repair materials, equivalent test methods may be proposed by the manufacturer.

Australian Standard (AS), International Standard (ISO), European Standard (EN), ASTM and British Standard (BS) methods will be considered in that order of preference.

Further details of test numbers and test descriptions are given in Clause 4 of MRTS01 *Introduction to Technical Specifications*.

All laboratory testing for the purposes of compliance and supplier registration including sampling are to be performed and reported by a NATA-accredited (or equivalent) laboratory, whose scope of accreditation encompasses the test method used. In situ testing (for example Dry Firm Thickness (DFT) and pull off testing) may be conducted without NATA-accreditation on approval by the Administrator of a suitable work method statement and competency records.

Table 4 – Standard test methods

| Property to be Tested | Method No. |
|---|---------------------|
| Polymers | |
| Compressive strength | BS 6319-2 |
| Tensile Strength | BS 6319-7 |
| Flexural Strength | BS 6319-3 |
| Bond Strength / Adhesion (pull off) | AS 1580.408.5 |
| Dry Film Thickness (DFT) | AS 1580.108.2 |
| CO ₂ Diffusion Co-efficient | AS/NZS 4548.5 App D |
| Crack Bridging Ability | AS/NZS 4548.5 App F |
| Cementitious Materials | |
| Compressive Strength (samples to be moulded in restrained condition) | AS 1012.9 |
| Bond Strength / Adhesion – cementitious | AS 1012.24 |
| Restrained shrinkage / expansion | EN 12617-4 |

5 Quality system requirements

5.1 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 5.1. There are no Milestones defined.

Table 5.1 – Hold Points, Witness Points and Milestones

| Clause | Hold Point | Witness Point | Milestone |
|--------|---|------------------------------------|-----------|
| 8.1 | 1. Approval of repair method by the Administrator | 1. Application of repair technique | |
| 9 | | 2. On site compliance testing | |

5.2 Construction procedures

Contractor procedures which are required to be submitted by the Contractor to the Administrator in accordance with MRTS50 *Specific Quality System Requirements* are listed in Table 5.2

Table 5.2 – Construction Procedures

| Clause | Procedure |
|--------|------------------|
| 8.1 | Repair Procedure |

5.3 Conformance requirements

The conformance requirements which apply to lots of work covered by this Technical Specification are those related to:

- a) materials, and
- b) application

6 Competency of personnel

All repair work shall be undertaken and supervised by suitably skilled and experienced personnel. Where necessary to preserve manufacturer warranties, relevant approvals/accreditations shall be held.

7 Nature and extent of defect

Prior to any repair, the cause, nature and extent of any defects shall be investigated and recorded. Cracks widths shall be measured at the concrete surface and recorded as the maximum width of the crack.

To prevent disagreements, exactly where cracks were measured should be indicated, and the time of day recorded. Fretting of crack edges should be noted but excluded from the width measurement.

Any damage due to deterioration, or likely to impact the concrete element's structural performance, or suspected of being due to inadequate reinforcement detailing, shall be referred to the Designer. The following defects shall always be so referred:

- a) cracks over 0.8 mm in width
- b) full thickness cracks
- c) active (non-dormant) cracks
- d) damaged reinforcement or strand, and/or
- e) fully exposed reinforcement or strand.

Repairs to defects referred in this manner shall be considered on a case-by-case basis with a specific repair specification developed. The materials and methods in this Technical Specification may not be sufficient.

Deterioration (e.g., alkali-silica reaction, reinforcement corrosion) is unlikely to occur during construction. Where deterioration is the cause of cracking or spalling, the cause needs to be addressed as part of the ensuing works. SA HB 84 gives guidance for the assessment of defects and the choosing of appropriate methodologies.

8 Repair Approval

8.1 Nature and extent of repair

The nature and extent of the proposed repair including proposed repair method and materials shall be documented and work shall not commence until approval of the repair procedure has been granted by the Administrator. **Hold Point 1**

The repair procedure shall include the following items:

- a) reference to the governing Technical Specification and its conformance requirements
- b) details of repair method including step-by-step activities (the Work Method Statement)
- c) details of materials (by name) used in repair method with accompanying technical data sheets and evidence of Transport and Main Roads-registration, and
- d) verification and reporting activities.

The Contractor shall advise the Administrator when the repair, including preparation, is to occur.

Witness Point 1

8.1.1 Pre-approved Repair Procedures

With agreement from the Administrator, the Contractor may prepare a standardised collection of repair procedures. In addition to the requirements above for individual repair procedures, this overarching, generic repair procedure shall include:

- a) criteria used to choose the applicable repair method
- b) whether the Hold Point for approval of the individual repair will be triggered
[refer to Hold Point 1]
- c) whether the Witness Point for the repair shall be triggered. The Witness Point shall apply for the first repair of each type **[refer to Witness Point 1]**, and
- d) whether a formal nonconformance report for the individual defect will be submitted to the Administrator.

Where individual nonconformance reports are not raised, the repair shall be noted in the relevant lot register.

This method of pre-approval of repairs is suitable for large projects and precast yards where similar defects are likely to reoccur.

Appendix A provides an example of how the criteria may be presented.

8.2 Withdrawal of Approval

Approval of the repair procedure may be withdrawn by the Administrator if:

- a) the quality of the repair work is not satisfactory
- b) adequate records of repair work and pre-repair quality are not kept, or
- c) the frequency of repairs indicate underlying quality management or design problems.

Repair methodologies should never be used as a substitute for quality workmanship and their use should be the exception.

9 Acceptance

Repair of concrete elements shall be conducted to the standard required by this Technical Specification, or the Design, whichever is higher.

Repairs shall restore, as far as practicable, the concrete element to the equivalent performance of a non-defective (conforming) element, including expected service life.

The acceptance requirements for each repair type are detailed in the requirements for the specific repair method. On-site compliance testing shall be a **Witness Point 2**

Material properties of proprietary products are not required to be tested on site unless a test frequency is specified.

It should be noted that any concrete elements that require repair, do so because they are non-conforming to the relevant Technical Specification. Approval of a repair procedure does not remove the requirement to raise notices of non-conformance. Acceptance of non-conforming or defective product is always at the discretion of the Administrator.

Where an equivalent performance is not practicable (e.g. if the repairs have a design life less than the original element) a reduced level of service arrangement may be appropriate (see *MRS50 Specific Quality System Requirements*).

10 Materials

Materials used in repairs shall be manufactured and prepared in accordance with quality control procedures (e.g. under a quality management system conforming to ISO 9001). Materials shall comply with the requirements listed under the various repair methodologies.

Proprietary repair materials shall be registered products. Where the primary repair material is registered, the associated products recommended by the Manufacturer are deemed acceptable. For testing against the relevant criteria, the repair system as a whole may be used to prove conformance. The use of single products or systems shall be noted in the testing reports.

For example, the registration of a repair mortar covers the bonding agent / primer and fairing coat listed in the Technical Data Sheet.

Products containing more than 1% crystalline silica shall have this clearly indicated on the product information sheet.

Working with materials with > 1% crystalline silica requires special care, in accordance with the *Managing respirable crystalline silica dust exposure in construction and manufacturing of construction elements: Code of Practice*.

10.1 Registration

Assessment and registration of proprietary repair products shall be in accordance with the *Product Index for Bridges and Other Structures*. Applications shall include NATA-endorsed (or equivalent) test certificates confirming material properties and performance, and an inspection and test plan for on-going testing.

Additional testing may be required by the Administrator should specific requirements or concerns on a project be applicable.

10.2 Water

All water used for cleaning substrates or mixing of repair materials shall be clean and potable.

10.3 Dowels

Where required by the repair methodology, dowels shall be a minimum 5 mm diameter, 500 MPa stainless steel.

10.4 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 in accordance with the relevant Technical Specification and reinstated to suit after approval by the Designer.

11 Repair of Cracks

The repair method for cracks shall be determined by crack width and position:

- a) Width \leq 0.3 mm by coating.
- b) Width $>$ 0.3 mm by injection.
- c) Width $>$ 0.3 mm by gravity feed.

Note: These may not be appropriate for active cracks. For example, coatings over active cracks require flexibility to withstand the movement.

11.1 Repair of fine cracking by means of coating

11.1.1 General

This clause applies to fine cracking with crack width below, or equal to 0.3 mm to be treated by means of application of a coating.

In certain applications, cracks of this size may not require repairs. See individual specifications for limits on acceptable crack sizes.

This repair category corresponds to Method 1.3 of EN 1504.

11.1.2 Materials

The concrete coating system shall produce a continuous protective layer on the surface of the concrete. The system shall comply with Table 11.1.2 and either:

- a) form an inert polymeric coating, or
- b) react with the concrete surface to produce a cementitious, crystalline, hydrophilic layer.

Table 11.1.2 – Required properties for crack sealers / coatings

| Property | Test Method | Criteria (polymeric) | Criteria (cementitious) |
|-----------------------------------|--|----------------------|-------------------------|
| Compressive strength | BS 6319-2 (polymeric) AS 1012.9 | > 60 MPa @ 7 days | > 60 MPa @ 28 days |
| Tensile Strength | BS 6319-7 | > 25 MPa @ 7 days | N/A |
| Flexural Strength | BS 6319-3 | > 30 MPa @ 7 days | N/A |
| Bond Strength | AS 1580.408.5 (polymeric) AS 1012.24 (cementitious) | > 0.75 MPa @ 7 days | > 0.75 MPa @ 28 days |
| Dry Film Thickness (DFT) | AS 1580.108.2 | > 150 µm | > 1 mm |
| Crack Bridging Ability (optional) | ASTM C1305 | Repair-specific | Not Applicable |

The criteria above are sourced from AS 5100.8 and EN 1504.2. Certification to EN 1504.2 will be deemed to comply.

Crack bridging ability is not specified here as mandatory as cracks are assumed to be inactive. In circumstances where active (moving) cracks are sealed, coating should be tested and assessed against the expected movement.

11.1.3 Surface preparation

Surfaces shall be cleaned by mechanical means, steam, pressure washing, or a combination as approved. Any dust or loose materials shall be removed by blowing with oil free compressed air.

All prepared surfaces shall be sound, clean and free from dust, laitance, plaster, oils, curing compounds, paint, grease, organic growth or any other deleterious substance.

In addition, the material manufacturer's instructions shall be followed or exceeded.

11.1.4 Coating application

Application of the primer or coating shall not be undertaken during the following conditions:

- a) if temperature is below or predicted to fall below 5°C
- b) in windy conditions where early-age dust adhesion may occur
- c) where rain is likely within 2 hours, and/or
- d) when the prevailing relative humidity exceeds 90%.

All materials shall be thoroughly mixed in their original containers, and progressively intermixed in containers of the same colour as the job proceeds.

Primer shall be applied in accordance with the manufacturer's recommendations and in one or more coats until the recommended application rate is achieved. If any matt or porous areas remain, a further application shall be made. The primer shall be allowed to dry for a minimum of 2 hours or as per the manufacturer's requirements before continuing.

All surfaces for repair are to be treated with two layers of protective coating in accordance with the manufacturer's instructions. There shall be no gaps or "raw edges" in the finished coating.

11.1.5 Acceptance

A visual inspection of the repair area shall be undertaken confirming the area treated. The final colour of the repair shall match the surrounding concrete surface.

The dry film thickness shall be checked once every 25 m² after final application of each coat to ensure the specified dry film thickness is achieved.

An adhesion pull off test shall be undertaken once every 50 m² after final application curing of the top coat. The coating shall be deemed acceptable if the pull off test exceeds 1.0 MPa or the test fails at the substrate.

The DFT and adhesion pull off tests are not required for cementitious coatings.

All test areas shall be made good and reinstated using approved materials.

The area represented by the pull off test may cover more than one repair operation if the procedure, material and work crew are kept the same.

11.2 Crack repair by means of injection

11.2.1 General

This clause applies to the repair of cracks by means of low viscosity resin injection, where the crack width is greater than 0.3 mm. This repair does not apply to live or flexible cracks.

This repair category corresponds to Method 1.5 of EN 1504.

11.2.2 Materials

Crack injection systems shall consist of an epoxy or polyurethane conforming to Table 11.2.2 and associated adhesive and hardware as nominated by the system manufacturer.

Table 11.2.2 – Material properties (crack injection)

| Property | Criteria | Test Method |
|----------------------|--------------------|---------------|
| Viscosity | ≤ 650 centipoise | ISO 3219 |
| Compressive Strength | ≥ 60 MPa @ 28 days | BS 6319-2 |
| Tensile Strength | ≥ 25 MPa @ 7 days | BS 6319-7 |
| Flexural Strength | ≥ 50 MPa @ 7 days | BS 6319-3 |
| Adhesive Strength | ≥ 2.5 MPa @ 7 days | AS 1580.408.5 |

Product certification to EN 1504 Part 5 for ductile filling of cracks will be deemed to comply to these requirements.

11.2.3 Surface preparation

A minimum of 50 mm clearance either side of cracks on all areas of application shall be prepared using appropriate methods to clean of all loose particles, dirt, dust, grease, oil, paints, curing compounds or efflorescence. Impurities which prevent or inhibit wetting and adhesion or penetration by the crack filling material shall be removed. Cracks and crack zones shall be allowed to dry thoroughly for a minimum of 24 hours or dried out by accelerated means prior to the application of materials, unless materials are water tolerant. The installation and spacing of injection ports shall be as per the manufacturer's recommendations.

In addition, the material manufacturer's instructions shall be followed or exceeded.

11.2.4 Crack injection

No materials shall be applied when the surrounding temperature is below 5°C, is predicted to fall below 5°C, or is above 35°C. The crack filling material shall be compatible with all materials with which it is intended to come into contact.

For vertical cracks, injection of resin shall begin at the lowest entry port and continue until there is an appearance of resin adhesive at the next entry port adjacent to the entry port being pumped.

For horizontal cracks, the injection shall proceed from one end of the crack to the other. For horizontal cracks, which are on grade, the crack shall be re-injected until the crack is full to compensate for any resin adhesive which may drain away due to the grade. Where a concrete component such as a wall or slab is cracked all the way through, the resin shall be injected through alternate entry ports on both sides where access is possible. For slabs, injection from the underside shall precede injection from the top.

When resin travel is indicated by appearance at the next adjacent port, injection shall be discontinued and the entry port capped, and the resin injection shall be transferred to the next adjacent port where the resin adhesive has appeared. Resin adhesive injection shall be performed continuously until cracks are completely filled. If port-to-port travel of resin is not indicated, the work shall stop immediately and Administrator notified.

11.2.5 Acceptance

All surfaces shall match surrounding surface finish, with all ports and surface adhesive ground off. The surface of the concrete repair shall not have cracks of width greater than 0.1 mm measured at the concrete surface nor craze cracking covering a significant area of the repair.

11.3 Repair of cracks by gravity feed

This method applies to cracks in horizontal surfaces where the resin infiltrates the crack without external pressure.

Note: Infiltration of cracks will not be as complete as when injection is applied. Infiltration is dependent on material viscosity and temperature, and crack width.

11.3.1 Materials

Crack filling systems shall consist of a cold curing, two component, solvent free, unfilled epoxy or polyurethane conforming to Table 11.3.1.

Table 11.3.1 – Material properties (crack filling)

| Property | Criteria | Test Method |
|----------------------|--------------------|---------------|
| Viscosity | ≤ 300 centipoise | ISO 3219 |
| Compressive Strength | ≥ 60 MPa | BS 6319-2 |
| Tensile Strength | ≥ 25 MPa @ 7 days | BS 6319-7 |
| Flexural Strength | ≥ 50 MPa @ 7 days | BS 6319-3 |
| Adhesive Strength | ≥ 2.5 MPa @ 7 days | AS 1580.408.5 |

11.3.2 Application

Filling and sealing of horizontally positioned cracks shall be executed by pouring and spreading suitable crack filling material onto the surface or placing into purposely formed reservoirs.

For large areas with multiple cracks, the crack filling material shall be poured onto the surface and spread with brooms, rollers or squeegees. The material shall be worked back and forth over the cracks to obtain maximum filling. Excess material shall be broomed off the surface to prevent slick, shining areas after curing. The feeding of material to the crack shall be uninterrupted, throughout the temperature-dependent workability of the crack filling material, until no more material can be absorbed.

Where the concrete surface is trafficable or where further pavement layers (including waterproofing membranes) are to be laid down, fine sand (or approved alternate) shall be spread evenly over the resin prior to setting to create an adequate surface texture. The target texture shall form part of the repair procedure.

For single cracks, a reservoir shall be formed by running a bead of silicone or acrylic sealant along both sides of the crack and formed together at the ends. The edge of the sealant shall be a minimum of 5 mm away from the crack and its height must be a minimum of 10 mm above the substrate. The crack filling material shall be poured into the reservoir and be topped up as its level drops. When the crack filling material in the reservoir starts to gel, both the excess resin and the sealant reservoir shall be scraped off.

11.3.3 Acceptance

All surfaces shall match surrounding surface finish. The surface of the concrete repair shall not have cracks of width greater than 0.1 mm measured at the concrete surface nor craze cracking covering a significant area of the repair.

Subsequently applied waterproofing membranes or priming layers shall not delaminate or peel away.

Pavement surfaces shall comply with the relevant skid resistance criteria.

12 Repair of chips, spalls and honeycombed concrete

The repair method for damaged concrete shall be in accordance with this clause and the manufacturer's instructions as listed on the repair materials' technical data sheets.

The procedure shall be adjusted as noted to account for unsound concrete, exposed reinforced and the size of the repair.

This repair category corresponds to Methods 3.1 and 3.2 of EN 1504.

12.1 Materials

Repairs shall be affected by cementitious repair material with primer and fairing coat if and as required by the material supplier's instructions.

The repair material, when classified according to its aggregate size, shall be chosen in the following order of priority as governed by practicality:

- a) Concrete (10, 20 mm) – used for large repairs where adequate compaction can be achieved.
- b) Micro-concrete (5, 7 mm) – used for large repairs with difficult access.
- c) Mortars (2 – 4 mm) – used for small repair.
- d) Grouts (< 1 mm) – used for small repairs with difficult access.

Concrete used in repair shall be equivalent to the original concrete used in the element.

Proprietary repair materials shall be classified as R3 or R4 and comply with Table 12.1.

Table 12.1 – Material properties (concrete repair)

| Property | Test Method | Criteria | |
|------------------------|-------------|-------------|-----------|
| | | R4 | R3 |
| Compressive strength | AS 1012.9 | ≥ 45 MPa | ≥ 25 MPa |
| Chloride content | AS 1012.21 | ≤ 0.05 % | |
| Bond strength | AS 1012.24 | ≥ 2.0 MPa | ≥ 1.5 MPa |
| Potential for cracking | ASTM C1581 | Report only | |
| Elastic Modulus | AS 1012.17 | ≥ 20 GPa | ≥ 15 GPa |

Note: EN methods referenced in EN 1504.3 are acceptable alternatives.

R3 materials shall only be used for concrete elements with a characteristic strength of 32 MPa and below.

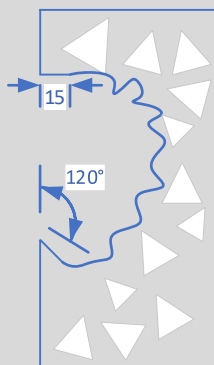
The above criteria are sourced from EN 1504.3, other than potential for cracking.
 Potential for cracking is an interpretation for results included in ASTM C1581 for comparative purposes.
 Product certification to EN 1504 Part 3 will be deemed to comply to these requirements.
 Product certification to ASTM C928 (R3) is deemed to comply with the R3 classification above.

12.2 Extent of repair

The repair area shall encompass all areas of damage or unsoundness and shall include surrounded areas of colour variation.

The perimeter of the repair shall be delineated by saw cutting to a depth of 15 – 20 mm at 90° - 120° to the concrete surface with a grinding disk or diamond wheel to avoid feather edges and provide a square or dovetail edge.

Saw cutting example with dimensions:



The area of repair shall be delineated to form square to rectangular shapes.

The Contractor shall ensure that no reinforcement is cut or damaged. The Contractor shall inform the Administrator immediately when any reinforcement is cut and stop the repair. If low cover is suspected the position of reinforcement shall be confirmed with a cover meter.

12.3 Breaking out concrete

Concrete within the delineated area shall be removed using hand tools or small handheld breakers to avoid unnecessary breakage. All breaking out shall be carried out using sharp tools to avoid unnecessary vibration and damage to the structure. The size of mechanical breakers shall be selected such as not to result in excessive vibration in the structure and over-break. Break out of concrete shall be safe to all personnel in the vicinity and shall minimise damage to sound sections of concrete, reinforcement and other nearby materials.

The Contractor may propose other methods of concrete removal, such as hydro-demolition, provided that the process is safe and causes minimal damage to the concrete substrate and any exposed reinforcement.

All demolished materials shall be removed from site and disposed of by the Contractor in accordance with local environmental laws and regulations.

Any plant, equipment, or other assets that are damaged as a result of concrete removal works shall be repaired by the Contractor to the satisfaction of the Administrator and at the Contractor's expense.

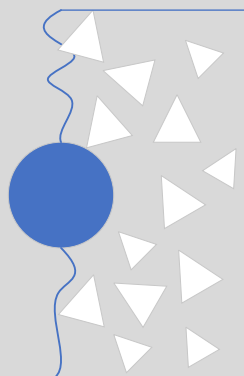
12.3.1 Fully exposed reinforcement or prestressing strand

Where the initial defect or the break out of concrete fully exposes steel reinforcement or prestressing strand, the repair shall not proceed without approval from the Administrator.

If required by the manufacturer's instructions, the steel shall be coated with a suitable primer.

For strand at ends of elements, the first 50 mm of steel shall be coated with a suitable primer prior to concrete reinstatement.

Note: Fully exposed reinforcement / strand is that which has 180 degrees or more of circumference visible.



Where steel is fully exposed, the concrete behind the bar may need to be removed to create better embedment. This is also necessary in cases where the steel is corroded so the whole bar can be cleaned.

12.4 Cast in items

If applicable, the means of reinstatement of any cast in items shall be determined by the designer.

12.5 Installation of dowels

Where the depth of repair exceeds 50 mm, dowels shall be installed in a 50 mm grid pattern over the repair area. The dowels shall be spaced at least 35 mm away from any tensioned strand. The dowels shall be inserted into clean predrilled holes 25 mm deep and extend 25 mm into the repair material. The dowels are to be adhered to the existing concrete by means of a registered chemical anchor suitable for purpose.

12.6 Surface preparation

All exposed broken out concrete surfaces that are to receive repair materials shall be prepared by high pressure water jetting to remove loose or weak concrete, surface laitance, and other contaminants and to produce a surface suitable to ensure that the bond of the repaired material to the substrate can satisfy the performance requirements.

Where concrete breakout is not required, the concrete surface shall be cleaned to the above condition, and the surface roughened as necessary, by light scabbling or grit blasting. A minimum Concrete Surface Profile (CSP) of 5 shall be achieved, as per ICRI 310.2R-2013.

Concrete substrate wetting shall be applied in accordance with the repair material manufacturer's instructions. Typically, the substrate should be saturated with water and any excess water removed from the surface.

Where the concrete repair material manufacturer's system requires a bonding agent to be applied the bonding agent shall be applied to the prepared concrete substrate. The method of application shall be by brush or by other method as recommended by the manufacturer and approved by the Administrator.

The time of substrate bonding agent application shall be immediately prior to repair mortar application and shall not exceed the maximum time as recommended by the manufacturer.

12.7 Application of repair material

Where concrete is used as the repair material it shall be placed in accordance with MRTS70 *Concrete*.

Where the repair is adjacent to a construction joint, it may be appropriate to incorporate the repair as part of the subsequent pour.

The repair material shall be mixed and applied fully in accordance with the repair material manufacturer's recommendations and approved by the Administrator.

The repair material shall be mixed using equipment of a type recommended by the repair material manufacturer and approved by the Administrator and shall normally be an electric powered forced action mixer. The mixing components shall be added and thoroughly mixed to achieve a uniform consistency.

Material shall either be applied to the substrate using manual packing (with trowelled finish) or form-and-pour, depending on the size and complexity of the repair and the material in use.

Repair mortars shall be built up to the original surface profile in layers not exceeding the repair material manufacturer's recommendations and approved by the Administrator.

Where multiple layers are applied, the surface of the repair mortar shall be scarified prior to curing to provide a mechanical key for adhesion of the next layer. Each layer shall be allowed to cure for a period recommended by the repair material manufacturer and approved by the Administrator, before subsequent layers are applied.

The applied material shall have no voids, shall be properly compacted and shall have no sagging of the repair material.

12.8 Curing

All curing methods shall be compatible with subsequent coating application to the concrete surface (e.g., repair material or protective coating system). Where doubt exists, non-contaminating curing systems (e.g., water-soaked hessian and/or polythene wrap) shall be used. The concrete repair material manufacturer and protective coating material manufacturer shall confirm in writing the acceptable curing systems.

12.9 Acceptance

The repair area shall be inspected for soundness to ensure no voids or debonding of the repair.

Appendix A: Example repair method matrix entries

| | | |
|------------------------------|----------------------|---------------------------------|
| Defect Type | Crack | Spall |
| Size (mm) | 0.3 – 0.8 | 10 – 200 |
| Extent | ≤ 2 m/m ² | ≤ 225 cm ² |
| Position | Vertical | All |
| Other | | Partially Exposed Reinforcement |
| Repair Method | §11.2 | Method A |
| Consult Designer | No | No |
| Trigger Hold Point | No | No |
| Trigger Witness Point | First | Yes |
| Raise individual NCR | No | Yes |

