

TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION M774

CONCRETE BRIDGE REPAIRS – CONSTRUCTION

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REVISION REGISTER

| Ed/Rev Number | Clause Number | Description of Revision | Authorised By | Date |
|----------------------|----------------------|--|----------------------|-------------|
| Ed 1/Rev 0 | | First edition | GM, IC | 19.11.12 |
| Ed 1/Rev 1 | 5.2 Annex M | Reference to “B204” deleted. Referenced documents updated. | DCS | 27.10.17 |
| Ed 1/Rev 2 | | Specification reference no changed from M769 to M774 | MCQ | 07.09.18 |
| Ed 1/Rev 3 | Global | References to “Roads and Maritime Services” or “RMS” changed to “Transport for NSW” or “TfNSW” respectively. | DCS | 22.06.20 |

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QA SPECIFICATION M774

CONCRETE BRIDGE REPAIRS – CONSTRUCTION

GUIDE NOTES

These guide notes provide guidance to TfNSW personnel on the application of the Specification and the preparation of the project-specific annexures. They do not form part of the Specification or the Contract [or Agreement].

USING M774

M774 has been developed specifically for use under TfNSW internal Alliance arrangements or Single Invitation Maintenance Contracts. It should not be used for any other types of contracts, without a full review of its practicability for the application.

M774 is a QA specification and the use of M774 requires the implementation of a quality management system by the Contractor that meets the quality management system requirements specified in TfNSW Q4M.

EDITION 1 (issued as M769)

This is the first issue of the Specification. Suggestions for improvement and amendments on technical issues following use of the Specification should be directed to the Senior Bridge Engineer (Rehabilitation Design), Bridge & Structural Engineering. Any other comments or suggestions should be forwarded to the Contracts Quality Manager, Commercial Services Branch.

OUTLINE OF M774

Concrete bridge repairs are covered by three TfNSW Maintenance Specifications and one set of TfNSW guidelines as follows:

M772: Concrete Bridge Repairs – Investigation

M773: Concrete Bridge Repairs – Design

M774: Concrete Bridge Repairs – Construction

TfNSW Concrete Bridge Repairs – Guidelines

The flowchart in Figure A outlines the repair process and the relevant TfNSW Maintenance Specifications.

The Principal commences the repair process by organising and carrying out a preliminary assessment of the defective bridge and deciding on the actions to be taken.

Where there is a need for immediate action to allow traffic on the bridge or to ensure the structural integrity of the bridge as part of an emergency response, the Principal should organise this before calling up Work under M774.

Main activities to be executed in M774

- Concrete removal;

- Substrate preparation;
- Trial repairs;
- Reinstatement and testing.

SECTION 1 GENERAL

Scope

The Work includes the repair of defective concrete bridge members utilising repair designs carried out in accordance with M773 and/or as specified in ANNEXURE A.1.

The Principal must seek advice and guidance from Bridge & Structural Engineering where the repairs:

1. Are deemed “significant” by the Principal;
2. The original bridge design is changed as a result of the repair or strengthening works;
3. Involve prestressed concrete members.

SECTION 2 PLANNING

Project Quality Planning Requirements

The PROJECT QUALITY PLAN (PQP) is critical to this QA Specification. The PQP should be prepared before the work commences, and be based on TfNSW guidelines, manuals or other relevant documents.

The PQP must be followed by the Contractor at all times during the work, be kept up to date and periodically resubmitted to the Principal.

Experienced officers should carry out regular surveillance of the Works for the Principal.

Include in the PQP an emergency response procedure.

Address the repair design requirements in the PQP, including planning, procedures for carrying out the repairs, concrete removal, substrate and reinforcement preparation, and reinstatement and testing. Include personnel qualifications and experience, and details of equipment, in the PQP.

Other Plans

Depending on the type and scope of repairs, the Contractor may be required to submit in addition to the TRAFFIC CONTROL PLAN, an Environmental Management Plan, including a Waste Management Plan, and/or Work Health and Safety Plan.

Documents

The Principal should provide the Contractor with all the available information on the bridge specified in ANNEXURE A.6. Principal-supplied information includes drawings and reports. Drawings may include repair design drawings, original design drawings, and Work-As-Executed drawings. Reports may include Bridge Information System condition and inspection reports, structural assessment reports, repair records, etc.

The Contract Manager must collate all the relevant information for the contract and supply it to the Contractor. Ensure that irrelevant or out of date documents are not provided to the Contractor.

Note that original drawings for most bridges are available electronically from TfNSW PLANS MANAGER.

SECTION 3 RESOURCES

Personnel

Experienced and qualified personnel must supervise and carry out the repairs.

Surveyors must verify the locations and levels of concrete members when measurements of settlements and misalignments are required.

Refer the names of consultants and structural engineers proposed by the Contractor to Bridge & Structural Engineering for review and acceptance.

Include the names of the following personnel in the PQP for review by the Principal:

- Project Engineer (the Project Manager);
- Site Supervisor (Works Supervisor);
- Scaffolder and Rigger where required.

Materials and members

The Contractor must submit certificates of conformity, qualification testing where appropriate, and technical datasheets for all repair materials at least two weeks before commencing the trial repairs. All repair materials must conform to this Specification and the performance criteria listed in ANNEXURE A.2.

Plant and equipment

Use all equipment for concrete removal, surface preparation, application of repair materials and testing, sampling and/or measurements within its safe working range. The Contractor must submit details of this equipment before commencing Work.

SECTION 4 EXECUTION

General

The Contractor must, where required:

1. Carry out a defect confirmation survey before concrete removal or surface preparation and assign identification numbers to areas to be repaired on the bridge;
2. Take work in progress photographs;
3. Certify the Loading Regime;
4. Control, contain and dispose of all emission and waste;
5. Establish and submit Bridge Survey Control.

Dismantling members

The Contractor must, where required:

1. Dismantle members in the specified sequence;
2. Protect dismantled bridge parts or members.

Temporary works

The Contractor must, where required:

1. Provide design certification for access, temporary supports and formwork;
2. Inspect all props for structural adequacy and safety;

3. Install props before concrete removal where structural capacity and/or safety is in doubt;
4. Provide adequate access at temporary supports;
5. Not permanently modify the bridge by adding to it or removing members from it;
6. Erect formwork using methods that minimise damage to the bridge;
7. Use formwork materials and release agents that give the required surface finish;
8. Not restrict the waterway unless appropriate design verification is provided.

Concrete removal

The Contractor must, where required:

1. Restrict removal of sound concrete to a minimum;
2. Certify the structural capacity of prestressed members before concrete removal;
3. Not use explosives, chemical pre-splitting, stitch drilling, or thermal cutting without the Principal's approval;
4. Delineate repair areas using simple rectangular 25 mm deep square sawcuts;
5. Use percussion equipment with limited blow energy to remove the concrete, to protect the substrate and reinforcing bars from damage and/or debonding;
6. During hydro-demolition, control and maintain safe water pressures and wash off all laitance.

Substrate preparation

The Contractor must, where required:

1. Clean and prepare the concrete substrate to the appropriate texture and profile;
2. Not use acid etching or flame cleaning methods;
3. Protect prepared surfaces until repairs are carried out;
4. Record and confirm with the Principal the actual extent of the preparatory work;
5. Apply a secondary preparation using water blasting or shot blasting, see Clause 4.5.2.7;
6. Jet-wash reinforcing bars with chloride-induced corrosion;
7. Install embedded sacrificial anodes on perimeters of patch repairs for chloride induced corrosion;
8. Apply bonding agents or primers as specified by the supplier, or as specified in the repair design;
9. Prepare exposed reinforcing bars by abrasive blasting to Class 3 or manually to Class 2½;
10. Not overcoat old or deteriorated coatings.

Reinstatement and completion

The Contractor must, where required:

1. Successfully trial the repair methods before proceeding with the actual repairs;
2. Use ready-mixed concrete conforming to B80 for full depth repairs;
3. Ensure soundness of additional or replacement reinforcing bars;
4. Submit procedures for splicing/welding of reinforcing bars;
5. Record actual repairs, i.e. work in progress photographs and QA records;
6. Submit Work-As-Executed drawings.

SECTION 5 CONFORMITY

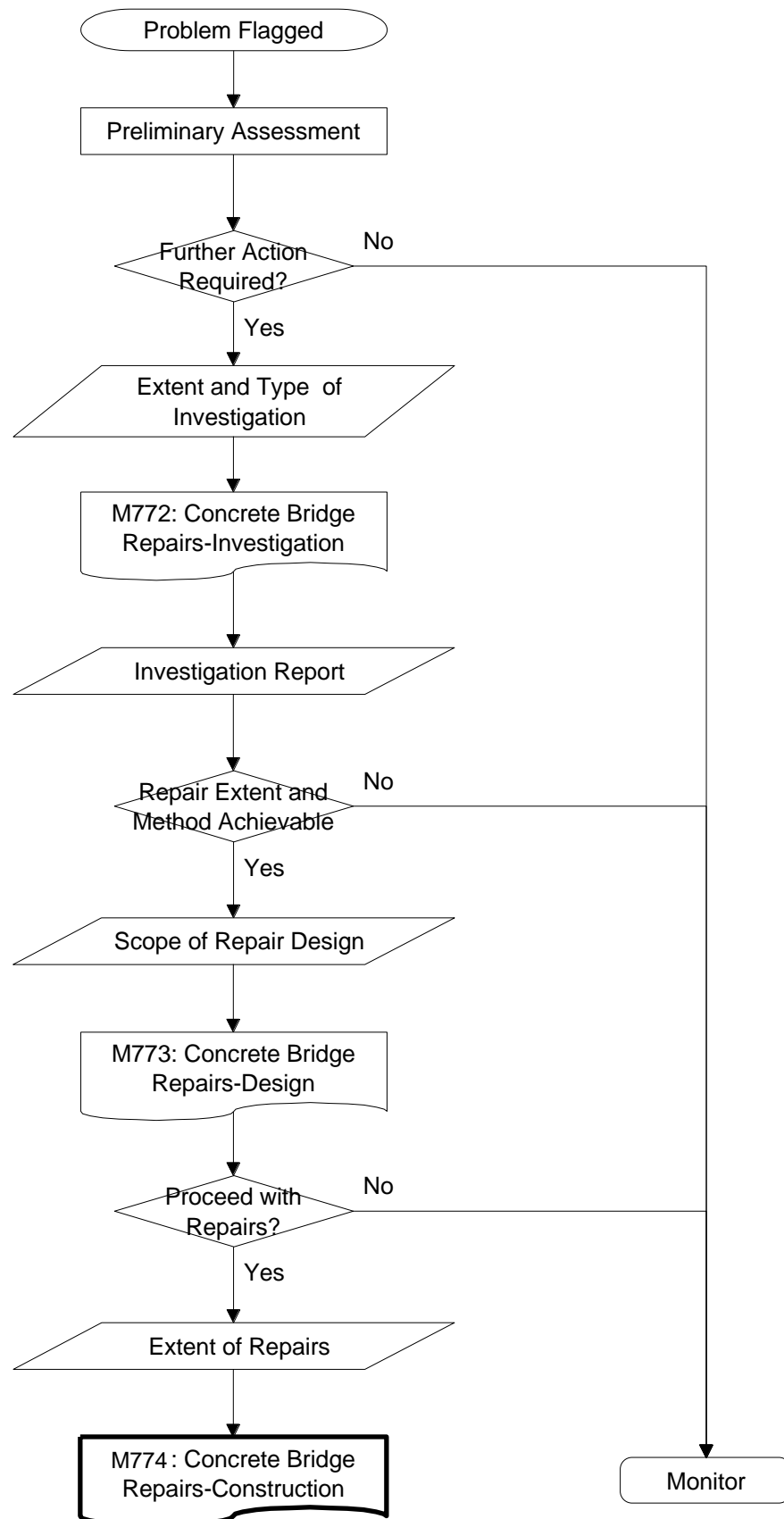
The Contractor must submit a summary report verifying conformity of both trial and actual repairs.

ANNEXURES

ANNEXURES A.1, A.6 & A.7 must be completed by the Principal detailing the nature of the Work.

ANNEXURE A.2 covers the performance requirements for repair materials. The Principal must customise this annexure to suit the specific project needs.

Figure A. Concrete Repair Process





CONCRETE BRIDGE REPAIRS - CONSTRUCTION

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| VERSION FOR: DATE: |
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CONTENTS

| | |
|--|----|
| FOREWORD | ii |
| TfNSW Copyright and Use of this Document | ii |
| Revisions to Previous Version | ii |
| Project Specific Changes | ii |
| 1 GENERAL | 1 |
| 2 PLANNING | 2 |
| 2.1 PROJECT QUALITY PLAN | 2 |
| 2.2 Other Plans | 3 |
| 2.3 Documents | 3 |
| 3 RESOURCES | 4 |
| 3.1 Personnel | 4 |
| 3.2 Materials and Members | 5 |
| 3.3 Plant and Equipment | 7 |
| 4 EXECUTION | 7 |
| 4.1 General | 7 |
| 4.2 Dismantling Components | 9 |
| 4.3 Temporary Works | 9 |
| 4.3.1 General | 9 |
| 4.3.2 Packing, Shoring and Bracing | 9 |
| 4.3.3 Repair access and modifications | 10 |
| 4.3.4 Formwork | 10 |
| 4.4 Concrete Removal | 11 |
| 4.4.1 General | 11 |
| 4.4.2 Marking Out and Sawcutting of Repair Areas | 11 |
| 4.4.3 Concrete Sawcutting | 12 |
| 4.4.4 Concrete Removal Using Percussion Tools | 12 |
| 4.4.5 Concrete Removal by Hydro-demolition | 13 |
| 4.5 Substrate Preparation | 13 |
| 4.5.1 General | 13 |
| 4.5.2 Preparation of Repair Areas for Patching | 14 |
| 4.5.3 Steel Reinforcement | 15 |
| 4.5.4 Removal of Coatings | 16 |
| 4.5.5 Cracks | 16 |
| 4.6 Reinstatement and Completion | 17 |
| 4.6.1 General | 17 |
| 4.6.2 Trial Repairs | 19 |
| 4.6.3 Patching | 21 |
| 4.6.4 Concrete coatings | 23 |
| 4.6.5 Crack filling | 25 |
| 4.6.6 Inspection and testing of repairs | 26 |
| 4.7 Warranty Period | 27 |
| 5 CONFORMITY | 27 |
| ANNEXURE A —DETAILS OF WORK | 28 |
| A.1 Work Summary – Repairs | 28 |
| A.2 Performance Requirements | 28 |
| A.3 Test Procedures | 31 |
| A.4 Number of Trial Repairs and Repair Tests | 32 |
| A.5 Test Samples | 33 |
| A.6 Information Supplied by the Principal | 33 |
| A.7 Loading Regime | 34 |

| | |
|--|----|
| ANNEXURE B —MEASUREMENT AND PAYMENT | 35 |
| B.1 General..... | 35 |
| B.2 Schedule of Pay Items..... | 35 |
| ANNEXURE C —SCHEDULE OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS | 36 |
| C.1 Schedule of Hold Points and Witness Points | 36 |
| C.2 Schedule of Identified Records | 36 |
| ANNEXURE D —PLANNING DOCUMENTS..... | 37 |
| D.1 Repair Process..... | 37 |
| ANNEXURES E TO L (NOT USED)..... | 37 |
| ANNEXURE M —REFERENCED DOCUMENTS AND DEFINITIONS | 38 |
| M.1 Reference Documents | 38 |
| M.2 Defined Terms | 39 |
| M.3 Definitions..... | 40 |
| LAST PAGE OF THIS DOCUMENT IS: | 40 |

FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW M774 Edition 1 Revision 2.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Project specific changes are not permitted in this document.

- | | | |
|-----|---|---------------------------------|
| 1.7 | Some technical terms and acronyms used in this Specification are also defined in ANNEXURE M. | Definitions and acronyms |
| 1.8 | Unless otherwise specified, the issue of an Australian Standard or TfNSW test method to be used is the issue current one week before closing date for tenders. The TfNSW specification to be used is the issue contained in the contract documents. | Applicable issue |
| 1.9 | You are responsible for all activities, actions, works and supply of materials, unless specifically stated otherwise. Accordingly, this Specification does not generally use wording such as "You must ..." or "You shall ..." because this is the underlying requirement. However, such wording is used where actions in a clause involve both You and the Principal and the roles need to be unambiguous. | Interpretation |

2 PLANNING

2.1 PROJECT QUALITY PLAN

- | | | |
|-------|---|------------------------------------|
| 2.1.1 | The requirements of the PROJECT QUALITY PLAN are defined in TfNSW Q4M. In addition, the PROJECT QUALITY PLAN must: | |
| .1 | Address the HOLD and WITNESS POINTS required by this Specification, as summarised in ANNEXURE 0. The Principal will consider the submitted documents prior to authorising the release of the HOLD POINT. | HOLD and WITNESS POINTS |
| .2 | Address each of the requirements in this Specification, as listed in ANNEXURE D.1 in summary form to aid preparation. | Processes |
| .3 | Include the submission of test reports and other documents verifying ongoing conformity of all work and materials. | Conformity documents |
| .4 | Be revised as necessary to reflect the assessment findings and to ensure that the repair procedures executed as documented will result in repairs that conform to the repair design | Revise PROJECT QUALITY PLAN |
| 2.1.2 | For the repair method(s) and materials nominated, include in the PROJECT QUALITY PLAN, as applicable: | |
| .1 | A repair plan showing sequence and progress of repairs. | Repair Plan |
| .2 | Repair procedures covering concrete removal, substrate preparation, welding/splicing of reinforcement, application and finishing and curing of repair materials, application of concrete coatings and crack repair methods. | Repair procedure |
| .3 | Methods of repair for members in splash and tidal zones. | Splash/tidal zones |
| .4 | Methods of repair for members contaminated with or containing hazardous materials. | Hazardous materials |
| .5 | Methods for preloading prestressed members. | Preloading |
| .6 | Measures for locating steel reinforcement, prestressing tendons and other embedments before concrete removal. | Locating metals |

- .7 Procedure for core drilling including fixing the coring machine in position. **Core drilling**
- .8 Accesses, platforms, shoring and formwork details, together with supporting design calculations, as appropriate. **Access**
- .9 Qualifications and experience of personnel carrying out the repair work. **Qualifications and experience**

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|-------|--|-------------------|
| 2.1.3 | <p>Process Held: Commencement of Work</p> <p>Submission Details: At least 10 Business Days prior to the planned date of commencement of Work, submit:</p> <ul style="list-style-type: none"> .1 The PROJECT QUALITY PLAN conforming to Clause 2.1.2. .2 Proposed audit procedures for ensuring conformity to this Specification in the absence of frequent testing and supervision by the Principal. <p>Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.</p> | HOLD POINT |
|-------|--|-------------------|

2.2 OTHER PLANS

- 2.2.1 Provide TRAFFIC CONTROL PLAN (TCP) for bridgeworks in accordance with: **TRAFFIC CONTROL PLAN**
 - .1 TfNSW Traffic Control at Work Sites manual; and
 - .2 The Approved Loading regime (refer to Clause 4.1.6).
- 2.2.2 Where you are provided with the Review of Environmental Factors (REF), Statement of Heritage Impact (SOHI) or the Conservation Management Plan (CMP) for the bridge, incorporate the relevant details into your Contractor’s Environmental Management Plan (CEMP) in conformity to Specification TfNSW G36. **Contractor's Environmental Management Plan**
- 2.2.3 As part of the CEMP, include in the Waste Management Plan control, storage and disposal of waste and residue. **Waste Management Plan**
- 2.2.4 Provide your Project WHS MANAGEMENT PLAN in conformity to Specification TfNSW G22. **WHS Management Plan**

2.3 DOCUMENTS

- 2.3.1 The Principal will supply the information listed in ANNEXURE A to provide the background and references for the Work. **Information**
- 2.3.2 Do not assume the information supplied by the Principal is correct representation of the existing bridge. **Verify supplied information**

Assess the adequacy of the information supplied by the Principal for accuracy and consistency with observations of current bridge and

operating conditions, correct locations of all existing components and features, and possible misalignments or clashes with existing details. However, structural engineering checks of the supplied drawings are not required

3 RESOURCES

3.1 PERSONNEL

- | | | |
|-------|---|--|
| 3.1.1 | Manage the Work using a Project Engineer with the following qualifications and experience: <ul style="list-style-type: none">.1 Member of Engineers Australia, or equivalent;.2 Experienced in bridge design;.3 At least 1 year experience on concrete bridge repair projects, including planning, construction and site inspection. | Project Engineer |
| 3.1.2 | Designers, Checkers and Certifiers must be Structural Engineers with the following qualifications and experience: <ul style="list-style-type: none">.1 At least 5 years experience in bridge analysis and design;.2 A detailed understanding of concrete bridge repair methods including site inspections;.3 Participation on at least 5 concrete bridge repair projects. | Qualified Designer, Checker and Certifier |
| 3.1.3 | Prepare and check drawings using personnel qualified and competent in Structural Drafting. | Drafting |
| 3.1.4 | Surveyors must have, as a minimum, a Diploma in Surveying from a recognised tertiary institution, or equivalent, and have at least two (2) subsequent years of satisfactory surveying experience. | Surveyors |
| 3.1.5 | Supervise the Work on-site using a Site Supervisor with at least 5 years supervisory experience, and at least 5 years of relevant experience, including the repair of concrete bridges. | Site Supervisor |
| 3.1.6 | Provide the following minimum personnel at the bridge site with skills and experience as follows: <ul style="list-style-type: none">.1 One team leader with delegated authority with at least 5 years experience rehabilitating concrete bridges..2 One qualified bridge and wharf or civil construction carpenter with at least 5 years experience rehabilitating and repairing bridges, including concrete bridge repairs. This person may also be the team leader..3 One additional person with at least 5 years experience rehabilitating and repairing concrete bridges..4 One person with a current NSW Workcover Intermediate Rigging Certificate during all temporary support works..5 One person with a current NSW Workcover Advanced | Personnel at the bridge site |

Scaffolding Certificate during all erection and dismantling of scaffolding (including suspended scaffolds).

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| 3.1.7 | Use only approved nozzle men to apply shotcrete to repairs in accordance with Clause 4.6.2.9. | Shotcrete |
| 3.1.8 | Propose alternative qualifications for personnel or changes to personnel to the Principal for consideration. | Alternatives or changes |
| 3.1.9 | Include Your bridge site personnel's names, qualifications, experience and role in the PROJECT QUALITY PLAN. Include the same information for consultants, designers, surveyors, sampling and testing officers proposed for the Work. | Document personnel in PQP |

3.2 MATERIALS AND MEMBERS

- | | | |
|-------|---|-------------------------------------|
| 3.2.1 | Use only Portland cement grout, mortar and concrete for new members or full depth replacement works, but not for patch repairs. Ready-mixed concrete must conform to Specification TfNSW B80 and/or Specification TfNSW R68. | Portland cement materials |
| 3.2.2 | Proprietary patch repair materials must be shrinkage compensated, polymer modified and cementitious based. Bagged repair materials may be used. To ensure compatibility of materials, obtain all proprietary patch repair materials and associated primers from the one supplier. | Proprietary repair materials |
| 3.2.3 | Do not use resin-based repair materials in areas subject to direct sunlight, except for thin surface coatings. | Resin-based materials |
| 3.2.4 | Do not use highly exothermic repair materials such as magnesium phosphate based materials. | Magnesium phosphates |
| 3.2.5 | Unless otherwise specified, all materials for patch and crack repairs and protective coatings must be approved prior to use. For approval, submit a certificate not more than one year old verifying conformance of the material with this Specification and ANNEXURE A.2, including conforming test reports. Where a certificate of conformance does not cover the performance requirements specified in ANNEXURE A.2 carry out tests to verify conformance. | Materials approval |
| 3.2.6 | For all repair materials, submit certificates of conformity, test reports (where applicable) and technical datasheets before commencing trial repairs (refer to Clause 4.6.1.4). | Materials submission |
| 3.2.7 | Use primers for steel reinforcement to the repair material manufacturer's instructions. | Priming/bonding agents |

| | | |
|--------|---|---|
| 3.2.8 | Concrete curing compounds must conform to TfNSW B80, be compatible with the proposed protective coating system and not impair the bond of subsequent coatings. | Curing compounds |
| 3.2.9 | Submit proposed curing compound and curing regime for approval together with a certificate stating that the proposed curing materials and methods conform to this Specification. | Curing regime |
| 3.2.10 | The colour and texture of all completed repair work must be as accepted by the Principal. | Colour and texture |
| 3.2.11 | Pigmented concrete coatings must be grey, not fade or discolour. | Coating |
| 3.2.12 | Keep materials sealed in their original containers until use. Clearly label containers with the manufacturer's name, product type, reference number and batch number. | Material labelling |
| 3.2.13 | Film form coatings must be elastomeric polyurethanes, acrylics or silicones and must: .1 Be compatible with alkaline surfaces; .2 Not sag when applied correctly to vertical surfaces; .3 Be capable of maintaining the specified dry film thickness following application onto a rough surface. | Film forming coatings |
| 3.2.14 | For tidal zones, use rapid curing and durable film forming coating systems suitable for application to damp substrates that may be submerged 3 hours after application of the coating. | Tidal zone coatings |
| 3.2.15 | Surface penetrating liquid coatings must contain at least 98% active ingredients and for non-liquid coatings, 80%. Surface penetrating coatings must contain a fugitive dye to verify the required coating of the specified areas. | Active ingredient Fugitive dye |
| 3.2.16 | Structural and non-structural crack repair resins must conform to ANNEXURE A.2. Where specified in ANNEXURE A.2, crack repair materials must: .1 Contain a fluorescent tracer dye that glows under black light to verify the depth of the crack filled. .2 Be moisture-tolerant for the repair of deep and damp cracks that may not fully dry out. | Crack repair materials |
| 3.2.17 | Carry out analysis of non-metallic abrasives for the presence of water soluble salts, which must not exceed 50 mg/L. | Abrasives |
| 3.2.18 | All reinforcing steel and prestressing tendons must conform to AS/NZS 4671. | Steel reinforcement |

3.2.19 Unless otherwise specified, replacement or additional reinforcement must be of similar grade and size to the existing bars. Use for repair D500N bars conforming to AS/NZS 4671 as the main reinforcement and R250N bars for stirrups and ligatures. **Reinforcement type**

3.2.20 Where dowels or chemical or mechanical anchors are proposed to anchor a thick patch to the substrate, submit full details before use. **Anchors**

3.2.21 **Process Held: Carrying out trial repair.** **HOLD POINT**

Submission Details: Documents required in Clauses 3.2.6 and 3.2.9 at least 14 Business Days before commencing trial repair.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

3.3 PLANT AND EQUIPMENT

3.3.1 Submit details of plant and equipment to be used for: **Equipment**

- .1 Moving/lifting bridge members;
- .2 Removing and cleaning concrete;
- .3 Shotcreting and grouting;
- .4 Inspection and testing.

3.3.2 Calibrate all devices used during jacking operations in conformity to Clause 3.3 of Specification TfNSW M783. **Jacking operations**

3.3.3 Conform to the requirements of TfNSW G22 for plant and equipment. **Plant safety**

3.3.4 All measuring, inspection and testing equipment must have current calibration certificates, and be operated within the tolerances and ranges or capacity appropriate to the Works. **Calibration and operation**

4 EXECUTION

4.1 GENERAL

4.1.1 Prior to commencing the Works, carry out a defect confirmation survey to locate and confirm the extent of specified repairs. Identify specified repair areas using a numbering system compatible with those on the design drawings. **Defect confirmation survey**

4.1.2 Report within 24 hours to the Principal all structural defects beyond those specified and await instructions before proceeding. **Unspecified defects**

4.1.3 If the specified repair is not appropriate for the nature of the defect, report this to the Principal and await instructions before proceeding. **Type of repairs**

| | | |
|--------|--|--|
| 4.1.4 | On completion of repairs, reinstate any damaged or disturbed bridge members, components, fasteners and services. Remove all excess materials and items from the Works and restore the topsoil, vegetation, gravel, etc. at the site to its original condition. | Original condition |
| 4.1.5 | Record the extent and details of each stage of the Works using photographs traceable to the repair work being recorded. | Photographs of progress |
| 4.1.6 | Certify the Principal’s proposed Loading Regime specified in ANNEXURE A.7, or propose an alternative Loading Regime together with supporting documents. If You consider that the Loading Regime is no longer adequate, submit to the Principal a revised Loading Regime together with documents supporting the proposed change. The Principal may vary the Loading Regime at any time. | Certify Loading Regime |
| 4.1.7 | Manage the work site in accordance with the approved TRAFFIC CONTROL PLAN (TCP) and Repair Drawings to ensure public safety and minimum disruption to traffic. Ensure that the TCP is consistent with the Loading Regime and the Repair Drawings. Include the load and dimension limits and the traffic and pedestrian restrictions at the bridge site on the TCP. | Traffic control |
| 4.1.8 | Where repairs are carried out with any part of the bridge open to traffic, control the traffic in accordance with the Loading Regime, Repair Drawings, construction sequence and the approved TCP. | Repairs under traffic |
| 4.1.9 | Carry out all jacking and moving of bridge members in accordance with the Repair Drawings and TfNSW M783. | Jacking and moving members |
| 4.1.10 | You are responsible for: .1 All structural engineering tasks relating to the Work, i.e. design of temporary supports, capacity assessment, Engineer’s certification, etc. .2 The integrity of the existing structure during the Works, including during temporary removal of existing members, and during replacement of members. .3 The capacity of the temporary works for the approved LOADING REGIME at all times during the Works (refer to ANNEXURE A.7). .4 The impact of the temporary works on river crossings and adjoining properties, as applicable. | Contractor’s responsibility for bridge safety |
| 4.1.11 | Control the discharge of all emissions. Design an emissions containment system conforming to the Specification and environmental and work health and safety legislation. | Emissions control and containment |
| 4.1.12 | Establish and submit the Bridge Survey Control for setting out and verification of the position and levels of bridge members under repair. | Bridge Survey Control |

4.1.13 Include the costs of all the specified tests, e.g. sampling, handling, storage, testing and reporting in Your rates. **Costs of testing**

| | | |
|--------|---|-------------------|
| 4.1.14 | Process Held: Site traffic management. Submission Details: TRAFFIC CONTROL PLAN (TCP) at least 15 Business Days prior to commencing the Works. Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point. | HOLD POINT |
|--------|---|-------------------|

4.2 DISMANTLING COMPONENTS

4.2.1 Loosen, dismantle and/or remove all bridge components, i.e. expansion joints, barriers, railings, public utilities, etc. which could be damaged during the repair operations. **Measures to protect bridge members**

4.2.2 Store with care all dismantled and/or temporarily removed bridge components until they are replaced. **Care of members**

4.2.3 Dismantle bridge members in accordance with the sequence specified on the Repair Drawings. Identify and mark dismantled members and keep records to facilitate reassembly operations. **Systematic dismantling**

4.2.4 Do not dismantle any more of the bridge than specified unless otherwise approved by the Principal. **Limited dismantling**

4.3 TEMPORARY WORKS

4.3.1 General

4.3.1.1 Provide an Engineer’s certification for the structural adequacy of:
 .1 Access and scaffolding designs.
 .2 Temporary supports and formwork. **Engineering certification**

4.3.1.2 Address any effects from the temporary works that may affect safety in the TCP, which must then be reviewed by the Certifier. **TCP revision**

4.3.1.3 When directed by the Principal, implement immediately measures such as load limits, lane closures or propping, to minimise hazards. **Additional measures**

4.3.2 Packing, Shoring and Bracing

4.3.2.1 Erect props or shores before preparing the substrate when there is doubt about the structural integrity of the member. **Effective propping**

4.3.2.2 To ensure that the support system for the Works can carry the applied loads safely, You must inspect existing bridge members that support the Works as well as the scaffolding and all other supports. **Propping supports**

4.3.2.3 Secure all packing plates, shims, etc. to prevent dislodgement. **Secure packers**

4.3.2.4 Assemble proprietary shoring systems to the manufacturer's instructions or the certified design for the system. **Proprietary shoring**

4.3.2.5 Install bracing and other restraints in accordance with the Repair Drawings and/or the specified construction sequence. **Bracing**

4.3.3 Repair access and modifications

4.3.3.1 Allow sufficient access at temporary supports for the repair works. **Repair access**

4.3.3.2 Do not permanently alter the bridge except as detailed on the Repair Drawings or as approved by Principal. **Permanent bridge alterations**

4.3.3.3 Do not remove, demolish, dismantle, cut, drill or otherwise disturb existing bridge members except as detailed on the Drawings or as approved by the Principal. **Disturbance to bridge members**

4.3.3.4 Process Held: Erection of scaffolding and other access works. **HOLD POINT**

Submission Details: Submit details of scaffolding and/or access works including design calculations and an Engineer's certification, at least 5 Business Days prior to their erection.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

4.3.4 Formwork

4.3.4.1 Formwork must conform to AS 3610. Fixing of formwork must not compromise the durability of the structure. **Formwork fixing**

4.3.4.2 For repairs carried out using grout, locate the grout inlet at the low point of the formwork. Fit air vents at the high points. **Venting of formwork**

4.3.4.3 Select formwork so that the finish of the repair matches the surrounding concrete. Apply a suitable formwork release agent. **Formwork finish**

4.3.4.4 Process Held: Erection of formwork. **HOLD POINT**

Submission Details: Formwork documentation and Engineer's design certificate, as appropriate, at least 5 Business Days prior to erection.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

4.4 CONCRETE REMOVAL

4.4.1 General

- 4.4.1.1 During concrete removal, You must: **General provisions**
- .1 Demonstrate the concrete removal method to the Principal on request.
 - .2 Use sawcutting to achieve sound and square edges at the perimeter of repair area on completion of concrete removal.
 - .3 Cut back to a depth equal to or greater than the nominal cover originally specified for the concrete member.
 - .4 Minimise the removal of sound concrete.
 - .5 Remove all delaminated and defective concrete.
 - .6 Remove bar chairs, tie wire, nails and other embedments from exposed concrete surfaces.
 - .7 Notify the Principal where the substrate is honeycombed.
- 4.4.1.2 Unconventional concrete removal methods such as explosives, chemical pre-splitting, stitch drilling or thermal cutting may only be used where conventional techniques are not feasible, and only as approved by the Principal. **Unconventional removal methods**
- Explosive blasting or crushing methods are not permitted.
- 4.4.1.3 When a bar following concrete removal has: **Concrete removal around bars**
- .1 More than half of its perimeter exposed; or
 - .2 Concrete cover < 5 mm for more than half of its length,
- remove the concrete behind the bar to a clearance of least 20 mm.
- If the bar requires replacement, remove sufficient additional concrete to allow complete concrete placement around the new bar.
- 4.4.1.4 Where there is defective concrete around or behind prestressing tendons, certify the structural capacity of the concrete member after concrete has been removed and before loading the member. **Prestressed members**
- 4.4.1.5 Break out defective concrete around corroding reinforcement to expose at least 50 mm of bright reinforcement at each end. **Corroding reinforcement**
- 4.4.1.6 Remove pop-outs from corroding form ties and other embedments by core drilling and/or cutting back to the nominal cover depth. **Pop-outs**

4.4.2 Marking Out and Sawcutting of Repair Areas

- 4.4.2.1 Delineate defective areas of concrete in rectangles using permanent markers. Avoid creating acute corners. **Squaring up**
- Include 50 mm wide buffer of sound concrete inside the perimeter of the marked out area.

- 4.4.2.2 Sawcut to a nominal depth of 25 mm at right angles to the surface adjacent to the marked lines. Combine small repair areas into one within the same cut perimeter. Do not cut or damage reinforcement. **Perimeter saw cutting**

Sawcut as close as possible to the marked lines within the buffer zone, so that the marked lines remain visible.

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| 4.4.2.3 Process to be Witnessed: Confirmation of marked out repair areas prior to sawcutting. WITNESS POINT |
| Submission Details: Submit drawings of marked out repair areas at least 2 business days before cutting. |

4.4.3 Concrete Sawcutting

- 4.4.3.1 Ensure that the blade size and saw capacity are adequate for the concrete strengths and depths of cut. **Cutting saw capacities**

- 4.4.3.2 Where a deep cut is not possible using diamond blade saws, You may use stitch core drilling, if approved by the Principal. Percussion stitch drilling is not permitted. **Deep cuts**

- 4.4.3.3 Cut reinforcement only in accordance with the repair design or as approved by the Principal. **Cutting reinforcement**

- 4.4.3.4 Cut concrete to its full depth only if specified in the repair design. Use full depth cutting only if the cut concrete can be disposed of using the plant and equipment available at the site. **Full-depth cutting**

- 4.4.3.5 Do not over-cut or extend sawcuts outside the repair area. **Over-cuts**
- Stop cutting before intersecting transverse cuts and complete the cut manually.

4.4.4 Concrete Removal Using Percussion Tools

- 4.4.4.1 Defective concrete within the sawcut areas may be removed using percussion tools. **Percussion tools**

- 4.4.4.2 Use hand-held jackhammers carefully to avoid damage to adjacent sound concrete or to the substrate. Use light equipment to bush hammer small areas and jackhammers for larger areas. **Hand held equipment**

Limit the energy delivered to protect the sound concrete and the rest of the bridge from damage. Limit the jackhammer size to 60 pounds. High frequency chipping hammers may be used up to a capacity of 10 pounds.

Only use boom-mounted breakers where the required concrete removal rates cannot be achieved using hand-held tools.

- 4.4.4.3 Ensure that removal of concrete near reinforcement does not damage the bond to sound concrete by first locating the reinforcement and using smaller or lighter jackhammers to expose it. **Prevent damage to bond**
- 4.4.4.4 Rotary-head milling machines may be used for flat areas and for shallow concrete remote from reinforcement. Only mill concrete with compressive strength < 30 MPa. **Milling**
- Rotary head milling equipment used on bridge decks must produce grooves with spacing < 12 mm and maximum surface texture depth of 1.5 mm. The tolerance on cut depth is +0 and -5 mm. **Deck milling**
- 4.4.4.5 Do not use scabblers with multiple heads. **Scabblers**
- 4.4.5 Concrete Removal by Hydro-demolition**
- 4.4.5.1 Ensure that the water pressure used during hydro-demolition is appropriate for the concrete condition, extent of damage and purpose of use, as follows: **Hydro-demolition**
- .1 Hydro-demolition - from 70 MPa to 140 MPa.
 - .2 Removal of micro-fractures during secondary preparation - from 140 MPa to 210 MPa.
 - .3 Cutting through concrete and reinforcement - from 210 MPa to 350 MPa.
- Maintain correct water pressures and safe operations at all times.
- 4.4.5.2 Water jet cutting of thin sections may be carried out provided that You address all safety and environmental issues. **Water cutting**
- 4.4.5.3 Wash off all laitance deposited on the substrate before it dries. **Wash-off laitance**
- 4.4.5.4 Prevent overbreaks outside the repair area. Direct the nozzle inwards to prevent overbreaks along the perimeter cuts. **Overbreaks**

4.5 SUBSTRATE PREPARATION

4.5.1 General

- 4.5.1.1 Prepare concrete substrates by removing loose or weak concrete, surface laitance and other contaminants and stains, to produce a surface profile and texture suitable for the repair. Ensure that the method of concrete preparation does not: **Substrate surface standards**
- .1 Cause weaknesses at the repair interfaces from fractured or loosened aggregates.
 - .2 Damage other bridge members or services.

- 4.5.1.2 Methods of cleaning the substrate may include the use of: **Cleaning methods**
- .1 Chemicals.
 - .2 Impact and rotary tools.
 - .3 Wet/dry grit or dry shot blasting.
 - .4 Water jets.
- Do not use acid etching or flame cleaning.
- Use mobile blasting chambers or equivalent for blast cleaning operations.
- 4.5.1.3 Substrates prepared using resin-based materials must be kept dry. **Dry substrates**
- 4.5.1.4 Protect prepared substrates from weather and from contamination by other repair activities. Where a prepared area is not protected, it may need to be cleaned again before applying the repair. **Protection of prepared surfaces**
- 4.5.1.5 Make good any damage caused to other bridge members or services using methods approved by the Principal at Your expense. **Damage repairs**
- 4.5.1.6 Record and confirm with the Principal on completion of substrate preparation the extent and locations of preparation work, including, as appropriate: **Actual extent of preparation**
- .1 Areas prepared for patching and coating.
 - .2 Lengths of cracks and dimensions of cracked areas.
 - .3 Depth of areas and cut-out holes to be patched, etc.
- Base the quantities of repair for payment on the actual extent of the preparation and Work-As-Executed (WAE) drawings compiled on completion of the Works (see Clause 4.6.1.14).
- 4.5.2 Preparation of Repair Areas for Patching**
- 4.5.2.1 Only use approved detergents or proprietary concrete cleaners on surfaces contaminated by oil, grease, dirt, etc. Do not use solvents. **Chemical cleaning**
- Where concrete cleaners are used, vigorously scrub the surface and rinse with clean water to remove residues.
- 4.5.2.2 Mechanical discs and grinders may be used to clean low strength concrete surfaces that have steel trowelled finish. **Mechanical cleaning**
- Impact tools, e.g. bush hammers and needle guns, may be used for surfaces with other than steel trowelled finish.
- 4.5.2.3 When directed by the Principal, clean the substrate by water-jetting immediately prior to placing repair material. **Water-jetting**
- 4.5.2.4 Use oil-free air when blast cleaning. **Oil-free air**
- 4.5.2.5 After wet grit blasting, rinse residue off the surface. **Grit blasting**

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| 4.5.2.6 | Dry shot blasting may be used to produce a uniform profile on decks and other horizontal surfaces, or may be used as a secondary preparation. The shot blasting machine must collect, retain and separate the debris and the used shot. | Shot blasting |
| 4.5.2.7 | Apply a secondary preparation of water or shot blasting to substrates where: .1 Concrete was removed using boom mounted or machine operated impact hammers. .2 Concrete was removed using impact hammers having blow energy greater than that specified. .3 Microfractures are discovered following initial preparation. | Secondary preparation |
| 4.5.2.8 | Water soak all substrates for cementitious based repair materials for at least 2 hours prior to applying the repair. The substrate must be “saturated-surface-dry” (SSD) at the start of repair. | Saturated surface dry substrates |
| 4.5.2.9 | Use bonding agents for thin repairs, i.e. < 40 mm thickness. Cement slurry bonding agents may be applied immediately before the repair. Where specified, apply resin based bonding agents in strict conformity to the manufacturer’s instructions. | Bonding agents |

4.5.3 Steel Reinforcement

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| 4.5.3.1 | Prepare the surface of all reinforcement in accordance with AS 1627, unless otherwise specified. Clean reinforcement contaminated with oil, grease or similar materials in accordance with AS 1627.1 before applying any coatings. Use only cleaning agents compatible with the coating system specified for the reinforcement. | Preparation standards |
| 4.5.3.2 | Carry out abrasive blast cleaning of reinforcement to Class Sa 3 of AS 1627.4, except where otherwise specified, prior to applying the reinforcement coating or the repair material. | Standards prior to application |
| 4.5.3.3 | In small patch areas, remove all scale, rust and bonded concrete from exposed reinforcement using hand or power tools to Class Sa 2½ of AS 1627.4. | Small areas class |
| 4.5.3.4 | For dry blast cleaning, use copper slag, ilmenite or other non-metallic abrasives. | Dry blasting |
| 4.5.3.5 | Where possible, bend reinforcing steel with concrete cover less than the nominal cover to obtain the nominal cover. Otherwise, notify the Principal who may: .1 Accept the nonconforming cover; .2 Direct the reinforcement to be cut off; or .3 Direct the repair thickness to be increased. | Concrete cover |

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| <p>4.5.3.6 In saline environments, jet wash exposed steel bars using potable water irrespective of the method of preparation.</p> <p>Unless specified otherwise, install embedded sacrificial anodes (ESAs) on the perimeter of the repair in accordance with the repair design and the manufacturer’s instructions.</p> <p>Fix ESAs to reinforcement prior to priming to ensure electrical connectivity. Ensure that surfaces in contact are clean.</p> | <p>Chloride induced corrosion</p> <p>Sacrificial anodes</p> |
| <p>4.5.3.7 Clean all replacement and additional reinforcement similarly.</p> | <p>Replacement</p> |
| <p>4.5.3.8 Lightly sand zinc primed surfaces exposed to the weather for an extended period, and scrub with nylon brushes and water.</p> <p>Brush blast coated/primed reinforcement before the repair. In small areas, light sanding or compressed air and brushing may be used.</p> | <p>Preparation prior to repair application</p> |
| <p>4.5.4 Removal of Coatings</p> | |
| <p>4.5.4.1 Inspect the area to be prepared for damage, weaknesses, cracks, spalls and contaminants.</p> | <p>Inspection of surfaces</p> |
| <p>4.5.4.2 Remove all damaged concrete, laitance, loose/non-adhering coatings, curing compound residues and contaminants and prepare the substrate to the specified profile in conformity to Clause 4.5.2.</p> <p>Mechanical abrasion may be used to remove weak upper layers of concrete, including laitance and curing compound residues.</p> | <p>Preparation of substrate</p> |
| <p>4.5.4.3 Abrade surfaces with old coatings not specified for removal by brush blasting to improve adhesion with the new coating.</p> <p>Where the old coating is worn and has thickness greater than the new coating, strip off the old coating completely before blasting.</p> | <p>Old coatings</p> |
| <p>4.5.4.4 After cleaning, allow the surface to be coated to dry completely, or as recommended by the coating manufacturer, before coating application commences. Do not dry the surface artificially.</p> | <p>Surface drying</p> |
| <p>4.5.5 Cracks</p> | |
| <p>4.5.5.1 Clean out individual cracks or cracked areas using wire brushes or grinders. For deep cracks, water jetting may be used.</p> <p>Remove debris in cracks, especially after grinding, using water blasting, oil-free compressed air or power vacuums.</p> | <p>Methods of preparation</p> |
| <p>4.5.5.2 In deficient substrates, v-groove the cracks back to sound concrete.</p> | <p>Deficient substrates</p> |
| <p>4.5.5.3 For cracks in coated areas, remove the coatings for at least 100 mm on each side of the crack.</p> | <p>Cracks in coated areas</p> |
| <p>4.5.5.4 After cleaning out cracks with water, allow time for natural drying or use accelerated drying, e.g. oil-free compressed or heated air.</p> | <p>Drying cracks</p> |

4.5.5.5 For crack repairs by epoxy injection, wire brush at least 20 mm each side of the crack for sealing of the cracks and injection points. **Injection repairs**

Fine cracks to be high-pressure injected must also be v-grooved to a depth of 25 mm for effective sealing.

4.5.5.6 For crack sealing by flooding, prepare the whole surface in accordance with this Clause and Clause 4.5.2. **Flooding repairs**

4.6 REINSTATEMENT AND COMPLETION

4.6.1 General

4.6.1.1 The repair material must be: **Mixing**

- .1 Mixed using only full bags, to the manufacturer's instructions. Operate electric drills used for mixing at low speed.
- .2 Mixed by adding the dry constituents to the liquid. Measure liquids using graduated containers.
- .3 Mixed close to the prepared areas to save transport time.
- .4 Transported and placed so as to prevent losses, segregation and stiffening. Do not retemper the mix or add liquids to restore workability.

4.6.1.2 Unless otherwise instructed, the manufacturer must store repair materials under cover, in the shade and keep them dry. Use in order of delivery. **Material storage**

Do not use materials that have deteriorated.

4.6.1.3 Before starting the repair, check that the air temperature and relative humidity will be suitable for successful application of the repair. **Weather conditions**

Do not proceed with the repair if rain is imminent or if the temperature or relative humidity is not suitable.

4.6.1.4 Carry out trial repairs in conformity to Clause 4.6.2 to verify the proposed repair methods. Trial repairs must be representative of the whole repair, i.e. substrate preparation, materials, equipment, operators, weather conditions and method of application. **Trial repairs**

4.6.1.5 Partial-depth repairs must not exceed half the member thickness. Otherwise, carry out only full-depth repairs. **Partial and full depth repairs**

Use concrete conforming to TfNSW B80 for full-depth repairs.

4.6.1.6 Where specified, connect embedded sacrificial anodes (ESAs) to reinforcement at the perimeter of patch repairs at spacings conforming to the manufacturer's instructions. Test the integrity of each anode connection with a multimeter before applying the repair. **ESAs**

Pre-wet ESAs prior to applying repair material.

- 4.6.1.7 Place overlays using materials at the thickness specified by the design. Ensure that overlays are placed, compacted, finished and cured to restore the nominal concrete cover and deck ride quality. **Deck overlays**
- Do not use overlays on decks with high chloride ion contents or cracking due to alkali aggregate reactions (AAR).
- 4.6.1.8 Ensure that prestressing anchorage corbels, where specified, will safely transfer the design prestressing forces into the member. **Prestressing anchorage corbels**
- Carry out prestressing operations after splicing strands and before patching, unless specified otherwise.
- 4.6.1.9 Use bonded dowels or epoxy or expansion anchors to secure thick patches to the member. **Anchoring patches**
- Where the member could be impacted again, secure repairs of impact damaged members to the substrate using bonded dowels.
- 4.6.1.10 Replace or supplement reinforcement that has lost 10% or more of its cross-sectional area due to corrosion. **Replacement reinforcement**
- Report to the Principal any reinforcement damaged during the Works and conform to the Principal's disposition of the report.
- 4.6.1.11 Splice additional or replacement reinforcement to the side of existing bars using welds $\frac{1}{2}$ the new bar diameter in size and a minimum 5 times the new bar diameter in length. **Reinforcement splicing**
- Additional concrete may need to be removed to expose sufficient lengths of bar for welding. In such case, mechanical splices or lapped splices in accordance with TfNSW B80 may be used.
- Fix new reinforcement not spliced to the existing reinforcement in drilled holes using epoxy grout. Alternatively, use steel dowels.
- 4.6.1.12 Apply the primer or first coat to reinforcement immediately after surface preparation. **Steel priming**
- Mix approved primers and apply them, using a brush, to the specified dry film thickness to the manufacturer's instructions.
- 4.6.1.13 Manually fill core holes or cut chases with repair mortar of a consistency suitable for placement and full compaction. **Repair mortar consistency**
- 4.6.1.14 Record the repairs on WAE drawings and submit for approval on completion of repairs. **WAE drawings**
- 4.6.1.15 The costs of rework or testing of nonconforming work must be at your expense. You will not be given an extension of time for delays thus caused. **Costs of rework and delays**

4.6.2 Trial Repairs

- 4.6.2.1 Trial repair areas must not be less than: **Extent of trial repair areas**
- .1 1.0 m² for conventional or shotcrete patch repairs.
 - .2 5.0 m² for protective coatings.
 - .3 2.0 m² for cracked areas or 2.0 m for crack length.
- 4.6.2.2 Take high resolution dated colour photographs of the prepared substrate and the finished trial repair. **Documenting the trial repair**
- Report on the trial, including photographs of the prepared substrate, weather conditions, method of applying the repair and results from inspection and testing.
- 4.6.2.3 Propose trial repair locations to the Principal for approval. The Principal may nominate other trial repair locations, **Principal's approval**
- 4.6.2.4 Process to be Witnessed: Trial repairs. **WITNESS POINT**

Submission Details: At least 2 Business Days notice of intention to carry out trial repairs.
- 4.6.2.5 Remove defective concrete from the trial area and prepare substrate and reinforcement, where appropriate, in accordance with the methods proposed for repair. **Preparation of trial repair areas**
- 4.6.2.6 Assess trial repairs as follows: **Trial repair assessment**
- .1 Hammer tapping to ASTM D4580 and visual inspection as specified in ANNEXURE A.4.
 - .2 Performance testing as specified in ANNEXURE A.4 using test samples as specified in ANNEXURE A.5.
- 4.6.2.7 Repair works represented by the trial repairs may only proceed if the trial repairs are successful, except for concrete removal which may proceed prior to a successful trial. **Conforming trial repairs**
- A trial repair is successful if:
- .1 All the performance criteria specified in ANNEXURE A.2 are proven by testing to have been met; and
 - .2 Patch trial repairs do not contain:
 - Surface cracks > 0.1mm;
 - Interface and perimeter cracks;
 - Trapped rebound or sand pockets;
 - Dampness or efflorescence;
 - Cracking;
 - Voids, honeycombing;
 - Drummy areas.
- 4.6.2.8 Using the proposed repair methods, plant, equipment and materials, carry out trial conventional patch repairs as follows: **Trial conventional patch repairs**
- .1 Prepare substrate and reinforcement.

- .2 Apply primer and/or bonding agents.
- .3 Carry out repair.
- .4 Prepare, mould and cure samples for compressive strength and modulus of elasticity testing as specified in ANNEXURE A.4 and ANNEXURE A.5.
- .5 At the end of the curing of patch repair, carry out bond tests as specified in ANNEXURE A.4 and ANNEXURE A.5, using the procedures specified in ANNEXURE A.3.1, as well as visual and soundness surveys.

4.6.2.9 Using the proposed repair methods, plant, equipment, materials and mix, carry out trial shotcrete patch repairs as follows:

Trial shotcrete patch repairs

- .1 Prepare substrate and reinforcement within the trial area.
- .2 Apply primer and/or bonding agents.
- .3 Shotcrete the trial area using a maximum of three nozzle men to apply the shotcrete evenly.
- .4 For each mix and nozzle man, prepare and shotcrete two 600 mm x 600 mm test panels with thickness not less than the maximum repair thickness or 160 mm, one in the horizontal position and one in the vertical position.
- .5 Label the test panels with the name of the nozzle man and the date and time of application.
- .6 Cut and core samples from the test panels for testing compressive strength and modulus of elasticity, as specified in ANNEXURE A.4 and ANNEXURE A.5.
- .7 At the end of curing of the shotcreted area, carry out bond tests as specified in ANNEXURE A.4 and ANNEXURE A.5, using the procedure specified in ANNEXURE A.3.1, as well as visual and soundness surveys.
- .8 Only nozzle men producing successful trial repairs will be approved for carrying out shotcreting of repairs.
- .9 If You need to use other than the approved nozzle men, repeat trial shotcrete patch repair during the Works.

4.6.2.10 Using the proposed repair methods, equipment and materials, carry out trial coating repairs as follows:

Trial coating repairs

- .1 Prepare the concrete surface, which may be sound concrete, an old coating or a treated cracked area.
- .2 Apply coating(s).
- .3 After curing the coating(s), carry out the tests specified in ANNEXURE A.4 and ANNEXURE A.5. Where testing for depth of penetration is required, carry out tests in accordance with ANNEXURE A.3.2.

Alternatively, carry out trial coating repair on a test panel of equivalent test area with the same substrate and surface preparation.

- 4.6.2.11 Using the proposed repair methods, equipment and materials, carry out trial crack repairs as follows: **Trial crack repairs**
- .1 Prepare the trial crack or cracked area.
 - .2 Carry out crack repairs.
 - .3 Prepare, mould and cure samples for testing compressive strength and modulus of elasticity as specified in ANNEXURE A.4 and ANNEXURE A.5.
 - .4 At the end of curing, carry out penetration tests as specified in ANNEXURE A.4 and ANNEXURE A.5, using the procedure specified in ANNEXURE A.3.3, and also carry out bond tests on repairs done using flooding.
 - .5 Where trial crack or cracked areas are to be coated, prepare 0.5 m long or 0.5 m² repaired areas. Apply coating. At the end of curing, carry out the bond tests and visual and soundness surveys specified in ANNEXURE A.4 and ANNEXURE A.5.

4.6.2.12 Process Held: Commencement of repair. **HOLD POINT**

Submission Details: All details in Clauses 4.5.1.6 and 4.6.2 applicable to the repair at least 2 Business Days before commencement.

Release of Hold Point: The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

4.6.3 Patching

- 4.6.3.1 Repair materials may be hand, trowel or gun applied or poured using conventional forms. **Placement methods**
- 4.6.3.2 Use dry pack mortar only for surface defects and form tie and construction holes. Do not use dry pack mortar for filling behind reinforcement or the repair of through thickness holes. **Dry pack repairs**
- 4.6.3.3 Do patch repairs only after the reinforcement coating, if any, is fully cured. **Reinforcement coatings**
- 4.6.3.4 Unless approved otherwise, compact repair materials using internal vibrators and ensure that the patch fully surrounds the reinforcement. **Compaction**
- 4.6.3.5 When repair jackets are used, repair thickness must not exceed 200 mm. Where possible, jackets must be circular. Construct repair jacket formwork after removing deteriorated concrete. **Repair jackets**
- 4.6.3.6 Repair damaged coating systems and all test core and anchor/bolt holes created during the Works at Your expense. **Repair of coatings and holes**

- 4.6.3.7 Place repair material at minimum and maximum layer thicknesses conforming to the manufacturer's instructions. When repair mortar is placed on a previous layer following drying/curing, mechanically roughen and brush blast the initial layer to key in the new layer. **Layers**
- 4.6.3.8 Achieve the required repair depth and profile using successive wet on wet layers. If sagging occurs, completely remove the material and use two or more wet on dry layers for the repair, or use forms. **Successive layers**
- 4.6.3.9 Remove and reapply patch repairs that lack uniformity or are segregated, honeycombed, delaminated or cracked, or which contain dry patches, voids or sand pockets, after changing the repair method or materials, as necessary. **Visual inspection of patch repair**
- 4.6.3.10 The formed surface finish class must be in accordance with TfNSW B80, TfNSW R68 or AS 3610, as appropriate. **Surface finish**
- Fill surface voids with an approved fairing mortar.
- Finish the repair to match the original texture and colour of the adjacent concrete to the Principal's satisfaction. White cement may be used to achieve a matching colour. Apply a scrape/fairing coating to fill blowholes and surface imperfections.
- Dimensional tolerances for formed and unformed surfaces must conform to TfNSW B80 or TfNSW R68, as appropriate. The repair must be flush with the surrounding concrete.
- 4.6.3.11 Cure proprietary repair materials to the manufacturer's instructions. Curing of concrete and shotcrete must conform to the repair design, or TfNSW B80 or TfNSW R68, as appropriate. **Curing**
- 4.6.3.12 Where cementitious repairs are directly exposed to the sun, water cure the repairs, using soaked hessian. Where this is not practical, seal cure using heavy duty polyethylene (PE) sheeting. **Additional curing requirements**
- Tightly wrap PE sheeting over the repair for the required curing period. Securely fasten all edges of the PE sheeting, overlap with existing concrete and seal to prevent ingress of water and contaminants and to limit circulation of air causing drying.
- If specified in the design, use thermal insulation to protect repairs.
- 4.6.3.13 Only use wet-mix shotcreting for repairs. Apply all shotcrete in permanent works using only approved nozzle men. **Shotcreting**
- Do not fill core holes using shotcrete. Use repair mortar.
- 4.6.3.14 When shotcreting: **Shotcrete application**
- .1 Use plant, equipment, materials, mix, procedures and operators to produce shotcrete conforming to this Specification.
 - .2 Do not apply cement grout or wet mortar before shotcreting.

- .3 Provide containment to minimise rebound or overspray onto fresh shotcrete, prepared substrates or reinforcement, and into waterways.
- .4 Use continuous operations to produce repairs free from cold or construction joints, unless specified otherwise.
- .5 Stop operations if materials segregate at the nozzle.
- .6 Clean reinforcement of rebound or overspray during shotcreting operations and before applying shotcrete.
- .7 Hold the nozzle at a distance and angle to allow placement of sound shotcrete around and behind the reinforcement before shotcrete accumulates on the working face.
- .8 Prevent bond failures, delamination and incomplete filling behind bars by applying sound shotcrete to the repair.

- 4.6.3.15 Reinstatement of shotcreted areas to their original profile by producing a repair of uniform thickness and finish over the reinforcement, at the specified minimum cover.

Shotcrete finish

Repair surfaces may be lightly screeded, using a steel float to remove buildups of excess shotcrete, but do not work the surface.

4.6.4 Concrete coatings

- 4.6.4.1 Apply concrete coatings, using approved application method to the manufacturer's instructions for overcoating times, coverage rates, and wet and dry film thicknesses.
- 4.6.4.2 Clean spray equipment with appropriate solvent. Thoroughly clean all tools and equipment of coating and solvent before reuse. Rollers/brushes may be washed clean and reused when dry.
- 4.6.4.3 Protect other parts of the bridge or services from overspray and spatter. Protect the public and adjacent properties as necessary.
- 4.6.4.4 Unless otherwise specified, use only penetrating coating systems, e.g. silanes, for plain concrete surfaces, or for surfaces subject to wear and abrasion.
- 4.6.4.5 Use coatings impermeable to water only if the concrete does not take up water from the environment, e.g. from ground water by capillary action, or from water ingress through untreated surfaces.
- 4.6.4.6 Where the substrate is porous, apply a filler coat to the manufacturer's instructions to fill pores.
- 4.6.4.7 Treat cracks appropriately prior to applying coating. Treat other surface defects with an approved fairing coat. Include the costs associated with crack repairs with the costs for the coating.
- 4.6.4.8 Unless otherwise specified, on concrete surfaces with repaired cracks, use only flexible coatings capable of accommodating long-term strains associated with crack widening of up to 25%.

Manufacturer's instructions

Cleaning tools and equipment

Overspray protection

Penetrating coatings

Water impermeable coatings

Pore filling

Crack treatment

Coating over repaired cracks

- 4.6.4.9 Where coatings are to be applied onto an existing film forming coating, carry out cross-cut adhesion tests to AS 1580.408.4 on the old coating at the frequency specified for bond tests. At least 75% of the cross-cut surface must remain attached to the concrete; otherwise, seek instructions from the Principal before applying the new coating. **Coating over existing coatings**
- 4.6.4.10 Cementitious repairs must be at least 14 days old, and any crack treatments fully cured, prior to preparing the surface for coating. **Age of repairs**
- 4.6.4.11 Unless otherwise specified, apply at least 2 coats to the repair area. **Number of coats**
- 4.6.4.12 Before applying coating, measure and record air temperature and relative humidity, and the temperature and moisture condition of the substrate. **Application conditions**
- Apply coating only when the substrate moisture condition conforms to the manufacturer's instructions. Concrete temperature must be at least 3° C above dew point (see AS 2312), but less than 40° C. The ambient air temperature must be between 10°C and 35° C.
- 4.6.4.13 Apply coating as follows: **Coating application**
- .1 Apply coating immediately after preparing the substrate.
 - .2 Only use solvents or thinners to the coating manufacturer's instructions.
 - .3 Strain the coating through a fine sieve before application.
 - .4 Apply coating within its specified pot life.
 - .5 Use a brush or roller for the first coat, thoroughly working it into the substrate.
 - .6 Do not exceed overcoating time limits or the specified coating thickness.
 - .7 Protect the fresh coating from wind-borne dust and grit.
 - .8 Protect the coating from the effects of temperature and wind during application, e.g. from evaporation using windbreaks.
 - .9 Document and submit records of areas treated and coating volumes and batches.
 - .10 When overcoating, use successive lighter tints to gauge the coating coverage.
- 4.6.4.14 Each coat must be smooth and uniform in texture and colour, and be free from defects, e.g. sags, runs, cracks, wrinkles, fat edges, blisters, pinholes, holidays, entrapped foreign bodies, etc. **Coating finish**
- 4.6.4.15 Use only TfNSW approved waterproofing membranes for bridge decks. Apply the membrane strictly in accordance with the manufacturer's instructions or relevant TfNSW specification. **TfNSW approved deck waterproofing membranes**

4.6.5 Crack filling

- | | | |
|----------|--|-------------------------------------|
| 4.6.5.1 | Fill cracks of width from 0.2 mm to 6.0 mm. Treat cracks wider than 6.0 mm as a patch repair. | Crack width |
| 4.6.5.2 | Carry out crack repairs by injection, gravity feed or routing and sealing methods. Gravity feed may include the following: .1 Using a caulking gun and cartridges. .2 Pouring into a reservoir formed over the crack. .3 Flooding the area with repair material. | Crack repair methods |
| 4.6.5.3 | Carry out crack repairs of the specified type, i.e. structural or non-structural. Repair dormant cracks as specified. | Crack repair type |
| 4.6.5.4 | Do not use structural repair materials for live cracks, e.g. epoxy resins, to prevent new cracks forming. | Repair of live cracks |
| 4.6.5.5 | Carry out structural repairs of dormant cracks using structural repair resins, including stitching or other strengthening as required. When specified, carry out stitching by drilling holes 90° to the crack centreline to a depth that extends beyond the crack. Fill the holes with an approved resin and insert deformed rebar dowels. Thin resin mortars may be used for structural repairs of cracked areas. For horizontal and similar surfaces directly exposed to the sun, overlays may be used in accordance with the design. Carry out structural repairs of live cracks by stabilising the cracks in accordance with the design and this Specification. | Structural crack repairs |
| 4.6.5.6 | Carry out non-structural repairs of dormant crack areas using non-structural repair resins. For horizontal cracked areas, repair resins may be applied, using gravity feed. Treat non-structural live crack repairs as an expansion joint, i.e. rout and v-groove and fill with an approved flexible sealant. | Non-structural crack repairs |
| 4.6.5.7 | Rout individual cracks down a sound substrate where the adjacent concrete is defective or a strong key is required for epoxy injection. | Crack routing |
| 4.6.5.8 | Where cracks exist in a coated area, remove the coating for 100 mm each side of the crack and prepare the surface in accordance with Clause 4.5.4. Reinstate the coating after the repair, lapping the old coating by at least 50 mm. | Cracks in coated areas |
| 4.6.5.9 | Use fine fillers, e.g. < 300 µm fine silica sand, with resins when filling cracks wider than 2.0 mm. | Filled resins |
| 4.6.5.10 | Fill cracks not able to be filled by gravity feed using an approved resin injection system with injection ports and cap seals. | Crack injection |

- 4.6.5.11 Use crack injection pressures < 400 kPa for crack widths \geq 2.0 mm and between 400 kPa and 2000 kPa for crack widths < 2.0mm. Use higher pressures only as required by crack configuration. **Injection pressure**
- 4.6.5.12 Use only surface mounted injection ports, to avoid drilling concrete. Drill into decks only where a suitable surface for mounting the ports does not exist, and/or where crack widths are smaller than 1 mm. **Injection ports**
- 4.6.5.13 Plug crack faces on both sides, as appropriate, to inject without leaks, using cap seals that function at the injection pressures. At individual cracks, clean the surface 15 mm each side of the crack to fix the cap seals. **Provisions for cap seals**
- Remove cap seals and injection ports by chipping or grinding.
- 4.6.5.14 When filling cracks by gravity feed, create a reservoir using sealant beads each side of the crack and pour in the repair material until the crack is full and expelled air bubbles have disappeared. **Repairs by gravity feed**
- When flooding cracked areas, seal around the entire area. Distribute the resin evenly and puddle with a squeegee on smooth surfaces, or with brooms or rollers on irregular surfaces. Allow the resin to penetrate until air bubbles stop. Remove excess resin with squeegees.
- 4.6.5.15 When resins are applied to decks, finish the deck surface at the repair areas for skid and/or slip resistance to match adjacent areas by broadcasting grit onto fresh resin or by grit blasting/grinding. **Deck crack repairs**
- 4.6.6 Inspection and testing of repairs**
- 4.6.6.1 Assess repairs on completion of curing, as follows: **Repair assessment**
- .1 Sounding by hammer tapping to ASTM D4580 and visual inspection as specified in ANNEXURE A.4.
 - .2 Performance testing as specified in ANNEXURE A.4, using test samples as specified in ANNEXURE A.5.
- 4.6.6.2 Mix resins to the manufacturer’s instructions and mould samples for testing. Cure samples under conditions matching those on site. Test for compressive strength and modulus of elasticity. **Crack repair materials testing**
- 4.6.6.3 A repair is successful if: **Conforming repairs**
- .1 All the test results conform to the performance criteria specified in ANNEXURE A.2; and
 - .2 Patch repairs do not contain:
 - Surface cracks > 0.1mm.
 - Interface and perimeter cracks.
 - Trapped rebound or sand pockets.
 - Dampness or efflorescence.
 - Cracking.
 - Voids, honeycombing.
 - Any drummy areas.

- 4.6.6.4 Repairs identified by visual inspection or testing to be nonconforming to this Specification will be rejected. **General non-conformity**

For nonconforming test results, where possible, the Principal may authorise a repeat of the test. Where a repeat test is not authorised or the repeat test is nonconforming, the repairs represented by the nonconforming test results will be rejected.

- 4.6.6.5 Remove and reinstate nonconforming repairs in accordance with this Specification, at your expense. **Removal of non-conforming repairs**

Cut out and reapply nonconforming shotcrete repairs. Cut back at least 50 mm outside the defective area to the substrate at an approximately 45° taper.

For coatings failing to meet the dry film thickness (DFT) criteria, an additional coating may be applied at the specified thickness.

4.7 WARRANTY PERIOD

Provide a minimum 12 months guarantee or warranty from the date of completion on the durability and serviceability of the repairs. Rectify all defects within this period at no cost to the Principal.

Transfer all guarantees or warranties to the Principal in accordance with Specification TfNSW G2.

5 CONFORMITY

- 5.1 Certify that all repairs conform to repair design and this Specification. **Conformity to repair design**
- 5.2 Certify that all repairs conform to TfNSW B80 and TfNSW R68, as appropriate. **Conformity to TfNSW Specifications**
- 5.3 When requested, submit a summary report verifying conformity of all work done in accordance with this Specification, with supporting documentation. **Conformity summary report**

Include the following in the summary report:

| Item | Reference | Conformity |
|-------------------------|----------------|---------------------------------------|
| Trial repair conformity | Clause 4.6.2.7 | Conforming trials. |
| Repair conformity | Clause 4.6.6.3 | Conforming repairs. |
| Nonconformities | TfNSW Q4M | List of NCRs issued and dispositions. |

ANNEXURE A—DETAILS OF WORK

A.1 WORK SUMMARY – REPAIRS

| | | | | | |
|----------------------------|---|-------------------------------------|--|-------------------------|--|
| TfNSW BRIDGE NO | | BRIDGE NAME AND LOCATION | | | |
| YEAR BUILT | | PLAN REG'N NO. | | DESIGN LOADS | |
| MEMBER | DEFECTIVE AREA | | ASSOCIATED MEMBERS COVERED BY REPAIRS | | |
| PILES | | | | | |
| PIERS | | | | | |
| ABUTMENT A | | | | | |
| ABUTMENT B | | | | | |
| GIRDERS | | | | | |
| X-GIRDERS | | | | | |
| DECK | | | | | |
| APPROACH SLABS | | | | | |
| BARRIERS | | | | | |
| NOTES: | ENTRIES TO THIS TABLE ARE BASED ON THE REPAIR DESIGN PROVIDED BY THE PRINCIPAL UNLESS OTHERWISE INDICATED. | | | | |

A.2 PERFORMANCE REQUIREMENTS

A.2.1 Repair Mortar/Shotcrete

| Property | Requirement | Test Method | Comments |
|---|----------------------------------|--------------------|---|
| Tensile strength (MPa) | 2.0, 3.0 & 4.0 at 1, 7 & 28 days | AS1012.10 | Indirect splitting. |
| Restrained expansion (%) | 0.02 & > 0.0 at 1 & 7 days | ASTM C878 | In air. |
| Shrinkage (%) | 0.04 at 28 days | AS 1012.13 | |
| Bond strength (MPa) | 1.0 at 7 days | ANNEXURE A.3.1 | Use laboratory test slab for qualification testing. |
| Compressive strength (MPa) | 25 & 35 at 7 & 28 days | AS1012.9 | |
| Coefficient of Thermal expansion (mm/mm/°C) | < 14 x 10 ⁶ | ASTM C531 | |
| Modulus of elasticity (GPa) | < 25 | AS 1012.17 | |
| Chlorides (% cement wt) | < 0.1 | AS1012.20 | |
| Sulphates (% cement wt) | < 0.4 | AS1012.20 | |

A.2.2 Protective Coatings - Anti-Carbonation

| Property | Requirement | Test Method | Comments |
|---|---|-------------------------|--|
| Dry Film Thickness (um) | > 150 | AS 1580.108.2 | Trial/Repair testing only. |
| Bond strength (MPa) | 0.75 at 7 days, or Failure at interface with concrete for coats on old coating | AS 1580.408.5 | Concrete or old coating substrate as appropriate, or between coatings. Only for trial/repair testing. |
| CO ₂ equivalent air layer thickness (R) (m) | > 150 | Klopfer Criteria | |
| CO ₂ equivalent thickness of concrete (S _c) (mm) | > 450 | Klopfer Criteria | |
| CO ₂ diffusion (cm ² /s) | < 2 x 10 ⁻⁷ | Fick's law of diffusion | After 2,000 hrs accelerated weathering. |
| Water vapour equivalent air thickness (m) | < 2.0 | Klopfer Criteria | |

A.2.3 Protective Coatings - Chloride Resistance

| Property | Requirement | Test Method | Comments |
|---------------------------|---|-------------------------|--|
| Dry Film Thickness (um) | > 200 | AS 1580.108.2 | Trial/Repair testing only. |
| Bond strength (MPa) | 0.75 at 7 days, or Failure at interface with concrete for coats on old coating | AS 1580.408.5 | Concrete or old coating substrate as appropriate, or between coatings. Only for trial/repair testing. |
| Chloride diffusion | < 5 x 10 ⁻⁹ cm ² /s | Fick's law of diffusion | After 2,000 hrs accelerated weathering. |
| CO ₂ diffusion | < 2 x 10 ⁻⁷ cm ² /s | Fick's law of diffusion | After 2,000 hrs accelerated weathering. |

A.2.4 Protective Coatings - Penetrating Type

| Property | Requirement | Test Method | Comments |
|------------------------|---|----------------|--------------------------------|
| Penetration depth (mm) | 5 mm silane coats 3 mm siloxane/silane coats | ANNEXURE A.3.2 | Only for trial/repair testing. |

A.2.5 Crack Repairs – Structural Repair Resins

| Property | Requirement | Test Method | Comments |
|----------------------------------|---|----------------|--|
| Moisture tolerant | <input type="checkbox"/> YES <input type="checkbox"/> NO | - | |
| Tracer dye required | <input type="checkbox"/> YES <input type="checkbox"/> NO | - | |
| Viscosity (mixed) (25°C) (mPa.s) | < 50, 200 & 1,000 for fine, medium and large cracks respectively. | ASTM D2393 | Crack width mm: Fine: < 0.5 Medium: > 0.5 - < 2.0, Large: > 2.0 - < 6.0 |
| Penetration ratio | > 75% for each test (3 cores) | ANNEXURE A.3.3 | Trial/repair testing only. |

| Property | Requirement | Test Method | Comments |
|-----------------------------|---------------------------------|-------------|------------------------|
| Vapour pressure (mm/Hg) | < 1 | ASTM D323 | Only for area repairs. |
| Flash point (°C) | > 90 | ASTM D3278 | |
| Compressive strength (MPa) | > 20 , 30 & 40 @ 1, 7 & 14 days | ASTM D695 | |
| Tensile strength (MPa) | > 20 @ 7 days | ASTM D638 | |
| Modulus of elasticity (GPa) | > 3 @ 7days | ASTM D638 | |
| Bond strength (MPa) | > 5 @ 1 day | ASTM C882 | |

A.2.6 Crack Repairs – Non-Structural Repair Resins

| Property | Requirement | Test Method | Comments |
|----------------------------------|---|----------------|--|
| Moisture tolerant | <input type="checkbox"/> YES <input type="checkbox"/> NO | - | |
| Tracer dye required | <input type="checkbox"/> YES <input type="checkbox"/> NO | - | |
| Viscosity (mixed) (25°C) (mPa.s) | < 50, 200 & 1,000 for fine, medium and large cracks respectively. | ASTM D2393 | Crack width mm: Fine: < 0.5 Medium: > 0.5 - < 2.0, Large: > 2.0 - < 6.0 |
| Penetration ratio | > 75% for each test (3 cores) | ANNEXURE A.3.3 | Trial/repair testing only. |
| Vapour pressure (mm/Hg) | < 1 | ASTM D323 | Only for area repairs. |
| Flash point (°C) | > 90 | ASTM D3278 | |
| Tensile strength (MPa) | > 2 @ 7 days | ASTM D638 | |
| Modulus of elasticity (MPa) | > 200 @ 7 days | ASTM D638 | |
| Bond strength (MPa) | > 5 @ 1 day | ASTM C882 | |

A.3 TEST PROCEDURES

A.3.1 Bond Test-Patching/Shotcreting

- .1 Prepare test specimens as follows:
 - .a Field testing – Place, compact and cure repair materials as specified.
 - .b For qualification laboratory testing, prepare a test slab as follows:
 - Cast a concrete slab 200 mm × 400 mm with 100 mm thickness.
 - Screed off and finish the top surface with a wooden float to an even uniform surface.
 - Water cure for 7 days.
 - Bring the slab to saturated surface dry.
 - Place and compact 50 mm layer of repair material on top of the slab using formwork.
 - Screed off and finish the top surface of the repair material as above.
 - Cure the slab to the manufacturer’s instructions.
- .2 Cut free three 50 mm diameter cores through the repair area or test slab as appropriate, to a depth of 20 mm in the substrate. Fix the core drilling machine to enable drilling without vibration or displacement of the specimen.
- .3 Bond 50 mm diameter dolly to each drilled core, using adhesive recommended by the tester manufacturer.
- .4 After curing of adhesive, apply a pull-off load parallel and central to the dolly at a rate of 20 kPa/sec until failure is reached.
- .5 If you obtain a valid failure, i.e. failure which does not occur at the interface between the dolly and the core, record the failure load and plane of failure.
- .6 If you do not obtain a valid failure, disregard the test result and carry out further testing as necessary to obtain the specified numbers of cores for testing.
- .7 Visually examine the extracted valid cores for defects and plane of failure. The repair material part must not have voids, laminations or other flaws.
- .8 Calculate bond strength by dividing valid failure load by dolly area.
- .9 Remove any parts of drilled cores not extracted and reinstate the holes.

A.3.2 Depth of Penetration – Coatings

- .1 Cut three 50 mm diameter cores to minimum depth of 50 mm through the treated area.
- .2 Seal and label the cores before sending off to the testing laboratory.
- .3 Oven-dry the cores for 24 hrs at 40°C.
- .4 Split each core and apply an indicator solution on both fresh surfaces of the split core.
- .5 Measure the minimum penetration depth, i.e. indicator non-absorbing depth, from the top edge of split faces in mm. Avoid aggregate particles that could have blocked the penetration.
- .6 Report average penetration depth of the three cores as the penetration depth.

NOTES:

- a. Indicator solution may be made of 10% v/v food dye in water.
- b. Where penetration depth is not distinctive, use petrographic examination.

A.3.3 Penetration Ratio – Cracks

- .1 Cut three 50 mm diameter cores to minimum depth of 100 mm through the treated crack/area.
- .2 Visually examine the cores and report the longest three surface cracks with width > 0.1 mm, in terms of crack width, length, and depth of penetration for each core.
- .3 Where tracer dye is specified, seal and label the cores before sending off to a testing laboratory to examine cores under black light and report on the longest three surface cracks as above, together with photographs of the findings.
- .4 For each core, calculate penetration ratio, i.e. penetration depth divided by crack length, for the three cracks and their average.

A.4 NUMBER OF TRIAL REPAIRS AND REPAIR TESTS

| | TEST ⁽¹⁾ | COMPRESSIVE STRENGTH | MODULUS OF ELASTICITY | BOND STRENGTH | DRY FILM THICKNESS | PENETRATION | VISUAL SURVEY% | SOUNDNESS SURVEY% |
|---------------------|---------------------|---|---------------------------------|--|-------------------------|--------------------------------|----------------|-------------------|
| | STAGE | | | | | | | |
| PATCH REPAIRS | TRIAL | 2 ⁽²⁾ | 2 ⁽²⁾ | 1 | - | - | 100 | 100 |
| | REPAIR | 1 PER 20 M ² | 1 PER 20 M ² | 1 PER 20 M ² | - | - | 100 | 50 |
| PROTECTIVE COATINGS | TRIAL | - | - | 1 | 1 | 1 | 100 | - |
| | REPAIR | - | - | 1 PER 30 M ² | 1 PER 30 M ² | 1 PER 30 M ² | 100 | - |
| CRACK REPAIRS | TRIAL | 2 | 2 | 2 ⁽³⁾ (COATING) | - | 2 | 100 | - |
| | REPAIR | 1 PER 50 M OR 20 M ² | 1 PER 50 M OR 20 M ² | 1 ⁽³⁾ PER 50 M OR 20 M ² (COATING) | - | 1 PER 50M OR 20 M ² | 100 | - |
| NOTES: | (1) | TEST METHODS ARE AS SPECIFIED IN ANNEXURE A.2. | | | | | | |
| | (2) | FOR SHOTCRETE, CUT ONE TEST SAMPLE FROM EACH TEST PANEL. | | | | | | |
| | (3) | ONLY WHEN A CRACKED AREA IS TO BE COATED OR REPAIRED BY FLOODING. | | | | | | |

A.5 TEST SAMPLES

| Test | Test Sample | Repair Type |
|-----------------------|--|--|
| Compressive strength | <input type="checkbox"/> 3 Cast-in cylinders Ø100 mm x 200 mm; <input type="checkbox"/> 3 Cores (Ø75 mm x 170 mm) shotcrete ; or <input type="checkbox"/> 6 Moulded cylinders Ø20 mm x 40 mm. | Patch repairs-conventional. Patch repairs-shotcrete. Crack repair. |
| Modulus of elasticity | <input type="checkbox"/> 3 Cast-in cylinders Ø100 mm x 200 mm; <input type="checkbox"/> 3 Cores (Ø75 mm x 170 mm) ; or <input type="checkbox"/> 6 Moulded cylinders Ø20 mm x 40 mm (use compression test sample). | Patch repairs-conventional. Patch repairs-shotcrete. Crack repair resin. |
| Bond strength | <input type="checkbox"/> 3 × Ø50 mm cores drilled 20 mm into substrate; <input type="checkbox"/> 3 measurements using 50 mm square test area in 0.5 m ² coating area; or <input type="checkbox"/> 3 measurements using 50 mm square test area in 0.5 m ² coating area. | Patch repairs. Protective coatings. Crack repairs. |
| Dry Film Thickness | <input type="checkbox"/> 5 readings in 1m ² | Protective coatings. |
| Depth of penetration | <input type="checkbox"/> 3 Cores (Ø50 mm x 50 mm minimum) penetrating coatings; or <input type="checkbox"/> 3 Cores (Ø50 mm x 100 mm minimum). | Penetrating coatings. Crack repairs. |

A.6 INFORMATION SUPPLIED BY THE PRINCIPAL

| Documentation | Supplied by Principal* | Paper copy | Electronic copy | Document Reference and Date (dd-mm-yyyy) |
|---|------------------------|------------|-----------------|--|
| 1. Bridge repair design. | YES / NO | | | |
| 2. Investigation Report produced under M772. | YES / NO | | | |
| 3. Bridge Survey Control. | YES / NO | | | |
| 4. Drawings of past design modifications. | YES / NO | | | |
| 5. Most recent construction drawings. | YES / NO | | | |
| 6. Work-As-Executed drawings. | YES / NO | | | |
| 7. Original drawings of the bridge. | YES / NO | | | |
| 8. Structural assessments and reports relating to the bridge. | YES / NO | | | |
| 9. BIS bridge condition inspection reports for the bridge. | YES / NO | | | |
| 10. Records of application or presence of toxic or hazardous chemicals on, or in bridge vicinity. | YES / NO | | | |
| 11. Other documentation: Future utilisation of bridge, forward planning etc. _____ | YES / NO | | | |
| NOTE: (*) Delete one option | | | | |

A.7 LOADING REGIME

| | |
|--|--|
| Design live load capacity or load limit ⁽¹⁾ | |
| Traffic and pedestrian restrictions ⁽¹⁾ | |
| Other loading conditions | |
| Stage construction sequence ⁽¹⁾ | |
| Scope of temporary support arrangements ⁽¹⁾ | |
| NOTES: ⁽¹⁾ | To conform to the repair drawings and repair design. |

ANNEXURE B—MEASUREMENT AND PAYMENT

B.1 GENERAL

| | | |
|-------|--|------------------------------|
| B.1.1 | Pay Items are identified in ANNEXURE B.2. | Pay Items |
| B.1.2 | Price pay items in the schedule of pay items taking into account all the costs associated with doing the work. Include the costs of any unpriced pay items in the priced pay items. | Prices |
| B.1.3 | Distribute overheads between priced pay items. | Overheads |
| B.1.4 | Pay items with a specified quantity of work must not be tendered as a lump sum. | No Lump Sums |
| B.1.5 | Pay Item 909 applies for work relating to provision for traffic. | Provision for traffic |
| B.1.6 | You will not be paid for work that does not conform to the Specification, i.e. You will not be paid for: <ul style="list-style-type: none"> .1 Removing nonconforming material and replacing with conforming material. .2 Rework required to achieve conformity. .3 Warranty repairs. | No payment |

B.2 SCHEDULE OF PAY ITEMS

| Maintenance Activity Code | Item Name and Description | Units of Measurement |
|----------------------------------|---|-----------------------------|
| B.2.1 | Patch repair Includes the following tasks: <ul style="list-style-type: none"> .1 Removal of defective concrete; .2 Preparation of substrate and reinforcement; .3 Addition or replacement of steel reinforcement; .4 Coating of reinforcement; .5 Sacrificial anodes for perimeter corrosion protection; .6 Placement of grout, mortar or concrete; .7 Curing of material. | m² |
| B.2.2 | Concrete coatings Includes the following tasks: <ul style="list-style-type: none"> .1 Anti-carbonation coatings; .2 Chloride-resistant coatings; .3 Penetrating coatings; .4 Fairing coatings. | m² |
| B.2.3 | Crack filling Includes the following tasks: <ul style="list-style-type: none"> .1 Substrate preparation; .2 Resin injection/flooding; .3 Surface treatment. | m |

ANNEXURE C—SCHEDULE OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 2.1.1.1.

C.1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

| Clause | Type | Process Held or Witnessed | Submission Details |
|---------------|-------------|--|---|
| 2.1.3 | Hold | Commencement of Work. | Submission of: 1. PROJECT QUALITY PLAN in accordance with Clause 2.1.2. 2. Proposed audit procedures for ensuring conformity with this Specification in the absence of frequent testing and supervision by the Principal. |
| 3.2.21 | Hold | Carrying out trial repair. | Submission of documents required in Clauses 3.2.6 and 3.2.9. |
| 4.1.14 | Hold | Site traffic management | Submission of TRAFFIC CONTROL PLAN (TCP). |
| 4.3.3.4 | Hold | Erection of scaffolding and other access works. | Submission of details of scaffolding and/or access works including design calculations and an Engineer's certification. |
| 4.3.4.4 | Hold | Erection of formwork. | Submission of formwork documentation and Engineer's design certificate, as appropriate. |
| 4.4.2.3 | Witness | Confirmation of marked out repair areas prior to sawcutting. | Submission of drawings of marked out repair areas at least 2 business days before cutting. |
| 4.6.2.4 | Witness | Execution of trial repairs. | At least 2 Business Days notice of intention to carry out trial repairs. |
| 4.6.2.12 | Hold | Commencement of a repair. | Submission of details in Clauses 4.5.1.6 and 4.6.2 applicable to the repair. |

C.2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW Q4M Annexure Q/E.

| Clause | Description of Identified Record |
|---------------|--|
| 4.1.5 | Progress photographs of repair activities. |
| 4.1.12 | Bridge Survey Control. |
| 4.2.3 | Dismantled members. |
| 4.5.1.6 | Extent and location of preparation work. |
| 4.6.1.14 | Work-As-Executed drawings of actual repairs. |
| 4.6.2.2 | Trial repair documents. |
| 4.6.4.12 | Weather and substrate conditions for coated areas. |
| 4.6.4.13 | Coated areas and coating batches and volumes. |

ANNEXURE D—PLANNING DOCUMENTS

D.1 REPAIR PROCESS

The information to be supplied by the Contractor must include, but not be limited to, the following:

| Clause | Process | Description |
|---------------|------------------------|---|
| 2.1.1 | Planning | PROJECT QUALITY PLAN. |
| 2.1.2.1 | Planning | Repair plan showing sequence and progress of repairs in a structured manner. |
| 2.1.2.2 | Repair procedures | Repair procedures covering: concrete removal, substrate preparation, splicing of reinforcement/welding, application of repair material, finishing and curing, application of concrete coatings and crack repairs. |
| 2.1.2.5 | Preloading | Preloading method where required for repairs of prestressed members. |
| 2.1.2.7 | Core drilling | Procedure for core drilling. |
| 2.2.1 | Traffic management | TRAFFIC CONTROL PLAN (TCP). |
| 2.2.2 | Environment management | Contractor's Environmental Management Plan. |
| 2.2.3 | Environment management | Waste Management Plan where appropriate. |
| 2.2.4 | Site safety | Project WORK HEALTH AND SAFETY MANAGEMENT PLAN. |
| 4.4.5.1 | Hydro-demolition | Procedure for safety and control of pressure during hydro-demolition. |
| 4.4.5.2 | Water jet cutting | Procedure for control and safety of water jet cutting |
| 4.5.1.2 | Blast cleaning | Protection measures for field blast cleaning operations. |
| 4.6.6 | Inspection and testing | Inspection and testing to verify repair conformity. |

ANNEXURES E TO L (NOT USED)

ANNEXURE M—REFERENCED DOCUMENTS AND DEFINITIONS

M.1 REFERENCE DOCUMENTS

M.1.1 Australian Standards

| | |
|---------------|--|
| AS 1012 | Methods of testing concrete |
| AS 1012.9 | Compressive strength tests – Concrete, mortar and grout specimens |
| AS 1012.10 | Determination of indirect tensile strength of concrete cylinders (Brasil or splitting test) |
| AS 1012.13 | Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory |
| AS 1012.17 | Determination of the static chord modulus of elasticity and Poisson's ratio of concrete specimens |
| AS 1012.20 | Methods of testing concrete - Determination of chloride and sulfate in hardened concrete and concrete aggregates |
| AS 1580 | Paints and related materials – Methods of test |
| AS 1580.108.2 | Dry film thickness - Paint inspection gauge |
| AS 1580.408.4 | Adhesion (crosscut) |
| AS 1580.408.5 | Adhesion - Pull-off test |
| AS 1627 | Metal finishing – Preparation and pre-treatment of surfaces |
| AS 1627.1 | Removal of oil, grease and related contamination |
| AS 1627.4 | Abrasive blast cleaning of steel |
| AS 2312 | Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings |
| AS 3610 | Formwork for concrete |
| AS/NZS 1349 | Bourdon tube pressure and vacuum gauges |
| AS/NZS 4671 | Steel reinforcing materials |

M.1.2 ASTM Standards

| | |
|-------|---|
| C531 | Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes |
| C878 | Standard Test Method for Restrained Expansion of Shrinkage-Compensating Concrete |
| C882 | Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear |
| D323 | Standard Test Method for Vapour Pressure of Petroleum Products (Reid Method) |
| D638 | Standard Test Method for Tensile Properties of Plastics |
| D695 | Standard Test Method for Compressive Properties of Rigid Plastics |
| D2393 | Test Method for Viscosity of Epoxy Resins and Related Components |

D3278 Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus

D4580 Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding

M.1.3 TfNSW Specifications

TfNSW B80 Concrete Work for Bridges

TfNSW B341 Demolition of Existing Structure

TfNSW G2 General Requirements

TfNSW G22 Work Health and Safety (Construction Work)

TfNSW G36 Environmental Protection

TfNSW G71 Construction Surveys

TfNSW Q4M Quality Management System (Type 4)

TfNSW R68 Shotcrete Work Without Steel Fibres

TfNSW M772 Concrete Bridge Repairs - Investigation

TfNSW M783 Bridge Bearing Repairs - Construction

M.1.4 TfNSW Publications

Traffic Control at Work Sites Manual

M.2 DEFINED TERMS

| | |
|-------------------------|---|
| Approved Loading regime | The live loading and other conditions that will apply during the Work (refer to ANNEXURE A.7). |
| Business Day | Any day other than a Saturday, Sunday or public holiday or 27, 28, 29, 30 or 31 December. |
| HOLD POINT | A point beyond which a work process must not proceed without the Principal's express written authorisation (refer TfNSW Q4M). |
| Principal | Means the Transport for NSW agency. |
| Specification | Means TfNSW M774. |
| Structural Engineer | Professional Engineer who is a member of Engineers Australia (IEAust) as a Structural Engineer on the National Engineering Register (NER), or equivalent. |
| WITNESS POINT | A point in a work process where You must give prior notice to the Principal and the option of attendance may be exercised by the Principal (refer TfNSW Q4M). |
| Work | The scope of work covered by this Specification under the Contract (refer to ANNEXURE A.1 and TfNSW Q4M). |
| You/Your | Means/relates to the Contractor, including subcontractors, employees and agents of the contractor. |

M.3 DEFINITIONS

The following definitions apply to this Specification:

| Term | Alternative Term | Definitions |
|-----------------------------|-------------------------|--|
| Bridge Information System | BIS | General term for the approved TfNSW bridge inspection and condition rating reporting system and its database. |
| Bridge moving | | Moving a bridge or part of it in any direction from or to a given position to enable bridge repairs and/or allow access to bearings. |
| Bridge Survey Control | | The survey control network for the bridge (refer to Specification TfNSW G71). |
| Efflorescence | | Deposition of white salts or lime mortar on the concrete surface. |
| Member | Component Element | Any member or part of member forming part of a structural assembly. |
| Honeycombing | Voids | Clear evidence of voids or spaces within concrete. |
| Live cracks | | Cracks showing progressive growth, excluding thermal cyclic opening/closing. |
| Non-structural crack repair | | A repair that fills or seals a crack to prevent seepage and to protect the reinforcement from corrosion and further deterioration. |
| Repairs | | The repairs covered by the scope of this Specification. |
| Repair design | | The design drawings and where appropriate the design report required to carry out permanent repairs of defective concrete members and associated members and public utility services. |
| Qualification testing | | Testing of a repair material before using in the Works. |
| Spalling | | Concrete fragments, usually detached from the parent concrete. |
| Structural crack repair | | A repair that restores concrete continuity and structural integrity across the crack and accommodates the stresses that result therein. |
| Temporary works | | All work which is not part of the permanent repair but is required before or during completion of permanent repairs, including, but is not limited to, interim repairs, access and scaffolding, temporary bracing and temporary supports (e.g. supplementary bearings, shoring, blocking, and cribbing). |
| Trial repairs | | A controlled repair carried out on limited area to verify the suitability of the proposed repair method, materials, equipment and operators before use on other repair areas with similar conditions. |
| Work-As-Executed drawings | WAE drawings | Drawings recording details of completed Work. |