SECTION 680 - BONDED ANCHORS

##This section cross-references Sections 175, 610, 611, 687 and 689.

The above sections are relevant, and they must be included in the specification.

680.01 GENERAL

This section specifies the requirements for supply of materials, workmanship, installation and testing of bonded anchors installed in concrete to make structural connections to concrete members of bridges and tunnels, structural roadway components and other related structural applications, for a design life of 50 years and 100 years as required in the specified in‑service exposure conditions and any other specific use.

The design of bonded anchors shall comply with the Department of Transport (DoT) Bridge Technical Note BTN006, Bonded Anchors.

Where bonded anchors are proposed, the Contractor shall demonstrate that the selected bonded anchor system satisfies the requirements of the design to the satisfaction of the Superintendent.

680.02 STANDARDS

Australian Standards are referenced in an abbreviated form (e.g., AS 2193).

(a) Australian Standards

AS 2193 Calibration and classification of force-measuring systems

AS 1391 Metallic materials - Tensile testing at ambient temperature

AS 1530.4 Methods for fire tests on building materials, components and structures

AS 5216 Design of post-installed and cast-in fastenings in concrete

(b) Additional Test Methods

ASTM E 488 Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

ASTM E 1512 Standard Test Methods for Testing Bond Performance of Adhesive-Bonded Anchors

EN 1363-2 Fire Resistance Tests - Part 2: Alternative and Additional Procedures

EOTA TR 048 – Details of tests for post-installed fasteners in concrete (https://www.eota.eu/en-GB/content/technical-reports/28/)

(c) Additional Documents and Referenced Specifications

ATIC-SPEC 38 – Metal anchors for use in concrete (published by the Australian Technical Infrastructure Committee (ATIC)

DoT Bridge Technical Note 006 (BTN006), Bonded Anchors

EOTA EAD 330499-00-0601 - Bonded fasteners for use in concrete (<https://www.eota.eu/en-GB/content/eads/56/212/>)

ICC-ES (USA) – International Code Council Approvals, Evaluation service for post installed anchors and other building products

ITA Guidelines for Structural Fire Resistance of Road Tunnels (International Tunneling Association)

Section 175 details the relevant references to these documents.

680.03 DEFINITIONS

**Anchor:** A steel stud, threaded rod, steel bolt or reinforcing steel drilled and secured into the existing hardened concrete.

**Bonded anchor:** A system comprising an anchor and a chemical adhesive that transmits structural loads from the embedded anchor into the hardened concrete by means of tension, shear, compression or a combination of tension and shear.

**Chemical adhesive:** A material or bonding agent used to bond together steel and concrete components to hardened concrete and provide the pathway for the required load transfer of the bonded anchor system.

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**Discrete population**: A population of bonded anchors that has bonded anchors of the same type (manufacturer and model), diameter, embedment depth, installed in the same substrate (e.g., same type and strength, same installation conditions such as wet or dry and temperature) and have all been installed by the same work crew in the same shift.

**Fatigue:** Fracture or failure of the bonded anchor which is caused by repetitive, cyclic or fluctuating loading and unloading in its in-service condition where once fatigue sets in, failure occurs after a number of fluctuating loads have been applied and this may occur at loads much lower than the actual capacity of the bonded anchor.

**Lot:** The number of bonded anchors from a discrete population installed in one continuous operation by the same work crew.

**Proof load test:** A tension test performed on a bonded anchor whose installation is complete and is intended to validate correct installation, by allowing bond failure but precluding concrete failure via a confined test. The proof load shall not exceed the lesser of the yield strength of the anchor rod or the design bond strength of the chemical adhesive.

**Ultimate load test:** A tension test performed on a bonded anchor whose installation is complete and is intended to aid in establishing the suitability of the bonded anchor in a hardened concrete where all the properties required for design are not known, by allowing concrete failure and/or bond failure via an unconfined test.

680.04 DESIGN REQUIREMENTS AND LIMITATIONS ON USE

The design and limitations on use of bonded anchors shall be in accordance with the requirements of BTN006.

Where, AS 5216 is referenced in the design of bonded anchors, BTN006 shall take precedence where they differ.

The design of the bonded anchor system shall make allowance for the following performance influencing factors:

(a) the substrate conditions at the time of installation

(b) the in-service substrate conditions (i.e. dry or wet, temperature, concrete strength, drilling method)

(c) the geometry of the host concrete member (i.e. edge distance, spacing between bonded anchors, member thickness)

(d) the nature of the applied loads (i.e. static, dynamic, cyclic, sustained and fatigue)

(e) depth of embedment

(f) the direction of loading; and

(g) the effect of the composition of the chemical adhesive on the load carrying capacity and performance.

The bonded anchor system design shall be certified by a Design Engineer who is a member of Engineers Australia and with a minimum of 5 years’ experience in the design and construction of bonded anchor systems of similar complexity. The bonded anchor system design shall be verified in accordance with the Contract to confirm that the design satisfies the performance requirements of the bonded anchors.

The bonded anchor system design shall be proof engineered by a Proof Engineer, who is independent of the design consultant’s firm and is prequalified at Proof Engineer Level under the DoT prequalification scheme.

**HP Subject to the requirements of BTN006, if it is proposed to use bonded anchors in tension , shear, compression, combined tension and shear or fatigue applications as described in BTN006, the Contractor shall submit full details of the proposal, including a Proof Engineering Certificate of Compliance, for the approval of the Superintendent, not later than two weeks prior to the intended use.**

Any amendment to the design after the issue of the Proof Engineering Certificate of Compliance shall be referred to the Proof Engineer for review and a new Certificate of Compliance shall be provided to also cover any amendments made to the design.

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680.05 MATERIALS

(a) General

Bonded anchor systems shall be certified in accordance with a third-party materials accreditation scheme or a technical approval scheme approved by the Superintendent. For this purpose, certification in accordance with one of the following is acceptable:

(i) AS 5216 Appendix A

(ii) ATIC SP 38

(iii) EOTA EAD 330499-00-0601 - Bonded fasteners for use in concrete

(iv) ICC (USA).

Bonded anchor systems with current ETA (European Technical Assessment/Approval) automatically conform to the requirements of AS 5216 Appendix A.

Where a 100-year design life is required, bonded anchor systems shall be certified to a current European Technical Assessment (ETA) which is supported by a current European Assessment Document (EAD) that prescribes the testing procedures and protocols used for the independent 100-year design life certification. This EAD shall be published in the Official Journal of the European Union (OJEU) and shall be available on the European Organisation for Technical Assessment (EOTA) website. Components from different types of bonded anchor or from different bonded anchor suppliers shall not be mixed, exchanged or substituted for the specified system.

As a minimum, the technical information to be specified on design drawings shall include the following:

(i) bonded anchor: manufacturer’s name, product name

(ii) details of steel element: strength grade, depth of embedment

(iii) drilled hole: diameter, depth, method of drilling

(iv) sequence of installation, including cleaning steps

(v) working time for the chemical adhesive

(vi) curing time of the chemical adhesive to gain sufficient strength to allow the bonded anchor to be loaded

(vii) temperature limitations applicable to adhesive resin

(viii) proof loads

(ix) requirements for fire resistance where required

(x) tightening torque.

**HP If the Contractor proposes to use an alternative to the specified bonded anchor system, including any deviation from the product, substrate or installation specified, the Contractor shall submit full details of the proposed alternative system and its design for approval by the Superintendent no later than two weeks prior to the proposed installation of the bonded anchors.**

The bonded anchor system shall include, but not be limited to, new adhesive cartridges, clean mixing nozzles, nozzle extensions, dispensing gun(s), and all manufacturer recommended supplies for correctly cleaning the drilled holes.

(b) Chemical Adhesives

In addition to satisfying all requirements stipulated by the bonded anchor supplier, the following restrictions apply:

(i) chemical adhesives containing styrenes are not permitted

(ii) polyester type chemical adhesives susceptible to alkaline hydrolysis shall not be used if the bonded anchor will be exposed to moisture during the life of the structure

(iii) the chemical adhesive shall be used in holes which have been drilled and cleaned using the technique (e.g., carbide-tipped rotary hammer or diamond-tipped core drill) prescribed by the manufacturer (refer to manufacturer’s installation instructions)

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(iv) the selected chemical adhesive shall perform in accordance with the design for expected ranges of loading, temperature and moisture content over the design life of the structure

(v) the Contractor shall comply with all requirements for the correct use of the chemical adhesive specified by the supplier in the manufacturer’s installation instructions, including but not limited to, temperature range, curing time, shelf life, mixing requirements and moisture content; and

(vi) bonded anchors used under sustained tensile, shear, compression, combination of tensile and shear or fatigue loading shall be certified for this loading type in accordance with clause 680.05(a).

(c) Metallic Components and Coatings

Steel reinforcement shall comply with the requirements of Section 611 and shall be prequalified for use with the chemical adhesive in accordance with clause 680.05(a).

Coatings for metal components shall have sufficient durability to achieve the required design life of the structure.

Galvanised steel components shall not be used as bonded anchors when used with a chemical adhesive in fatigue loading applications (i.e fluctuating stresses with time). For all other loading applications galvanised steel components shall comply with the requirements of BTN006.

Stainless steel grades 1.4401, 1.4404, 1.4362 and 1.4571 (marking A4) shall not be used in conditions where the component is either permanently inundated in seawater or in the splash zone. Stainless steel grades 1.4529 (marking C) may be used in conditions where the component is either permanently inundated in seawater or in the splash zone.

**Proprietary threaded anchor rods and metallic bolts shall be subject to certification by the third-party materials accreditation scheme or technical approval scheme as required in clause 680.05(a).**

680.06 CONTRACTOR COMPETENCY AND TRAINING OF PERSONNEL

**HP The bonded anchor installers, and all of its site personnel, shall be certified by the Australian Engineered Fasteners and Anchors Council (AEFAC), and shall provide evidence of this certification and of its competency acceptable to the Superintendent.**

**HP All personnel, including supervisory personnel, who are required to install bonded anchors shall also be trained on-site by the supplier of the bonded anchor system in the specific installation requirements of the project before bonded anchor installation works commence.**

In addition to the above, the installation Contractor or sub-contractor and installation personnel shall have a minimum 5 years of experience and a demonstrated competency for the installation of bonded anchors. Such experience shall be supported with documented evidence of previous experience including previous projects and relevant references.

Training shall include but not be limited to the following:

(a) requirement that reinforcing bars, pre-stressing tendons, other steel embedments and services that may lie within the depth of the drill hole have been previously located prior to commencement of drilling.

(b) hole drilling, preparation and cleaning procedure.

(c) adhesive dispensing and injection technique.

(d) anchor preparation and installation in horizontal, overhead, downward, inclined and declined orientations.

(e) application of torque; and

(f) general principles of proof load and ultimate load testing.

Individuals who have successfully completed training shall be issued with either a card, which includes their name and photograph and the details of the training undertaken, or a certificate of training. The Contractor shall hold on site documented evidence of this training, including qualifications and skills of all personnel and sub-contractors and present it to the Superintendent on request.

The bonded anchor system installation supervisor shall be trained and qualified in all aspects of the applied techniques and shall be present at each stage of the bonded anchors installation works, including any trial installations and all testing.

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680.07 EQUIPMENT

Bonded anchors shall be installed using the equipment specified or provided by the bonded anchor supplier in the manufacturer’s installation instructions.

680.08 WORKMANSHIP AND INSTALLATION

(a) General

Bonded anchors shall be installed in the manner specified by the bonded anchor supplier by a competent person who has received appropriate training in accordance with clause 680.06.

Holes for bonded anchors shall be drilled with carbide or diamond drill bits in accordance with the manufacturer’s installation instructions and shall be of the depth and diameter specified by the supplier for the selected bonded anchor and as required by the design. The depth and diameter of holes shall be verified prior to installation of the bonded anchor system in order to prevent potential reduction in bonded anchor capacity. Incorrect depth and/or diameter of holes is not - allowed.

Unless otherwise shown on the drawings, holes shall be drilled perpendicular to the concrete surface.

Holes for bonded anchors shall be positioned to avoid damage to reinforcement and pre-stressing tendons or to embedded services such as electrical conduits. Prior to drilling of holes, reinforcing bars and pre-stressing cables that lie within the depth of the drill hole shall be accurately located by reference where available to as‑constructed drawings. Notwithstanding this, the actual position of bars and tendons shall be located by use of a recently calibrated concrete cover meter or ground penetrating radar (GPR), operated by a competent and experienced person, prior to drilling of holes for the installation of bonded anchors. If reinforcement is encountered during drilling, drilling shall cease immediately, and the Contractor (following consultation with the design engineer) shall provide the Superintendent with an acceptable course of action consistent with the design requirements.

Holes for bonded anchors shall be drilled, roughened and cleaned in accordance with the manufacturer’s installation instructions. However, as a minimum, the procedure for drilling and cleaning of holes shall be as follows:

(i) drill to required depth

(ii) air flush twice at the pressure specified by the manufacturer

(iii) brush clean twice

(iv) air flush twice at the pressure specified by the manufacturer

(v) fingertip test the hole surface for dust, and if dust is still present, brush clean and air-flush until all dust is removed including a potential dust plug at the bottom of the hole which reduces embedment depth. At the end of the cleaning process, the hole shall be clean and free of debris, dust particles, oil and other contaminants over its full depth. Over-brushing shall be avoided to prevent polishing the inside surface of the drilled hole.

If a mechanical compressor is used to provide the air flush, the compressed air shall be free of oil.

The hole shall be filled with chemical adhesive and the anchor rod installed immediately following the cleaning process. The anchor rod shall be inserted with a twisting motion to ensure that the chemical adhesive completely surrounds the embedded portion of the anchor, any trapped air is expelled and the specified embedment depth in the concrete is reached.

If the hole is allowed to stand open and unprotected without immediate installation, the cleaning and drying process shall be repeated to remove any contamination and moisture prior to installation of bonded anchors.

The Contractor shall implement adequate precautions and provide temporary supports as required to secure the anchors in the center of the holes such that a uniform thickness (bond line thickness) of adhesive is maintained between the anchor and the sides of the hole until the chemical adhesive has cured.

Loss of adhesive during curing shall be prevented by sealing the surface around the anchor as required.

Bonded anchors shall not be installed in concrete until at least 28 days after concrete has been placed and the minimum 28-day compressive strength has been achieved.

A discrete population of bonded anchors shall be installed by the same work crew.

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(b) Additional specific requirements

The following requirements shall also be satisfied:

(i) Immediately prior to installation of the bonded anchor system, holes for bonded anchors shall be completely free of water (dry) or be free of standing water (damp), in accordance with the manufacturer’s installation instructions.

(ii) Bonded anchors shall not be used if the temperature of the concrete is less than **‑**5ºC, above 40ºC, or outside the requirements specified in the manufacturer’s installation instructions.

(iii) Check temperature of hole prior to injecting chemical adhesive, note the working time which is the time allowed to place the anchor rod into the chemical adhesive and the curing time which is the time required for the chemical to gain strength from the time of first mixing until the time when the bonded anchor can be loaded.

(iv) The procedure for placing chemical adhesives and anchor rods shall be in accordance with the manufacturer’s installation requirements.

(v) Chemical adhesive shall not be injected into the drilled hole until it is thoroughly mixed using the proprietary equipment to a uniform consistency, colour and appearance in accordance with the manufacturer’s installation requirements.

(vi) The initial discharge of chemical adhesive from the mixing nozzle and for every new mixing nozzle used thereafter shall be discarded. Only mixing nozzles that come with the chemical adhesive and which are designed specifically to mix the components of the specific product shall be used.

(vii) The chemical adhesive shall be injected into holes proceeding from the bottom of the hole and progressing towards the surface in such a manner as to avoid the creation of air voids in the adhesive. Nozzle extensions shall be utilised as required to allow full depth insertion and filling from the bottom of the hole.

(viii) Each hole shall be checked visually to ensure that the chemical adhesive is injected to the correct depth (typically 2/3 of the hole depth) prior to insertion of the metal anchor rod.

(ix) Excessive chemical adhesive shall be removed from the concrete and anchor rod surfaces after inserting the anchor rod.

(x) The anchor rod shall not be disturbed or moved during the specified curing period.

(xi) If a popping or cracking sound is heard while inserting the anchor rod, then air voids are present in the chemical adhesive. Remove the anchor rod, allow the chemical adhesive to fully harden, redrill the hole and repeat the entire installation process.

(xii) Following mixing, the chemical adhesive shall be used within the specified time limit (working time or gel time) stated in the manufacturer’s installation requirements.

(xiii) Capsule chemical adhesives shall be installed in accordance with the manufacturer’s installation instructions.

(xiv) Contact between anchor rods and galvanically dissimilar metals embedded in concrete shall not be allowed in accordance with the requirements of clause 611.17.

(xv) Anchors shall be kept clean and all debris, oils and any other deleterious material removed from anchors prior to insertion, to avoid contamination of the bonding chemical adhesive within the hole, such that reduction in bond capacity is avoided.

(xvi) The final embedment depth of the anchor shall be verified based on the length of the projected portion of the anchor from the concrete surface as shown on the drawings.

**Chemical adhesives shall be allowed to gain strength for the minimum time specified by the manufacturer’s installation instructions before torque is applied to bolts and load is applied to the bonded anchor system.**

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680.09 LOAD TESTING OF INSTALLED BONDED ANCHORS

(a) General

The scope of the testing described in this clause is limited to demonstration of the suitability of the selected bonded anchor for use in a particular application and for validating the quality of installation of all bonded anchors. Certification and testing of the bonded anchor system and components as required by clause 680.05 shall be conducted in accordance with the nominated independent third-party materials testing body.

The requirements for site-testing of bonded anchors are limited to tension testing of the tensile capacity of all types of bonded anchors at the sampling and testing frequency as specified in this clause.

Separate requirements are given below for suitability testing of bonded anchors based on ultimate load testing in tension as defined in clause 680.03 and for testing of bonded anchors based on proof load testing in tension.

Test bonded anchors shall be installed by suitably competent and experienced personnel, as described in clause 680.06 and in accordance with the requirements of clause 680.08, in positions that are representative of the positions of the bonded anchors required by the design.

Testing shall be conducted by a competent person from an independent testing agency who has a minimum of 5 years experience in testing of bonded anchors or similar products and test reporting.

Bonded anchors shall be tested using testing equipment that has been calibrated as a minimum, on an annual basis at the required loading increments in accordance with AS 2193.

**HP One week prior to testing the Contractor shall submit to the Superintendent calibration certificates conforming to the requirements of AS 2193 Grade B for the jack and pressure gauges or other force measuring devices to be used.**

The measuring equipment shall be capable of measuring the applied force to an accuracy of ± 2%. If measurement of displacement is required, the measuring equipment shall comply with AS 1391 and shall be capable of measuring the elongation with an accuracy of ± 0.02 mm, with measurements made directly on the head of the anchor.

The test load shall be applied at pre-determined increments and loading rates.

**HP Details of the test method including load increments and duration of sustained loading shall be submitted to the Superintendent for review not later than one week prior to the testing.**

Tested bonded anchors shall be identified with a unique reference number.

(b) Ultimate Load Testing in tension for the suitability of bonded anchors

Unless approved otherwise by the Superintendent, where the proposed bonded anchor system or where the characteristics of the substrate and/or installation are outside the scope of the bonded anchor prequalification as specified in clause 680.05(a), the Contractor shall carry out ultimate load tests to validate the suitability of the bonded anchor system design and to demonstrate that the bonded anchor components, chemical adhesives, the substrate preparation and the proposed procedure will achieve the specified bonded anchor durability and load capacity.

Ultimate load tests shall be conducted after the manufacturer’s curing time has elapsed and prior to installation of any permanent bonded anchors.

Bonded anchors to be tested for ultimate load shall be installed in an identical manner and shall be situated in a substrate identical to that of the permanent bonded anchors and shall be positioned such that the installation and performance of the bonded anchors is not compromised in any way.

A sample consisting of at least ten of the proposed total number of bonded anchors required by the design shall be subject to an ultimate load test which shall be conducted separately, for each type of bonded anchor system, in each type of concrete or other substrate material, in each orientation and in uncracked and, if present, cracked concrete.

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The testing personnel shall ensure that the bonded anchors are bonded securely and are undisturbed prior to testing. Testing personnel shall be suitably competent and possess the relevant experience at conducting testing of bonded anchors on site and reporting the findings including the different possible modes of failure.

The mode of failure and corresponding ultimate load for each test shall be recorded in the test report. In the event that multiple failure modes are observed, testing shall continue until the required minimum number of dominant mode of failure results are achieved. The capacity of the bonded anchor shall be calculated from test results of the dominant mode of failure.

Bonded anchors shall be tested to the ultimate load certified by the design engineer for the bonded anchor used, in accordance with the requirements of ASTM E 488 and ASTM E 1512 or EOTA TR 048, based on the unconfined test method.

(c) Proof Load Testing in tension of bonded anchors

All bonded anchors that will be subject to tensile loads, a combination of tensile and shear loads or fatigue loads in service shall be subject to the minimum percentage of proof load tests for any lot size in accordance with the requirements of Table 680.091.

**Table 680.091**

|  |  |  |
| --- | --- | --- |
| **Lot Size**  **(Number of anchors)** | **Percentage of anchors subject to tensile loads, a combination of tensile and shear loads or fatigue loads to be tested (%) (min)** | **Percentage of all other types of bonded anchors to be tested (%) (min)** |
| 1 - 50 | 100 | 5% |
| 51 - 150 | 50 |
| 151 – 300 | 25 |
| 301 – 500 | 20 |
| 501 – 1000 | 15 |
| > 1000 | 10 |

All other types of bonded anchors (including, those subject to shear loads) shall be subject to the minimum percentage of proof load tests for any lot size in accordance with the requirements of Table 680.091.

Proof load testing shall not occur prior to the completion of curing time stated in the manufacturer’s installation instructions. The application of load shall occur smoothly with the proof load being achieved between one to three minutes from the commencement of loading. The proof load shall be maintained for a minimum period of 60 seconds.

A bonded anchor shall be deemed to have failed a test if either visible displacement is detected at a load less than or equal to the test load, or if the anchor fails to achieve the required test load.

If failure is encountered in any sample, all anchors within the lot shall be proof load tested.

Bonded anchors shall be proof load tested to 1.5 x the maximum serviceability design load certified by the design engineer for the bonded anchor used in accordance with the requirements of either ASTM E 488 and ASTM E 1512 or EOTA TR 048, based on the confined test method.

Bonded anchors in cracked concrete shall be proof load tested to 2 x the maximum serviceability design load certified by the design engineer for the bonded anchor used in accordance with the requirements of either ASTM E 488 and ASTM E 1512 or EOTA TR 048, based on the confined test method.

(d) Actions if a bonded anchor test fails

**HP In the event that a bonded anchor fails either the ultimate load testing for suitability or the bonded anchor proof load test, the Contractor shall submit rectification proposals for review by the Superintendent prior to any further bonded anchor installation.**

Failed and discarded empty anchor holes shall be filled with rapid set cementitious mortar or grout as stated in clause 680.10.

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680.10 INSTALLATION AND REMOVAL OF BONDED ANCHORS ON CONCRETE DECKS AND APPROACH SLABS FOR HOLDING DOWN TEMPORARY TRAFFIC BARRIERS

Bonded anchors used for holding down temporary traffic barriers and other temporary traffic control items shall comply with the requirements of this section including sampling and testing.

The Contractor shall locate the position of steel reinforcement, pre-stressing tendons and other embedments, drill holes and install the anchors with chemical adhesive in accordance with clause 680.08. Anchoring holes shall be adjusted as required to avoid damage to steel reinforcement, pre-stressing tendons and other embedments and if possible, temporary barriers may be repositioned marginally provided a uniform face is presented to traffic and the required minimum clearance to the traffic lane is achieved.

After removal of temporary barriers, bonded anchors shall be completely removed from concrete decks and approach slabs.

Where approval is given by the Superintendent not to remove the bonded anchors, they shall be drilled (cut) and removed to either a depth of at least 40 mm below the concrete surface level or to the depth of the minimum cover thickness whichever is greater.

Complete removal or where approved, drilling (cutting) of bonded anchors, shall be undertaken with due diligence and care such that damage to the concrete, existing steel reinforcement, pre-stressing tendons and other embedments is avoided.

Bonded anchors shall not be cut flush with the concrete or asphalt surfaces.

Anchoring holes left on concrete decks and approach slabs, by the complete removal or where approved by drilling (cutting) of bonded anchors, shall be filled with rapid set cementitious mortar or grout with a minimum strength of 40 MPa in accordance with the requirements of Section 610 and Section 689, consolidated by rodding as required and struck-off flush. Epoxy materials shall not be used for the patch repair of anchoring holes.

680.11 WORK METHOD STATEMENT AND INSPECTION AND TEST PLANS

The Contractor shall submit a detailed work method statement (WMS) and inspection and test plans (ITPs) for the specific bonded anchor works. The WMS and ITPs shall reference all specification clauses and identify all performance requirements and hold points. Generic or incomplete WMSs and ITPs shall not be allowed.

The Contractor shall provide documented evidence of conducting toolbox meetings of all bonded anchor installation personnel on all aspects of the WMS, the ITPs and specification requirements, including sampling and testing, immediately prior to commencement of the bonded anchor works.

**HP** **The Contractor shall not proceed with drilling or cutting holes into the concrete, installation or removal of bonded anchor works until the WMS and ITPs have been reviewed and approved by the Superintendent.**

680.12 TRIAL INSTALLATION

A trial installation of 5 bonded anchors shall be conducted by each work crew of installers, separately for each type of bonded anchor system used in the works, in each type of concrete or other substrate material and in each orientation required in-situ, and in uncracked and if present, cracked concrete, a minimum of fourteen (14) days prior to the commencement of permanent bonded anchor installation works.

**HP The Contractor shall not proceed with the permanent bonded anchor installation works until the trial system installations have been carried out and the outcomes reviewed and approved by the Superintendent.**

The trial bonded anchor installation shall satisfy all the requirements of the material manufacturer’s recommendations and this specification.

If a trial installation is successful, the bonded anchor system shall be utilised in the works.

If a trial installation is deemed by the Superintendent not to comply with the requirements of the specification, a new trial installation shall be carried out until the performance criteria of this section, including the requirements of clauses 680.08 and 680.09 are satisfied.

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If the trial installation is rejected, the Contractor shall remove and dispose of any work deemed as unacceptable by the Superintendent, submit a new proposal to rectify the deficiencies and repeat the trial installation as described above. Any delays caused through rejection shall not constitute a basis for additional payment and/or an extension of time.

680.13 HANDLING AND STORAGE OF MATERIALS

Adhesive materials shall be stored in dry conditions and shall not be exposed to direct sunlight, in strict accordance with the material manufacturer’s data sheet requirements and within the manufacturer’s specified maximum and minimum temperature range. Materials shall remain in their original, sealed containers until time of use.

All material shall be brought to site in the original containers clearly labelled with the appropriate manufacturer’s name, product type, reference number and batch number. Materials stored beyond the manufacturer’s recommended shelf life shall not be used. The Contractor shall not incorporate into the works any product that is within 30 days of its expiry date and/or shelf life.

The Contractor shall provide, for each batch of adhesive material, a copy of the manufacturer’s information as specified below:

(a) manufacturer’s name and address

(b) product reference

(c) batch number of identification

(d) quantity manufactured in the batch

(e) certificate of date of manufacture

(f) shelf life.

Adhesives shall be used in the order of their manufacture.

Anchors and other metallic components shall be stored and handled in accordance with the requirements of Section 611.

680.14 FIRE RESISTANCE AND ELEVATED TEMPERATURE EFFECTS

Where fire resistance of bonded anchors is shown on the drawings or stated in the specification for the installation of bonded anchors in the specified in-service exposure conditions, the Contractor shall undertake as a minimum a 2‑hour hydrocarbon fire test of 5 test panels in accordance with EN 1363-2 based on the hydrocarbon fire curve of AS 1530.4 and also covered in the ITA Guidelines, and determine the bonded anchor capacity in accordance with ASTM E 1512.

In addition, bonded anchors which require fire resistance shall be supported with documented evidence of test data which follows the fire testing requirements of the European Assessment Document (EAD) which assesses bonded anchors for use in concrete and for which the bonded anchor system ETA certification is based on.

Where shown on the drawings or stated in the specification a 2‑hour modified hydrocarbon fire test of 5 test panels shall be undertaken based on the modified hydrocarbon fire curve as stated in the ITA Guidelines and the bonded anchor capacity determined in accordance with ASTM E 1512.

The fire resistance report and test data shall be reviewed and certified by an independent fire protection engineer who is a member of the Society of Fire Safety, Engineers Australia and with a minimum of 5 years’ experience in the design, protection and application of fire safety engineering, specialising in major infrastructure. The fire resistance report shall be provided with evidence of all test data based on the maximum loading (kN) for the specified fire resistance time, for review by the Superintendent.

Protection against elevated temperature and fire effects shall be as shown on the drawings and as stated in the specification or as stated in the fire resistance report.

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Where required fire protection materials such as coatings and thermal barriers shall be used to reduce fire effects and elevated temperatures on bonded anchors. Insulating barriers may include but not be limited to spray applied cementitious based plasters or coatings, cement-based fire-resistant mortars with special formulations and gypsum-based plasterboard or plates.

680.15 SEALING OF CRACKS

The Contractor shall repair cracks by pressure injection of low viscosity epoxy resin exhibited on concrete surfaces of the specified works in accordance with the requirements of Section 687, as follows:

(a) cracks of width equal to or greater than 0.10 mm for all pre‑cast pre‑stressed concrete elements

(b) cracks of width equal to or greater than 0.20 mm for reinforced concrete elements, except that for reinforced concrete elements located in marine and other saline environments, epoxy injection shall be for all cracks of width equal to or greater than 0.10 mm.

680.16 PROTECTION OF BONDED ANCHORS AGAINST MOISTURE INGRESS

Bonded anchors shall be protected against exposure to moisture ingress as shown on the drawings and as stated in the specification. Protection against moisture ingress shall be provided but not be limited, to construction joints formed at the interface between the two connected surfaces, around the anchor at the concrete surface and any portion of projecting anchor not encapsulated in concrete.

Where required protective measures against moisture ingress shall include but not be limited, to installation of waterproofing membranes, pressure injection of low viscosity epoxy resin at any separation of connected surfaces forming part of the bonded anchor system installation, polyurethane based fire rated sealants and heat-shrinkable polymer tubings or sleeves. The design life of protective measures shall be in accordance with the design life of the bonded anchor system.

**680.17 BONDED ANCHORS SUBJECT TO FATIGUE LOADING**

Where bonded anchors are used in applications subject to fatigue loads over their design life, they shall be designed and installed using a chemical adhesive which has been independently tested and which complies with the capacity reduction factor specified in BTN 006 (i.e., ≤ 0.4) for bonded anchors subject to fatigue loading.

680.18 REPORTING

**The Contractor shall provide a test report to the Superintendent for review.**

The test report shall identify the performance of each tested bonded anchor, including the following:

(a) tester’s name and employer

(b) supplier and type of bonded anchor

(c) date of installation of bonded anchor

(d) date of testing

(e) bonded anchor reference number

(f) bonded anchor position

(g) condition of bonded anchor

(h) condition of concrete substrate – all defects such as cracks and delamination to be reported

(i) strength of concrete substrate - including how this was determined

(j) testing equipment used

(k) calibration certificate for testing equipment

(l) test method including load increments and duration of sustained loading

(m) test load and time of holding at the test load

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(n) failure load (if applicable)

(o) mode of failure (if applicable)

(p) amount of permanent displacement

(q) any other relevant comments or observations.

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