

Master Specification

Part ST-SC-C3

Fibre Reinforced Polymer Composite Strengthening of Concrete Structures

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ST-SC-C3 Fibre Reinforced Polymer Composite Strengthening Of Concrete Structures

1 General

- a) This Master Specification Part specifies the requirements for fibre reinforced polymer composite (FRPC) strengthening of concrete structures, including:
 - i) the documentation requirements, as set out in section 2;
 - ii) the materials requirements, as set out in section 3;
 - iii) the system installation requirements, as set out in section 4;
 - iv) the trial system application requirements, as set out in section 5;
 - v) the Contractor competency requirements, as set out in section 6;
 - vi) the inspection and testing requirements, as set out in section 7;
 - vii) the system repair requirements, as set out in section 8;
 - viii) the sealing of cracks requirements, as set out in section 9;
 - ix) the application of decorative / anti-carbonating coating requirements, as set out in section 10;
 - x) the application of anti-graffiti coating requirements, as set out in section 11;
 - xi) the protection of works and property clean up requirements, as set out in section 12;
 - xii) the Hold Point and Witness Point requirements, as set out in section 13; and
 - xiii) the verification requirements and records, as set out in section 14.
- b) This Master Specification Part applies to the supply of materials, surface preparation, installation, relevant inspection and testing and acceptance criteria for the strengthening of bridges using strengthening systems.
- c) The application of ultraviolet protection, anti-graffiti and anti-carbonation coatings, and crack repairs which may be required also form part of the FRPC strengthening system installation work and is included in this Master Specification Part.
- d) The fibre reinforced polymer composite (FRPC) strengthening of concrete structures must comply with the Reference Documents, including:
 - i) AS 1627.4 Metal finishing - Preparation and pretreatment of surfaces, Part 4: Abrasive blast cleaning of steel;
 - ii) AS 2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings;
 - iii) EN 1542 Products and systems for the protection and repair of concrete structures - Test methods - Measurement of bond strength by pull-off; and
 - iv) Department Road Structures Inspection Manual - Appendix D: Bridge Repair Manual (available from: <https://dit.sa.gov.au/standards/manuals>).

2 Documentation

2.1 Construction Documentation

In addition to the requirements of PC-CN3 “Construction Management”, the Construction Documentation must include the following documents, procedures and instructions:

- a) evidence of the performance of the materials to be used (refer section 3), including relevant test results and certificates of compliance, which must not be more than 24 months old;
- b) proposed methods of obtaining access to the Works;
- c) methodology for application of strengthening system, including information on the proposed substrate preparation, method of application, equipment, and operators;
- d) if resin is to be factory applied or applied onto the fabric on-Site, the additional procedural information required by section 4.7g); and
- e) the evidence demonstrating that Contractor's FRPC system installation personnel or Subcontractor are adequately trained and skilled in the installation procedures of the FRPC system to be installed required in section 6b).

2.2 Quality Management Records

In addition to the requirements of PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable), the Quality Management Records must include:

- a) results of the testing of test cubes required by section 7.5; and
- b) the verification records required by Table ST-SC-C3 14-1.

3 Materials

3.1 Handling and storage of materials

- a) Adhesives and other resins must:
 - i) be stored in dry conditions not exposed to direct sunlight, in accordance with the material manufacturer's data sheet requirements and within the manufacturer's specified maximum and minimum temperature range; and
 - ii) remain in their original, sealed containers until time of use.
- b) All material must be brought to Site in the original unopened cans clearly labelled with the appropriate manufacturer's name, product type, reference number and batch number. Materials stored beyond the manufacturer's recommended shelf life must not be used.
- c) The Contractor must provide, for each batch of FRPC system material, a copy of the manufacturer's information including the following:
 - i) manufacturer's name and address;
 - ii) product reference;
 - iii) batch number of identification;
 - iv) quantity manufactured in the batch; and
 - v) certificate of date of manufacture.
- d) FRPC system materials, including adhesives and resins, must be used in order of date of manufacture.
- e) FRPC plates, laminates, and strips must be supplied and stored on Site such that damage or contamination does not occur. Plates, laminates, and strips must be free from unintended curves, bows, wraps, undulations, or twists.
- f) FRPC plates, laminates and strips must be handled with clean gloves under dry conditions, and touching of ready for bonding surfaces without peel ply must be avoided.

- g) Where FRPC materials are fitted with protective peel ply to ensure a clean surface, the ply must be removed immediately prior to application, and touching of the surface must be avoided.
- h) FRPC fabric sheets or rolls must be kept free from any contamination. The FRPC fabric sheets must be handled carefully and must be free from wraps, twists, or fibre misalignment. Any protective peel ply must be removed immediately prior to application. The FRPC fabric sheets must be stored either by being rolled to a radius greater than 300 mm or by being dry stacked after cutting and must be protected from dust and moisture.
- i) Handling and preparation precautions must be in accordance with the material manufacturer's recommendations and material data sheets.
- j) The Contractor must maintain records showing which elements were treated with each batch of FRPC system material.

3.2 Carbon fibre laminate (carbon fibre reinforcement with epoxy matrix)

The carbon fibre laminate material must be a pre-fabricated, pultruded section, specifically designed for adding tensile strength as part of a compatible, load transferring, bonded system.

3.3 Carbon fibre fabric (high strength carbon fibres)

The carbon fibre fabric materials must be pre-woven into sheets, specifically designed for adding strength as part of a compatible, load transferring, bonded system.

3.4 Adhesive for carbon fibre laminate

The adhesives for carbon fibre laminate must be a thixotropic paste used to bond procured FRPC laminate systems to the concrete substrate and provide the required shear load path between the concrete substrate and the FRPC reinforcing laminate. Adhesives must also be used to bond together multiple layers of FRPC laminates where required.

3.5 Saturating resin

The saturating resin must be used to impregnate the reinforcing fibre fabric to fix it in place and must be capable of providing a shear load path to effectively transfer the load between fibres. The saturating resin must also serve as the adhesive for wet lay-up systems and must be capable of providing a shear load path between the previously primed concrete substrate and the FRPC system.

3.6 General resin requirements

Resins used as part of FRPC strengthening systems (including primers, putty fillers, saturants and adhesives) must have the following characteristics:

- a) compatibility with and adhesion to the concrete substrate;
- b) compatibility with and adhesion to the FRPC system;
- c) resistance to in-service environmental effects, including but not limited to moisture, salt water, temperature extremes and chemicals normally associated with exposed concrete;
- d) filling ability;
- e) workability;
- f) pot life consistent with the application;
- g) compatibility with and adhesion to the reinforcing fibre; and
- h) development of appropriate mechanical properties for the FRPC.

3.7 Primer

The primer must be a very low viscosity resin used to penetrate the concrete surface and provide an improved adhesive bond for the adhesive.

3.8 Putty filler

The putty filler must be a thixotropic paste used to fill small voids in the concrete substrate (including bug holes), to provide a smooth surface to which the FRPC system bonds and also prevent bubbles from forming during curing of the saturating resin.

4 System installation

4.1 Concrete surface and preparation

- a) Concrete surfaces must be dry and free from all bond-inhibiting materials. The concrete surface must be prepared with an appropriate method to provide a clean sound surface.
- b) Abrasive blast cleaning must be carried out in accordance with AS 1627.4 Metal finishing - Preparation and pretreatment of surfaces, Part 4: Abrasive blast cleaning of steel, and all other applicable Laws (including WHS and environmental Laws imposed by relevant Authorities including the EPA). Waste material resulting from the surface preparation must be removed by suitable means. The surface must be vacuumed before the application of the FRPC laminate.
- c) The surface layer of the concrete must be removed to expose small particles of well-bound aggregate such that the roughness to be achieved lies between an amplitude of 0.5 mm to 1 mm, with a surface presenting similar to 60 grit sandpaper. The surface must not be roughened excessively.
- d) Prior to the commencement of full-scale surface preparation procedures, the Contractor must prepare Construction Documentation for the representative sample area, and then trial a representative sample area in accordance with the requirements of this Master Specification Part.
- e) Preparation of the sample area required in section 4.1c) constitutes a **Hold Point**. No additional concrete surface preparation works can occur until this Hold Point has been released. Upon release of the Hold Point, the Works, as a minimum, must adopt the methodology and finished surface of the trial representative sample area.
- f) Any blow holes, areas of honeycombing, loose surface layers and weak concrete, shrinkage cracks of width less than 0.20 mm or other Defects, either revealed by a grinding process or exposed by other surface preparation methods, must be filled with a suitable putty filler, compatible with the FRPC strengthening system to be applied.
- g) If the surface of the concrete is weak, more material must be removed, and the amount removed and refilled must be sufficient to result in a strong, sound substrate suitable for the intended FRPC strengthening system. Where necessary, projecting fins, rough spots, sudden steps, or other surface irregularities must be ground to less than 1 mm by light abrasion with an angle grinder or filled with a suitable putty filler to provide a smooth concrete surface.
- h) Any breakouts or core holes must be repaired with hand-applied polymer modified cementitious materials to the original surface profile and in accordance with the material manufacturer's recommendations. The polymer modified cementitious materials must be compatible with the parent concrete, in terms of electrical resistivity and compressive strength.
- i) Where fibre fabric is to be wrapped around corners, the corners must be rounded to a minimum radius of 25 mm to avoid local damage to the fabric.
- j) The unevenness of the concrete substrate surface must be such that the gap under a 2 m straight edge does not exceed 4 mm. The general unevenness with respect to a 0.3 m straight edge must not exceed 1 mm. Any out of tolerance areas must be rectified with a suitable rapid setting putty filler.

- k) Concrete cracks of width equal to or greater than 0.20 mm must be sealed by resin injection compatible with the FRPC strengthening system. Cementitious repairs must be cured for at least 14 days prior to undertaking any FRPC strengthening application.
- l) A trial application of the overall FRPC system to check the suitability of the surface, the surface preparation method, method of application and other requirements must be undertaken in accordance with section 5.

4.2 Primer and putty filler requirements

- a) Where the FRPC strengthening system requires the use of a primer to seal the surface, it must be uniformly applied to all areas of the prepared concrete surface using brush or roller, in accordance with the manufacturer's recommendations and specified rate of coverage.
- b) Compatible putty filler must only be used to fill voids, smooth surface discontinuities, and treat minor imperfections prior to the application of other materials.
- c) Rough edges or lines of cured putty must be ground smooth prior to proceeding with the installation.
- d) The putty filler must have rapid strength gain characteristics which enable over-bonding to be carried out after a short time and must be capable of being applied in thin layers where required.
- e) Prior to applying the adhesive or the saturating resin the primer and putty filler must be allowed to cure for the required period in accordance with the material manufacturer's specified requirements, to ensure satisfactory adhesion at the interface of the 2 materials.
- f) Where the primer and putty filler are completely cured, additional surface preparation may be required prior to the application of the saturating resin or adhesive consistent with the FRPC strengthening system compatibility requirements.

4.3 Mixing of resins

- a) The mixing of resins must be in accordance with the FRPC system manufacturer's recommended procedures including recommended batch sizes, mix ratios, mixing methods, mixing times, current material safety data sheets, and as specified in this section 4.3. The ambient temperature of all resin components must be between 10°C and 30°C at the time of mixing.
- b) Resin and hardeners must be mixed together in the correct proportions and required mixing times until there is a uniform, homogeneous mixing of components and colour streaks are eliminated. Excess material must not be left in the individual component containers.
- c) Scales or volumetric equipment used must be calibrated at 3-monthly intervals.

4.4 Drying and curing requirements

The Contractor must adhere to the manufacturer's instructions regarding drying and curing requirements, reapplication time intervals for adhesives and other resins, and prevailing weather conditions.

4.5 Environmental conditions

FRPC strengthening systems must not be applied under any of the following conditions:

- a) windy conditions where over spray or spatter may be generated;
- b) when wind-borne debris is likely to contaminate the uncured surface of the freshly applied coating;
- c) when the ambient temperature exceeds 30°C or is below 5°C;
- d) when the concrete surface temperature exceeds 35°C or is below 8°C;
- e) when the relative humidity exceeds 85%;

- f) when rain spatter or run-off may occur, including leakage through deck joints, contaminating the surface, and adversely affecting the adhesion to the substrate;
- g) when the surface temperature of the substrate is less than 3°C above the dew point calculated in accordance with AS 2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings, or exceeds 35°C;
- h) when the moisture content of the concrete or cementitious repairs exceeds 8%; or
- i) when the surface moisture condition of the concrete is not dry, and it does not satisfy the manufacturer's recommendations.

4.6 Application of plates, laminates or strips

- a) The bonding surface of the FRPC plate, laminate, or strip must be thoroughly cleaned and, where required, abraded lightly as per the manufacturer's recommendations prior to application.
- b) The adhesive must be applied to the prepared bonding concrete surface as a thin layer by means of a notched steel trowel or equivalent immediately after mixing. The adhesive must cover the whole of the bonding area and must be maintained at a thickness in the range of 1 to 2 mm. A further adhesive layer must be applied to the cleaned and fully dried FRPC plate, laminate, or strip to form a dome profile across the plate with 3 mm of adhesive material in the centre and 1 mm on the edges.
- c) The FRPC plate, laminate, or strip must be brought into contact and lightly pressed with the fingers onto the prepared bonding area. The FRPC material must be further pressed on with a hard rubber roller until the extra adhesive is squeezed out along the sides.
- d) The roller pressure must be applied from the centre going to the outer edge such that no voids are formed between the laminate and the concrete substrate surface. The excess adhesive must be removed.
- e) The layer thickness of the final adhesive along the bond line of the laminate must be a minimum of 1.5 mm and a maximum of 3 mm.
- f) Adhesive residues on the laminate surface must be removed with a compatible chemical remover prior to hardening. Where required, additional parallel FRPC plates, laminates or strips must be applied at a minimum distance of 5 mm from the adjacent FRPC material. Where FRPC plates, laminates or strips are lapped, the minimum overlap, in the longitudinal fibre direction, must be 200 mm.
- g) If temporary shoring of the FRPC plate, laminate or strip is required to be retained in position then the FRPC system must be fully cured before removing the shoring.

4.7 Application of fabric sheets

- a) The saturating resin or bonding adhesive must be uniformly applied to saturate the concrete surface using hand-held foam roller, brush or scraper at the coverage rates specified in the material manufacturer's data sheet to ensure adhesion of the fabric material.
- b) The FRPC sheets must be applied to the resin-saturated concrete surface by pressing manually onto the adhesive such that it is stretched by avoiding any wrinkles or the introduction of voids.
- c) The surface of the fabric must be rolled over the backing paper to force the impregnation of the resin into the fabric material. Rolling must be in the longitudinal direction of the fibres along the centreline and working outwards to expel excess adhesive at the edges to ensure the removal of any entrapped air and produce an even adhesive line. The backing paper must then be peeled away.
- d) Where subsequent layers of saturation resin are required as part of the FRPC strengthening system, the required time must be allowed between the first and second coat of resin in accordance with the material manufacturer's data sheet. The time between mixing and

application of the saturation resin must be in accordance with the material manufacturer's data sheet.

- e) Where FRPC fabric sheets or strips are lapped, the minimum overlap in the longitudinal fibre direction must be 200 mm. Additional resin must be applied to the outer surface of the fabric layer to be overlapped. No lapping in the lateral fibre direction will be allowed. Any lifting or delamination that may occur during the application period must be corrected by pressing the fabric sheet using a foam roller or spatula.
- f) Where multiple layers of FRPC fabric sheet are required as part of the design of the FRPC strengthening system, these must be applied in accordance with the material manufacturer's recommendations, data sheet, and as specified in this Master Specification Part.
- g) Regardless of whether the resin is factory applied or it is applied onto the fabric on Site using hand-held foam rollers, brushes or impregnation machines prior to application, procedures on how the installation will be supported must be included as part of the Construction Documentation.

5 Trial system application

- a) A trial application on a test area nominated by the Principal of the actual substrate must be completed 7 days prior to the commencement of FRPC strengthening work. The trial must include the sampling and testing of epoxies and resins as outlined by the Principal. The test area must be prepared and strengthened by the Contractor to satisfy all the requirements of the material manufacturer's recommendations, unless otherwise specified in this Master Specification Part.
- b) The trial FRPC strengthening application must prove the adequacy of the Contractor's proposed materials. Actual coverage rates of adhesives and other resins must be recorded, in order that due allowance may be made in the full-scale application for rough, irregular, or highly absorbent concrete substrate. Additional requirements or observations must be recorded and considered for the full-scale application. If the trial application is successful, the FRPC strengthening system may be utilised in the Works.
- c) Completion of the trial area, required by this section 5, will constitute a **Hold Point**. FRPC strengthening must not commence until this Hold Point has been released.

6 Contractor competency

- a) The Contractor's FRPC system installation personnel or Subcontractor must have a minimum of 5 years' experience in the repair and rehabilitation of reinforced concrete structures and a demonstrated competency for surface preparation and application of the FRPC system to be installed. Such experience must be supported with documented evidence of previous experience, including previous projects and relevant references.
- b) The Contractor must provide documented evidence from the FRPC system manufacturer demonstrating that Contractor's FRPC system installation personnel or Subcontractor are adequately trained and skilled in the installation procedures of the FRPC system to be installed, as part of the Construction Documentation.
- c) The Contractor's FRPC system installation supervisor must be trained and qualified on all aspects of the applied techniques and must be present during work at all times.

7 Inspection and testing

7.1 General

- a) The Contractor must undertake all inspection and testing of the installed FRPC strengthening system as specified in this section 7. The Contractor must maintain all required documentation and results as specified in this Master Specification Part and PC-QA1 "Quality Management Requirements" for all stages of the FRPC strengthening Works.

- b) The Works must be inspected by the Contractor at each stage of the FRPC strengthening operation as a minimum, including:
 - i) after surface preparations;
 - ii) mixing of materials,
 - iii) prior to and after adhesive and resin application; and
 - iv) any touch-up that may be required and both during and after installation of FRPC plates, laminates, strips, or fabric sheets.
- c) The Contractor must provide at least 5 days' written notification of its intention to carry out FRPC strengthening Works, which will constitute a **Witness Point**. FRPC strengthening works must not commence until the Contractor has progressed passed this Witness Point.

7.2 Testing for drummy areas

- a) A visual inspection of the FRPC works must be conducted immediately after installation is complete and any Defects recorded. The cured FRPC strengthening system must be visually inspected and checked for delaminations, air voids, and bubbles between multiple layers or between the FRPC system and the concrete, 7 days after completion of installation.
- b) A "drumminess" test must be conducted along the whole length of each applied FRPC plate, laminate, strip, or fabric sheet using a small hammer (or similar). Areas where the FRPC material has not bonded correctly to the concrete or to subsequent layers will be characterised by a "drummy" or hollow sound.
- c) Delamination size, location, and quantity relative to the overall application area must be recorded and evaluated with respect to structural integrity and durability of the FRPC system.
- d) Small delaminations, less than 25 mm x 25 mm, do not require corrective action provided the total delaminated area is less than 5% of the FRPC strengthened area and there are no more than 5 such delaminations per 1 m².
- e) Where delaminations exceed those allowed in section 7.2d), the effective delaminated area must be considered as a large delamination area and repaired in accordance with the requirements of section 8. Individual or isolated delaminations, air voids or bubbles larger than 25 mm x 25 mm must be marked and repaired in accordance with the requirements of section 8.

7.3 Testing for flatness

The evenness for the FRPC plates, laminate, strip, or fabric sheets must not:

- a) deviate by more than 4 mm when checked with a 2 m straight edge; or
- b) deviate by more than 1 mm when checked with a 300 mm straight edge.

7.4 Adhesion (pull-off) testing

- a) The Contractor must conduct partially cored direct pull-off tests of the fully cured FRPC system to verify the tensile bond between the FRPC material and the existing concrete substrate, 7 days after the completion of installation.
- b) The pull-off testing must be undertaken in accordance with EN 1542 Products and systems for the protection and repair of concrete structures - Test methods - Measurement of bond strength by pull-off, except that reference to standard concrete test specimens must be replaced by in-situ concrete substrate. Sub-sections 4.1, 4.2, 4.3, 4.4, 4.12 and Sections 5 and 6 of EN 1542 Products and systems for the protection and repair of concrete structures - Test methods - Measurement of bond strength by pull-off, must not apply in the adhesion testing of the FRPC system.
- c) Testing for FRPC plates, laminates or strips and testing for FRPC fabric sheets must be carried out at the frequency stated in Table ST-SC-C3 14-1. The mean bond strength at 7 days must be greater than 1.5 MPa, and no individual result must be less than 1.35 MPa.

- d) The mode of failure of the pull-off test must be in the concrete substrate. Mean bond strengths less than 1.5 MPa or failure between the FRPC system and the concrete substrate or between layers of FRPC must be raised as a Non-Conformance, and the associated Hold Point set out in PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable) will apply, and disposition must be to the satisfaction of the Principal.
- e) After the pull-off test is complete (and prior to anti-carbonation coating) the cored hole must be filled and smoothed with a polymer modified cementitious material or the FRPC system putty. If a polymer modified cementitious material is used, then it must be cured for 7 days before application of the anti-carbonation coating.

7.5 Compressive strength of adhesives and resins

- a) The Contractor must take 3 x 75 mm test cubes from the first batch of material mixed, then 3 x 75 mm cubes for every 100 kg of material used thereafter to test for compressive strength.
- b) The test cubes referred to in section 7.5a) must be cured for 7 days as per the material manufacturer's recommendations. 2 test cubes must be tested at 7 days and the third test cube at 28 days, to confirm compliance with the minimum compressive test cube strengths in accordance with Table ST-SC-C3 14-1.
- c) Results of testing of the test cubes in this section 7.5 must be provided as part of the Quality Management Records.

8 System repairs

- a) Should any of the FRPC strengthening system application work not comply with the provisions of this Master Specification Part:
 - i) a Non-Conformance must be raised and the associated Hold Point set out in PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable) will apply;
 - ii) the Non-Conformance Report must include a procedure for any repair work which may include removal of the FRPC areas concerned, follow by surface preparation and application of new layer of FRPC; and
 - iii) the Principal may direct remediation of the Non-Conformance by repair of the areas concerned.
- b) For the purpose of this section 8, non-complying work includes delaminations, air voids, or bubbles larger than 25 mm x 25 mm.
- c) Large delaminations greater than 300 mm x 300 mm must be repaired by selectively cutting away the affected FRPC material, followed by surface preparation and application of overlapping FRPC layer.
- d) Determinations, air voids or bubbles greater than 25 mm x 25 mm in size but less than 300 mm x 300 mm must be repaired by either resin injection for FRPC layer replacement in accordance with this section 8.
- e) Wrinkling of the FRPC material or broken fabric must be repaired by the application of additional layers.

9 Sealing of cracks

The Contractor must undertake epoxy injection of cracks of width equal to or greater than 0.20 mm to both the FRPC strengthened and non-strengthened surfaces of the specified works. The epoxy injection system must be compatible with the FRPC system and applied in accordance with Department Road Structures Inspection Manual - Appendix D: Bridge Repair Manual, Standard Repair No. 5 (SR05).

10 Application of decorative / anti-carbonating coating

- a) The Contractor must apply 2 coats of a decorative / anti-carbonation coating to a total minimum dry film thickness of 150 μm , to both the FRPC strengthened and non-strengthened surfaces of the specified works on the underside and sides of the bridge superstructure only. The decorative / anti-carbonation coating must be alkali resistant, be suitable for use on FRPC material surfaces and applied in accordance with the manufacturer's recommendations.
- b) The application of the coating system must ensure a uniformity of colour with the surrounding concrete surfaces.

11 Application of anti-graffiti coating

The Contractor must apply a non-sacrificial anti-graffiti coating to the whole of the specified works in accordance with the Contract Documents. The anti-graffiti coating must be compatible with the decorative / anti-carbonation coating applied.

12 Protection of Works and property and clean up

12.1 Protection of Works / property

- a) The Contractor must protect already completed Works during abrasive blasting operations or any other surface preparation process and during FRPC system application processes. The Contractor must ensure that the FRPC Works are protected from adverse conditions, dust, and debris during the curing period of the FRPC system in accordance with the requirements of section 4.5.
- b) The Contractor must undertake suitable protective measures and methods during the installation of the FRPC system to ensure that vehicles and pedestrians are adequately protected from the FRPC Works.

12.2 Environmental requirements

- a) The Contractor must remove all adhesive residues, droppings, and smudges from all surfaces, including surfaces not being treated. The Contractor must remove from the Site all spent abrasive and all other rubbish accumulated during the work on a daily basis.
- b) The Contractor must dispose of such wastes and adhere to EPA and other Laws and Authority requirements with respect to how waste generated during surface preparation, FRPC system application, and clean-up will be collected, segregated, handled, controlled, and disposed of.

12.3 Disposal of waste materials

Waste materials including liquid wastes must be deposited in suitable containers and disposed of at sites to be located by the Contractor that are acceptable to the EPA and other relevant Authorities. Liquid or other waste materials must not contaminate creeks, waterways, or the stormwater drainage systems.

13 Hold Points and Witness Points

- a) Table ST-SC-C3 13-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.
- b) Table ST-SC-C3 13-2 details the review period or notification period, and type (documentation or construction quality) for each Witness Point referred to in this Master Specification Part.

Table ST-SC-C3 13-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
4.1e)	Concrete surface preparation sample area	Construction quality	6 hours notification
5c)	Completion of the trial system application	Construction quality	24 hours notification

Table ST-SC-C3 13-2 Witness Points

Section reference	Witness Point	Documentation or construction quality	Review period or notification period
7.1c)	Notification of commencement of FRPC strengthening work	Construction quality	5 days notification

14 Verification requirements and records

The Contractor must supply written verification as part of the Quality Management Records that the requirements listed in Table ST-SC-C3 14-1 have been complied with.

Table ST-SC-C3 14-1 Verification requirements

Section reference	Subject	Property	Test procedure	Test frequency	Acceptance limits
3.1c)	Material batches	a) Manufacturer's name and address; b) product reference; c) batch number of identification; d) quality manufactured in batch; and e) date of manufacture.	-	Each batch	-
4.1j)	Concrete substrate	Surface evenness	2 m straight edge 300 mm straight edge	Each strip Each strip	Gap not greater than 4 mm Gap not greater than 1 mm
4.5	Environmental conditions	Ambient temperature Concrete surface temperature Relative humidity Moisture content of concrete or repairs	Dew point AS 2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings	At commencement of each component of work	Not greater than 30°C, or less than 5°C Not greater than 35°C, or less than 3°C, above dew point Not greater than 85% Less than 8%
7.2c)	Drummy areas	-	-	Each strip	-
7.3	FRPC strips	Flatness	2 m straight edge 300 mm straight edge	Each strip Each strip	Gap not greater than 4 mm Gap not greater than 1 mm

Section reference	Subject	Property	Test procedure	Test frequency	Acceptance limits
7.4a)	FRPC strips	Adhesion (pull off) testing	EN 1542 Products and systems for the protection and repair of concrete structures - Test methods - Measurement of bond strength by pull-off	a) 2 per span on underside of bridges; and b) one at each pier on bridge deck.	a) Mean greater than 1.5 MPa; and b) no individual result less than 1.35 MPa.
7.5	Adhesives and resins	Compressive strength -		a) 3x75 mm cubes from first batch; and b) 3x75 mm cubes from each 100 kg of each material thereafter.	Not less than 60 MPa
10	Decorative / anti-carbonating coating	Dry film thickness -		1 test per strip	Not less than 150 μm