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TII Publications

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Waterproofing for Concrete Structures

CC-SPW-02000
April 2019

CC Construction & Commissioning

Standards

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TII Publications

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Contents

Updates to TII Publications resulting in changes to
Waterproofing for Concrete Structures CC-SPW-02000

Date: April 2019

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Amendment Details:

This document supersedes the December 2010 publication of CC-SPW-02000. The following principal amendments have been incorporated into this document:

a) The document has been re-formatted in line with the current TII Standards.
b) Requirements for hydrophobic impregnation of concrete structures have been added which supersede the requirement of Clause 1709 of CC-SPW-01700.
c) The areas to receive various waterproofing treatments are defined in DN-STR-03012 and cross-referenced in this Specification.
d) Paragraph 1.2 – requirement for epoxy resin to comply with I.S. EN 1504-2 system 2+ introduced.
e) Paragraph 1.4 – pull-off test requirement introduced to verify requirement for minimum adhesion values.
f) Paragraph 2.2 - requirement has been removed for certification procedure to be repeated for each subsequent operation or location.
g) Paragraph 2.3.1 - requirement introduced for installers to be trained and approved by the Certificate holder of the system.
h) Paragraph 2.3.2 - surface finish requirements have been updated and requirements for checking crack widths prior to applying waterproofing as well as provision of a dossier (consisting of data sheets and a crack map) detailing any repairs undertaken has been included.
i) Paragraph 2.4.1 – requirement for red tinting of APL removed.
j) Paragraph 2.5.2 - The additional test requirements for tensile strength, elongation at break and tear strength have been removed.
k) Paragraph 2.5.4 – requirements for pull-off tests have been revised.
l) Paragraph 3.1 - requirement introduced for structures to be impregnated as soon as possible and before being subjected to de-icing salt spray.
m) Paragraph 3.2 – additional performance requirements for hydrophobic pore liners introduced.
n) Paragraph 3.3.1 – requirements for curing membranes and release agents revised.
o) Paragraph 3.4 – additional requirements for site trial panels introduced.
p) References section added – Paragraph 4

Contents Table

1. Buried Concrete Surfaces

1.1 General

This section sets out the requirements for epoxy resin waterproofing of concrete surfaces as required by DN-STR-03012.

1.2 Materials

Epoxy resin waterproofing shall comply with I.S. EN 1504-2 (system 2+).

Alternative materials or proprietary systems must be agreed in writing with the Authority prior to commencement of the Works, subject to any restrictions specified in Appendix 20/1.

1.3 Workmanship

1.3.1 General

All areas to be waterproofed shall be clean, dry and free from all loose particles, laitance, dust, oil and other contaminants. All blowholes in concrete surfaces shall be cleared out, filled with approved non-shrink cementitious filler and the repair work properly cured before application of the waterproofing.

1.3.2 Application

Each coat shall be applied at a minimum rate of 300 grams/m^2. The concrete shall have a minimum compressive strength of 25 N/mm^2 at the time of application.

1.3.3 Proprietary Materials

For proprietary materials the method of application, rate of spread, number of coats and other requirements for each system shall be in accordance with the manufacturer's recommendations and the data sheet for the product .

1.4 Testing Requirements

A minimum sub-strata pull-off strength of 1.5 N/mm^2 is required prior to application. A minimum of one pull-off test shall be performed for each element to be treated, the location of which is to be agreed in advance with the Employer’s Representative.

2. Bridge Deck Waterproofing

2.1 General

This section sets out the requirements for bridge deck waterproofing of concrete surfaces as required by DN-STR-03012.

2.2 Materials

Bridge deck waterproofing systems shall be spray applied, satisfy the requirements of DN-STR-03009 - Waterproofing and Surfacing of Concrete Bridge Decks, shall be capable of being non-destructively tested and shall have a current NSAI Agrément Certificate or equivalent.

Prior to the commencement of the Works the Contractor shall provide to the Employer's Representative a copy of the NSAI Agrément Certificate or equivalent appropriate to the work to be undertaken.

2.3 Workmanship

2.3.1 General

Permitted waterproofing systems shall be installed in accordance with the NSAI Agrément Certificate or equivalent. The system shall only be applied by installers who have been trained and approved by the Certificate holder. The installer shall provide evidence of approval in writing to the Employer's Representative prior to commencement of the works.

2.3.2 Surface Preparation

All un-formed concrete surfaces which are to receive bridge deck waterproofing shall be Class U4 in accordance with the Specification for Road Works Series 1700 – Structural Concrete (CC-SPW-01700). Where the surface does not meet Class U4, repair work shall be undertaken to achieve this class.

Formed surfaces shall be grit blasted to provide a lightly textured finish equivalent to a U4, with the exception of buried or non-trafficked formed surfaces which shall be prepared to the satisfaction of the approved installer responsible for the application of the system.

All areas to receive bridge deck waterproofing shall be clean, dry and free from all loose particles, laitance, dust, oil and other contaminants. All blowholes in concrete surfaces shall be cleared out, filled with approved non-shrink cementitious filler and the repair work properly cured before application of the waterproofing.

Prior to applying the waterproofing system to concrete surfaces, the concrete surface shall be checked for the presence of surface cracks. The inspection shall be undertaken at least 3 days after hardening of the concrete and not more than 7 days prior to waterproofing. Where cracks are present with a crack width greater than the permitted crack width for the applicable exposure conditions and design working life, these shall be repaired and a crack map dossier shall be provided to the Employer's Representative. The crack map dossier shall provide a plan view of the concrete element, at a scale of 1:100, showing the location, spacing and orientation of cracks with a width exceeding the permitted crack width. The dossier shall include datasheets for the approved repair materials and the workplan describing the repairs undertaken. The crack map dossier shall be included in the as-built documents.

Refer to Section 5 of DN-STR-03009 for further requirements.

2.3.3 Temperature Requirements

The concrete deck shall not be primed or the waterproofing applied:

i. when the ambient temperature is below 6° centigrade

ii. when the surface temperature of the concrete is 3° centigrade or less above dew point

Where the concrete deck is required to be primed or waterproofed outside of these temperature requirements, it must be agreed in writing with the Employer's Representative prior to commencement of the Works and is subject to the conditions set out in the NSAI Agrément Certificate or equivalent for the system being met.

2.3.4 Concrete Age Requirements

The concrete deck shall not be primed or the waterproofing applied:

i. until the deck has been cast for at least 28 days and cured as specified

ii. until cementitious repairs have been cured for at least 10 days

Where the concrete deck is required to be primed or waterproofed prior to the deck being cast for 28 days, but no earlier than 7 days, or prior to cementitious repairs being cured for 10 days, it must be agreed in writing with the Employer's Representative prior to commencement of the Works and is subject to the conditions set out in the NSAI Agrément Certificate or equivalent for the system being met.

Notwithstanding Sections 2.3.3 and 2.3.4 above, all the requirements of Section 2.5 shall apply regardless of application conditions.

2.3.5 Defects and Repairs

The formation of defects affecting the integrity of the membrane including pin/blow holes (continuous or non-continuous) and blisters in the waterproofing shall:

i. be made good by repair in accordance with the NSAI Agrément Certificate or equivalent before any subsequent layers are applied; or

ii. require the system to be replaced.

2.3.6 Expansion Joints

The detail of the overlap between the deck waterproofing system and the expansion joint system shall be such that there is no loss of effectiveness or damage to the deck waterproofing or to the expansion joint.

2.4 Protection

2.4.1 Additional Protective Layers

Any protective layer additional to that included as part of a permitted waterproofing system shall be laid immediately after the waterproofing layer's bonding agent has set or cured.

Bituminous protection is required as an additional protective layer and shall comply with IS EN 13108-4 recipe type F wearing course mixture designation 0/2.

The bituminous protection shall be laid on the clean and dry substrate, and compacted in accordance with Section 10 of CC-SPW-00900 to the areas and thickness shown on the drawings in the Contract.

The additional protective layer or surfacing laid on the waterproofing system shall be firmly bonded to the system for the life of the system. The bond shall be achieved by either:

i) the binder within the directly applied additional protective layer or surfacing; or

ii) a separate tack coat which has been assessed by the NSAI or equivalent as part of the registration procedure and details of which are given on the NSAI Agrément Certificate or equivalent.

Where the tack coat is of the type activated by the heat of the succeeding bituminous layer, the rolling temperature of this layer shall be sufficient to ensure adhesion.

2.4.2 Protection During Construction

On any structure, providing no damage results, only plant and equipment fitted with rubber tyres may stand or travel on permitted waterproofing systems solely for the purposes of laying an additional protective layer or surfacing course on that structure. Rollers shall not be permitted to stand or travel directly on the waterproofing system.

Where it is necessary for plant, equipment or traffic to stand or travel on a bridge deck that has been waterproofed before the laying of an additional protective layer, suitable temporary protection shall be provided. All such plant and equipment shall have its tyre treads regularly inspected and any embedded hard objects removed.

2.5 Testing Requirements

Bridge deck waterproofing systems shall be tested to verify their integrity in accordance with the requirements below.

2.5.1 Certification

The Contractor shall provide with all batches of material delivered to site a certificate of compliance with the Specification.

2.5.2 Coverage Rate

The Contractor shall continuously monitor the coverage rate of the material applied to the deck and shall provide the Employer's Representative with daily sheets showing the start/finish weights and area covered for each period of spray operation.

2.5.3 Wet Film Thickness

The Contractor shall continuously monitor the wet film thickness using a gauge pin or a standard comb type thickness gauge. The Contractor shall provide the Employer's Representative with daily sheets indicating the wet film thickness measured and location.

2.5.4 Adhesion Test

A minmum tensile strength of 0.7 N/mm^2 is required between the concrete substrate and the spray applied waterproofing membrane. The Contractor shall measure the adhesion of the fully cured membrane to the concrete surface using Elcometer Adhesion Tester Model 106 or similar.

A minimum of four tests shall be required per $500m^2$ of sprayed membrane, but no less than four tests per bridge deck. For bridges with deck areas greater than 500 m^2, an additional test per each additional $125m^2$ of deck shall be carried out. The test locations should be representative of the entire area to be waterproofed and the locations shall be agreed in advance with the Employer's Representative.

Further areas to receive bridge deck waterproofing in accordance with Section 2.1 above shall be tested as per the direction of the Employer's Representative.

The Contractor shall provide the Employer's Representative with the test values and location of tests before these areas are covered. The Contractor shall reinstate the test areas, including primer if necessary. Test values below 0.7N/mm² shall require spraying operations to be suspended while further investigation is undertaken. Areas deemed not to meet this value shall be removed and resprayed.

2.5.5 Holiday Test

The Contractor shall undertake a "Holiday Test" on the finished waterproofing membrane surface as described in the following sections. Any defects detected shall be rectified by the Contractor in accordance with the manufacturer's recommendations and to the satisfaction of the Employer's Representative.

2.5.5.1 Detection Equipment

Pinhole detection shall be carried out using an approved manufacturer's detection equipment having the following facilities:

i. Variable DC test voltage (1-20kv DC)
ii. Audible and visual alarm signals
iii. Sensitivity adjustment
iv. Phosphor Bronze or Silicon Rubber electrode
v. Earth lead connection with clip

2.5.5.2 Voltage Restrictions

The output voltage of the pinhole detector shall be adjusted in accordance with the following table.

Coating Thickness (mm)	Test Voltage
2.0 to 2.5	12.5kv
2.5 to 3.0	13.5kv

The selection of the test voltage above shall be based on the maximum expected coating thickness, not the average.

2.5.5.3 Procedure

1. Identify a site on the bridge deck to which the earth lead connection from the pinhole detector can be fixed, i.e. a metal object embedded in the bridge deck.
2. Connect the leads from the pinhole detector in accordance with the manufacturer's written instructions.
3. Fix the earth lead from the pinhole detector to the substrate and ensure that a good electrical contact is made.
4. Adjust the pinhole detector to the required test voltage in accordance with the above test voltage table.
5. With the pinhole detector turned off, connect any extension rods that may be required to the test probe handle.

Connect the electrode to the end of the extension rods if fitted. A damaged electrode that does not make 100% contact along its length shall not be used.

6. To check the pinhole detector is working correctly, touch the electrode onto the exposed substrate. The pinhole detectors alarm signal should be activated. If not, check the lead connections to the equipment and the earth lead to the substrate, also it may be necessary to adjust the sensitivity control on the equipment.
7. Pass the electrode over the coated surface at a maximum rate of 100mm/s, paying particular attention to edges, holes and visible irregularities in the coating. The test may have to be reduced where testing edges as the coating may be thin.
8. When a fault has been identified by the detector, the electrode shall be moved sideways in order to identify its precise location. Subsequently the fault shall be ringed with a suitable marker. Such markings shall be made sufficiently distant from the coating defect to allow the repair procedure to be carried out without detriment to the adhesion of the repair material.
9. Continue testing and marking defects until all the coating has been tested, changing the electrode size as necessary.
10. All repaired areas shall be re-tested.
11. Always follow safety precautions as laid down in the equipment manual.

2.6 Repair and Replacement

The repair and replacement of existing bridge deck waterproofing systems shall comply with the requirements of this Specification and any additional requirements described in Appendix 20/1.

3. Exposed Concrete Surfaces

3.1 General

This section sets out the requirements for the hydrophobic impregnation of concrete surfaces as required by DN-STR-03012.

Structures shall be impregnated as soon as possible after concrete construction is completed and before being subjected to de-icing salt spray, but not less than 7 days after the concrete has been placed or 3 days after concrete repairs have been completed.

3.2 Materials

All hydrophobic pore liners shall:

i. Comply with the requirements of I.S. EN 1504-2 (system 2+) for hydrophobic impregnation
ii. Have a current NSAI Agrément Certificate or equivalent
iii. Comply with I.S. EN 1504-2 Table 3 requirements for loss of mass after freeze-thaw-salt stress
iv. Comply with I.S. EN 1504-2 Table 3 Class II depth of penetration
v. Comply with I.S. EN 1504-2 Table 3 Class I drying rate coefficient
vi. Provide demonstrable graffiti protection – products shall allow graffiti on treated areas of a concrete structure to be removed without damage to the concrete substrate

Prior to the commencement of the Works the Contractor shall provide to the Employer's Representative a copy of the NSAI Agrément Certificate or equivalent appropriate to the work to be undertaken.

The assessment of the durability of an impregnating material will be based on the submission of evidence that it has, in practice, provided an effective water repellent but vapour-permeable layer at the concrete surface for a period of not less than 15 years after application.

The hydrophobic pore liner shall be colourless following application to the concrete substrate.

3.3 Workmanship

3.3.1 Surface Preparation

Areas to be treated shall be protected from adverse effects of the weather and shall be surface dry for a minimum of 24 hours before application commences. Artificial drying of surfaces shall not be permitted. Where a system is to be applied outside of these requirements, it must be agreed in writing with the Employer's Representative prior to commencement of the Works and is subject to the conditions set out in the NSAI Agrément Certificate or equivalent for the system being met.

Surfaces shall be free from loose or deleterious matter, graffiti and graffiti removal agents. Where curing membranes and release agents have been used, they must be removed or fully degraded before impregnation is carried out.

Existing structures shall be hand brushed with a stiff bristle brush to remove surface deposits.

Where deleterious surface deposits cannot be removed using a stiff bristle brush they shall be removed by light grit blasting. Immediately prior to application, the surface of the concrete shall be cleaned with dry compressed air through a lance to remove any loose material and dust. A water trap shall be incorporated in the air line.

Water jetting or steam cleaning shall not in general be used as a means of surface preparation without agreement with the Employer's Representative.

3.3.2 Application

A power driven continuously circulating pumped system operating at a low nozzle pressure shall be used to apply the material in such a way as to avoid atomisation. Water shall be prevented from entering any part of the equipment.

A pressure gauge shall be installed between the trigger valve and spray lance to enable the pressure to be monitored.

A 'kill' switch shall be provided so that the pumping system may be stopped immediately should this be required.

Impregnation of the face of a structural element shall be carried out in a single continuous operation for each application.

The material shall be applied by continuous spray technique giving saturation flooding, working from the lowest level upwards. The material shall be applied in accordance with the manufacturer's recommendations such that the dosage rate is not less than the amount found necessary to meet the requirements of I.S. EN 1504-2 for hydrophobic testing criteria.

Impregnation shall not be carried out in the following conditions:

i. when the shade temperature is below 5°C;
ii. when the temperature of the concrete surface is greater than 25°C;
iii. when the wind speed is in excess of 8 km/hr unless the working area is fully encapsulated.

Concrete elements shall be protected from rain and spray during application and for at least six hours after completion.

Where a system is to be applied outside of these requirements, it must be agreed in writing with the Employer's Representative prior to commencement of the Works and is subject to the conditions set out in the NSAI Agrément Certificate or equivalent for the system being met.

3.3.3 Protective Measures

Use and handling of the impregnant material shall be in strict accordance with the manufacturer's recommendations, and in full compliance with all current Health and Safety legislation. The Contractor shall ensure that only fully trained operatives undertake impregnation operations, and where necessary carry out trials to verify procedures.

Measures shall be taken to ensure that no impregnation material enters into any drainage system or watercourse. The Contractor shall obtain all necessary written permissions and licences from the appropriate authorities, prior to any impregnant material operations above or adjacent to any watercourse.

Measures shall be taken to ensure that no impregnation material comes into contact with any humans, animals, vegetation or vehicular traffic by providing suitable and adequate protection and traffic management.

The Contractor shall submit details of the proposed protection measures and shall obtain all other consents associated with traffic safety, management and protective measures in advance of the commencement of impregnation operations.

Elastomeric bearings, painted steel surfaces, exposed bituminous materials and joint sealants adjacent to structural elements to be impregnated shall be masked off or covered before and during impregnation operations.

3.4 Testing Requirements

The Contractor shall demonstrate by site procedure trials the suitability of the proposed product, the method of working and the competence of the proposed operatives executing the application of the product as follows:

i. Construct two concrete trial panels of minimum dimensions 2m x 2m, one on each of a vertical and horizontal surface

ii. The operatives shall apply the hydrophobic impregnation in accordance with manufacturer's recommendations and the agreed method statement

iii. The appearance of the trial panel following application of the hydrophobic impregnation shall be agreed with the Employer's Representative to confirm that it has not had a detrimental effect on the appearance of the concrete surface

iv. Graffiti shall be applied to the treated trial panels and allowed to cure

v. Once the graffiti is cured, cleaning of the trial panels shall be undertaken to demonstrate the removal of graffiti without damage to the concrete substrate

4. References

4.1 TII Publications (Standards) References

DN-STR-03012 – Design for Durability

DN-STR-03009 – Waterproofing and Surfacing of Concrete Bridge Decks

CC-SPW-00900 - Road Pavements - Bituminous Materials

CC-SPW-01700 – Structural Concrete

4.2 References to IS/EN/BS Standards

I.S. EN 1504-2 - Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Surface protection systems for concrete.

IS EN 13108-4 - Bituminous mixtures - material specifications. Hot rolled asphalt

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