VOLUME 2 HIGHWAY STRUCTURES: DESIGN (SUBSTRUCTURES AND SPECIAL STRUCTURES) MATERIALS

SECTION 4 PAINTS AND OTHER PROTECTIVE COATINGS

PART 2

BD 43/03

THE IMPREGNATION OF REINFORCED AND PRESTRESSED CONCRETE HIGHWAY STRUCTURES USING HYDROPHOBIC PORE-LINING IMPREGNANTS

SUMMARY

This Standard covers the use of pore lining impregnants on new concrete structures and for those in service.

INSTRUCTIONS FOR USE

This revised Standard is to be incorporated in the Manual.

1. This document supersedes BD 43/90, BA 33/90 and SB 3/92.

2. Replace existing contents pages for Volume 2 and insert new contents page for Volume 2 dated February 2003.

3. Remove BD 43/90, BA 33/90 and SB 3/92 and archive as appropriate.

4. Insert BD 43/03 in Volume 2, Section 4, Part 2.

5. Please archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.

THE HIGHWAYS AGENCY

SCOTTISH EXECUTIVE DEVELOPMENT DEPARTMENT

WELSH ASSEMBLY GOVERNMENT
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THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

The Impregnation of Reinforced and Prestressed Concrete Highway Structures Using Hydrophobic Pore-Lining Impregnants

Summary: This Standard covers the use of pore lining impregnants on new concrete structures and for those in service.

REGISTRATION OF AMENDMENTS

Amend No	Page No	Signature & Date of incorporation of amendments	Amend No	Page No	Signature & Date of incorporation of amendments

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THE IMPREGNATION OF REINFORCED AND PRESTRESSED CONCRETE HIGHWAY STRUCTURES USING HYDROPHOBIC PORE-LINING IMPREGNANTS

Contents

1. INTRODUCTION

1.1 This Standard provides criteria and background information for the impregnation of reinforced and prestressed concrete elements of highway structures, using hydrophobic pore-lining impregnants to help prevent and control chloride induced reinforcement corrosion from de-icing salts, and in marine environments.

1.2 Penetration of concrete by chloride ions is the primary cause of reinforcement corrosion in concrete highway structures. The most effective resistance to penetration is achieved when concrete itself forms a water-resistant barrier. Impregnation of reinforced and prestressed concrete members immediately after construction will provide additional protection against chloride attack before they come into service, and improved durability in service. For structures already in service, where corrosion is not yet occurring, impregnation of reinforced and prestressed concrete members will help protect them from further attack. Impregnation using hydrophobic pore-lining materials involves treating the concrete surface to form a water-repellent, but vapour-permeable layer which helps protect the concrete from the ingress of water and salt and provides added protection against reinforcement corrosion. The near surface zone pores and capillaries in the concrete are internally coated, but they are not filled. There is no film on the surface of the concrete and there is little visible change to external appearance.

1.3 This Standard replaces both Standard BD 43/90 and Advice Note BA 33/90, ‘Impregnation of Concrete Highway Structures’ and also Scottish Technical Memorandum SB 3/92, and should be read in conjunction with the Specification for Highway Works and the Notes for Guidance.

1.4 The opportunity has been taken to bring the previously published documents (BD 43/90 and BA 33/90) up to date and to combine them, and to bring them in line with the revised Specification for Highway Works and the Notes for Guidance, dated May 2002. This has been undertaken based on experience and feedback on the application of the existing documents, research work, and to signal the move towards the adoption of European Standards.

1.5 Mandatory requirements are shown in boxed text, and guidance is in plain text.

2. SCOPE

2.1 This Standard shall apply to reinforced and prestressed concrete structural elements in new construction, and in-service structures.

2.2 The previously published documents (BD 43/90 and BA 33/90) drew a distinction between in-service structures less than or greater than 6 years old. This has now been dropped, since the previous documents have been in place for over 10 years, and the distinction is now irrelevant. The Standard provides criteria to allow decisions to be made as to whether impregnation is appropriate for any in-service structure.

3. SAFETY

3.1 The legal provisions of the various statutory requirements for Health and Safety shall be observed in planning and execution of impregnation operations. The main safety aspects with regard to work on the Overseeing Organisation's properties are access, safety zones, traffic signing, and working near trafficked roads. Rigorous precautions are also required in handling the impregnants, and providing adequate protection to the work area, and for operatives.

3.2 The Maintenance Organisation shall consult the local Environmental Health Officer, and the Health and Safety Executive, as soon as the scale and location of the work is known, so that any precautions considered necessary can be included in advance of the Contract. Reference shall also be made to the Specification for Highway Works and the Notes for Guidance. On Contracts where impregnation operations are taking place, the Contractor must fully comply with all Health and Safety legislation including Control of Substances Hazardous to Health (COSHH) requirements and with the directives of the relevant Waste Disposal Authority.

3.3 Where impregnation operations are taking place in the vicinity of water or sensitive environments, full consultation shall take place with the appropriate responsible parties. Similarly, for work on or near railway lines or other transport infrastructure, the responsible organisations must be consulted and their requirements included in Contract documents. Particular care will be required in the vicinity of occupied properties, businesses and in urban situations.

4. NEW CONSTRUCTION

4.1 New structures shall be impregnated before they come into service. Where new structures are built on existing trafficked carriageways they shall be impregnated at the earliest opportunity, after concrete construction is completed, and before being subject to de-icing salt spray. New construction in a marine environment shall be impregnated as soon as possible, after concrete construction is completed. New structures do not require testing before impregnation. Reference shall be made to Clause 8.15 for minimum periods to elapse after concreting and before impregnation.

4.2 It is preferable to apply the impregnant before the concrete receives its first exposure to de-icing salts, subject to the prior degradation of any curing membranes, because a substantial amount of chloride can enter the concrete by capillary absorption during this initial exposure period. Early impregnation is particularly important in a marine environment, where there is a natural and continuously aggressive environment.

4.3 The Maintenance Organisation shall decide on the structural elements to be impregnated in accordance with the guidance in Clause 6 of this Standard.

5. STRUCTURES IN SERVICE

5.1 Structures in service, which have not been impregnated previously, shall be impregnated provided they comply with certain criteria below.

5.2 There are likely to be few structures in service less than 10 years old where impregnation has not taken place. Such structures are relatively new and the chloride ion concentration at the level of the reinforcement is probably low. The condition of the concrete in these structures is assumed to be good. Site testing prior to impregnation is not considered essential, unless there are visual signs to the contrary, ie rust staining, cracking and concrete spalling. Where silicate-based curing membranes have been used, it is possible that degradation of the membrane has not fully occurred and this may cause difficulties during application and reduce the effectiveness of impregnation. If there is any doubt, it would be prudent to test for the presence of any curing membrane.

5.3 For structures over 10 years old, and which have not been previously impregnated, current practices vary on the basis for decisions on whether to undertake impregnation. This can be assessed by visual indications alone, and supplemented with 'fingertip' inspection and 'hammer tap' surveys to detect delamination. The alternative is to undertake more extensive preliminary testing as part of an ongoing management regime for structures. These testing arrangements are outlined in Appendix 1, and represent the current practice adopted by the Highways Agency in England.

5.4 The Overseeing Organisation, in consultation with the Maintenance Organisation, shall decide on the type and extent of testing to be undertaken to determine whether structures or particular elements should be impregnated.

5.5 The Maintenance Organisation shall decide on the structural elements to be impregnated, in accordance with the guidance in Clause 6 of this Standard.

5.6 Structural elements to be impregnated shall be free from rust staining, cracking, delamination and spalling. Where there are defects present, other repairs may be necessary before impregnation is undertaken.

5.7 Decisions on when to impregnate structures in service are not dealt with within this Standard. They are matters to be decided in consultation between the Maintenance Organisation and the Overseeing Organisation. Normal practice would be to undertake impregnation work in association with other planned maintenance operations, though separate contracts have been set up to undertake impregnation on a number of structures.

6. STRUCTURAL ELEMENTS TO BE IMPREGNATED

6.1 Within the structural stock there is a wide variety of structural types and span arrangements etc. Consequently all parts of a structure are not equally at risk from chloride attack. Unless the structure is in a marine environment, the risk depends upon the degree of exposure to de-icing salt, which in turn will depend on the geometry, design and location of individual structural elements. It is highly desirable to treat all exposed reinforced and prestressed concrete surfaces subjected to de-icing salt spray and/or possible leakage from deck joints. Where part of a structural element lies within the affected zone then all that face of an element should be impregnated. The following is intended as a guide:

(a) Piers, columns, crossheads and abutments within 8 metres of the edge of the carriageway subjected to de-icing salt spray.

(b) Piers, columns, crossheads and abutments with a deck joint above, but with no provision for positive drainage. Where accessible, the tops of these members should also be treated.

(c) Bearing shelves, ballast walls and deck ends with a deck joint above, where accessible.

(d) Concrete parapets and parapet plinths (all inclinations), and concrete deck surfaces not protected with deck waterproofing.

(e) Deck beams and soffits directly over, and within 8 metres of the edge of, the carriageway.

(f) Wingwalls with parts within 8 metres of the edge of carriageway.

(g) Retaining walls within 8 metres of the edge of the carriageway.

6.2 In marine environments, all exposed structural concrete elements are potentially at risk of chloride attack and shall be impregnated. Columns and soffits over brackish water shall also be impregnated.

6.3 A detailed record shall be made of the members treated, and recorded on as-built drawings, and the materials detailed in the Maintenance Manual for all structures, both for new and in-service structures. Reference shall be made to BA62 ‘As built operational and maintenance records for highway structures’ and to BD63 and BA63 ‘Inspection of highway structures’ for requirements.

7. MEASURES TO BE TAKEN BEFORE IMPREGNATION OF STRUCTURES IN SERVICE

7.1 In order to ensure that the concrete is surface dry before impregnation, it is important to check that waterproofing and drainage systems are performing satisfactorily. Inspection records should be examined to decide whether any remedial work is necessary. If there is insufficient information or a Principal/General Inspection has not been recently carried out, it may be necessary to carry out a visual inspection followed by a Special Inspection.

7.2 Leaking deck joints and inadequate drainage systems should be repaired or replaced. Damp patches on soffits may indicate that the deck waterproofing membrane has failed. If further investigation shows the waterproofing membrane is not performing satisfactorily, consideration should be given to its early replacement or when carriageway resurfacing is next carried out. The provision of prefabricated drip strips (except where drip channels already exist) bonded with a moisture-tolerant adhesive at the ends of deck soffits as shown in Figure 1, can prevent water running across soffits and contaminating large areas.

7.3 Where there are concrete defects present, such as cracks, spalling and honeycombing, repairs to the concrete should be undertaken before impregnants are applied.

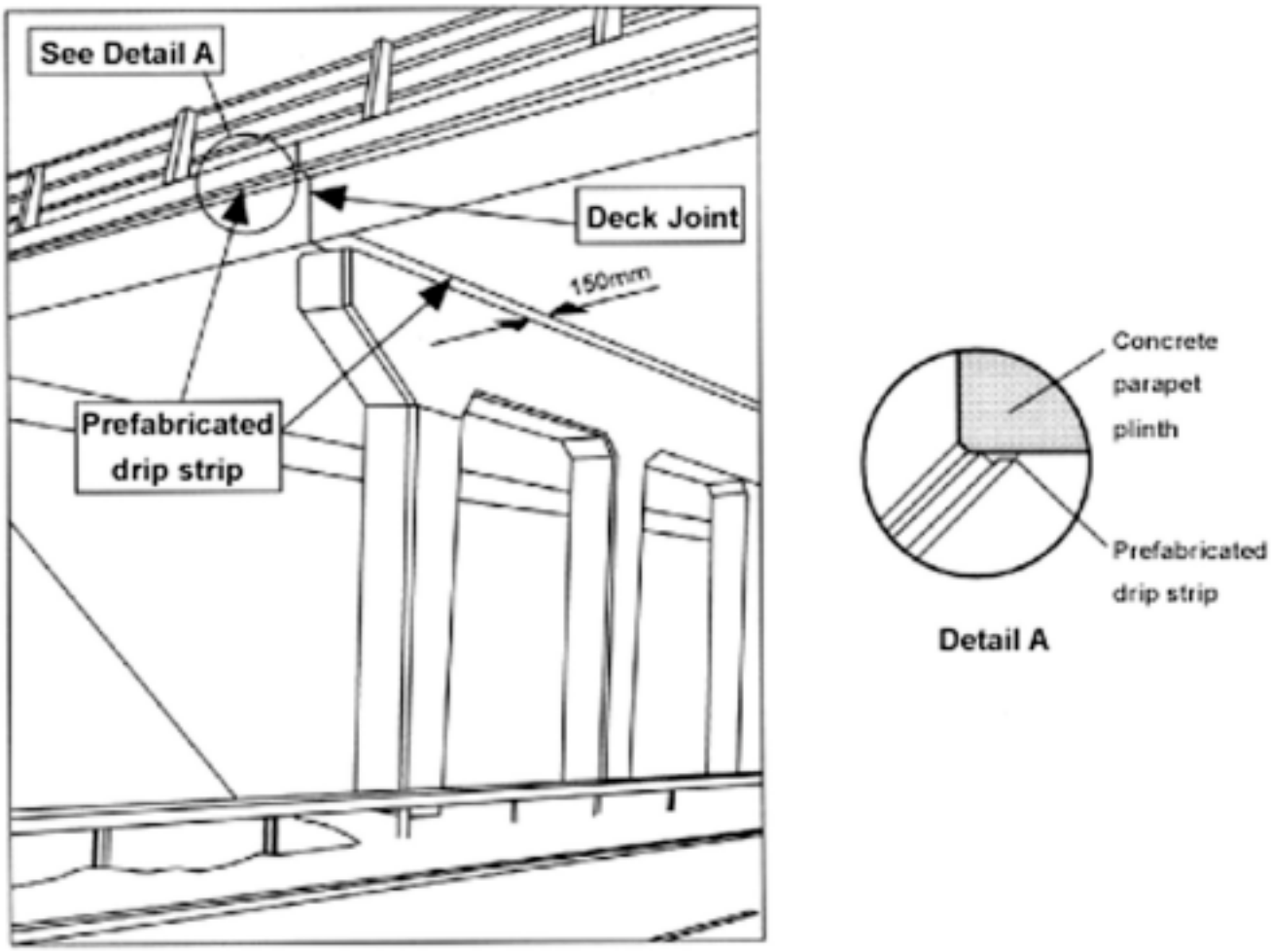

Figure 1: Example of Prefabricated Drip Strips on Bridge Deck Soffits

8. SURFACE IMPREGNATION REQUIREMENTS

8.1 Impregnation is carried out by spraying concrete surfaces with a hydrophobic pore-lining material which reacts with the silicates and moisture present. This produces a water-repellant but vapour-permeable layer that inhibits the ingress of water and chloride ions.

8.2 Effectiveness of this layer is determined by the quality of the hydrophobisation and the strength and permanence of the bond between molecules of the impregnant and the concrete substrate, and is not directly dependent on the depth of penetration. Impregnation undertaken in the UK is known to be effective for at least 15 years, provided it is applied correctly. Longer service life is anticipated. However concrete surfaces subject to physical abrasion and degradation mechanisms may be subject to shorter service lives, through loss of the impregnated surface.

8.3 The application rates given in the Specification for Highway Works and the Notes for Guidance are assumed to be appropriate for normal coverage using approved equipment, and the specified impregnant (refer to clause 8.4). Alternative materials may be accepted, but must be applied in accordance with manufacturers' requirements and subject to a satisfactory proving trial by the Contractor.

8.4 Generally, in the UK, silane has been used for impregnation of concrete. Silane is a generic descriptor, and the current Specification for Highway Works and the Notes for Guidance require the use of monomeric alkyl (isobutyl) – trialkoxy silane with a minimum active content of 92%. There has been opportunity for the submission of alternative impregnants for acceptance by the Overseeing Organisation, based on proven evidence of their durability and ability to provide an effective water repellant, but vapour-permeable layer at the concrete surface, for a period of not less than 15 years after application. However a new European Standard currently under development will require compliance with tests for 'pore-lining impregnants'. In particular two tests originally developed by TRL have been included, and details are provided in Appendix 2 of this Standard. It is anticipated that by compliance with these tests and the quoted acceptance criteria, this will allow other pore-lining impregnants to be used, particularly variant forms of silane and siloxanes.

8.5 As a result of some past site problems in the fraudulent use of adulterated materials, where silane has been found to be contaminated with paraffin or white spirit, and without any other visual indications, a new test has been introduced into the Specification for Highway Works to allow discrimination of compliant and non-compliant transparent materials. The test is based on the determination of the refractive index of the material, which shall comply with the value stated in the manufacturer's product specification, within a limit of 0.003 units. The refractive index shall be checked as follows:

a) Collect samples of the material from a newly opened container and from the spraying nozzle.

b) Measure the refractive index of three samples from both the container and spray nozzle using a portable refractometer.

c) Measure the temperature of the samples (portable refractometers have temperature measuring capability).

d) Correct the refractive index measurements to the temperature stated in the manufacturer's product specification.

e) If the temperature corrected measured value of the refractive index exceeds the manufacturer's specified value by more than 0.003 units then a laboratory check shall be undertaken to confirm compliance. If the material still does not meet these requirements, it shall not be used.

8.6 Impregnant materials received on site shall be accompanied by a Certificate of Compliance. No material shall be used in the works until the certificate has been accepted by the Overseeing Organisation. They shall be delivered to site in sealed airtight containers

8.7 Care should be taken on site to ensure that impregnants are stored in a secure facility that has a dry frost-free environment and protected from direct heat. Containers are to remain sealed until their contents are required for use. The contents of any opened container shall be used within 48 hours or else disposed of safely. This is because the specified silane hydrolises with moisture in the atmosphere.

8.8 To apply the impregnant, spraying equipment is generally required, using a power driven, continuously circulating, pumped system operating at a low nozzle pressure to avoid atomisation. Care must be taken to prevent water from entering any part of the equipment. Nozzle pressure must be monitored by a pressure gauge installed between the trigger valve and spray lance. Should the pumping system require to be stopped, a 'kill' switch is to be provided. The type of nozzle used and spraying distance shall be in accordance with the manufacturer's instructions.

8.9 Silane is classed as a toxic material and is an irritant to human tissue and so it is essential to adhere strictly to current Health and Safety legislation, and manufacturers' recommendations, and employ protective measures when handling and spraying. Similar requirements will apply to other impregnants. Contractors are required to ensure that only fully-trained operatives undertake impregnation operations, and must carry out advance trials to verify procedures. In the case of spillages, the Contactor must immediately take action to limit the extent of the spillage and the Overseeing Organisation and the other relevant responsible authorities must be informed at once (as noted in Clause 3).

8.10 Measures must be taken to ensure that no impregnant enters into any drainage system or watercourse. The Contractor is required to obtain all necessary written permissions and licences from the appropriate responsible authorities, prior to impregnation operations above or adjacent to any watercourse (as noted in Clause 3).

8.11 Measures must also be taken to ensure that no impregnant comes into contact with any humans, animals, vegetation or vehicular traffic by providing suitable and adequate protection and traffic management. The Contractor is required to obtain approval from the Maintenance Organisation and all others licences, agreements and permissions associated with traffic safety, management and protective measures in advance of the commencement of impregnation operations (as noted in Clause 3).

8.12 Special precautions must be taken for impregnation operations over, or adjacent, to watercourses which will require protective sheeting or complete encapsulation beneath the structure. Impregnation on structures over, or adjacent to roads will require protective sheeting or complete, encapsulation. Consideration should also be given to the introduction of appropriate traffic management and safety measures. Vegetation that could be subject to spray, needs to be covered or otherwise protected, and the protective covering must be maintained in position and in good condition.

8.13 Impregnants may damage elastomeric bearings, painted steel surfaces, exposed bituminous materials, and joint sealants adjacent to structural elements and the Specification for Highway Works and the Notes for Guidance include requirements to mask off, or cover, these components and materials before and during impregnation operations. After completion of impregnation operations, all contaminated protective sheeting and materials used for masking or covering must be safely disposed of to licensed waste disposal facilities.

8.14 Critical to the success of the impregnation operation is the surface condition of the concrete. To be effective, the areas to be treated must be protected from adverse effects of the weather and be surface dry for a minimum of 24 hours before application commences. Artificial drying of surfaces is not acceptable as it has a tendency to continue to draw moisture to the surface of the concrete by capillary action from within the concrete, when the drying equipment is removed. Depending on climatic conditions, it may be necessary to protect surfaces to be treated to ensure that they are surface dry before impregnation. In a marine environment, impregnation should be carried out at the earliest opportunity after it has been demonstrated that there are no deposits of the curing membrane remaining. Surfaces must also be free from loose or deleterious matter and residues of curing membranes, release and graffiti removal agents. The presence of a curing membrane or its residual effects may render impregnation ineffective. This is particularly important to check when silane is to be applied less than a month after the concrete was placed. In service structures must be cleaned with a stiff bristle handbrush to remove surface deposits, wirebrushing or by light grit blasting. High pressure grit blasting is not acceptable as it damages the surface of the concrete, nor is water jetting or steam cleaning as a means of surface preparation, as they wet the concrete substrate. In exceptional circumstances, where there is substantial contamination, water jetting or steam cleaning may be used with care, subject to a satisfactory trial being undertaken. However, where this has been allowed, impregnation should not commence for a minimum of 48 hours from completion of the cleaning works, and remains subject to the other application and surface condition requirements, particularly the need for a period of surface dryness of the concrete substrate for a period of 24 hours in advance of the impregnation operation.

8.15 As a result of research work carried out at TRL, some of the previous requirements for application of impregnants have been relaxed. In particular the impregnation operations may be undertaken for new construction (both insitu and precast concrete) not less than 7 days after the concrete has been placed for new construction, or 3 days where concrete repairs have been completed on a structural element. However, attention is particularly drawn to the need to comply with the surface condition requirements at 8.14. Impregnation operations using the specified silane should be carried out in a single continuous operation for each application, and applied by continuous spray technique giving saturation flooding, working from the lowest level upwards. Two applications are required at a coverage of 300 ml/m² with an interval between each of at least six hours. This coverage rate must be regularly monitored by determining the quantities of silane material used on particular areas of each structure. Achieving the required rate may result in some loss of material, by run down and evaporation. Application of silane can be judged by a characteristic 'wet look' to the concrete surface.

8.16 Environmental conditions for impregnation operations shall be imposed. The work should not be undertaken when the shade air temperature is below 5°C, or when the temperature of the concrete surface is greater than 25°C, or when the wind speed is in excess of 8 km/hr (unless the working area is fully encapsulated by appropriate protective measures). Impregnated concrete surfaces must be protected from rain and spray during application and for at least 6 hours after completion.

8.17 The Specification for Highway Works and the Notes for Guidance make provision for the Contractor to carry out impregnation trials where required in the Contract. The Contractor is required to demonstrate that the proposed method of working will meet the Contract requirements, on both horizontal and vertical trial panels.

9. RE-APPLICATION OF IMPREGNANTS

9.1 Impregnation using monomeric alkyl (isobutyl)-trialkoxy silane is known from research evidence to be highly effective for at least 15 years provided it is applied correctly. Longer service lives are anticipated. However it is considered advisable, until further experience is gained, to assume that re-application will be necessary after about 20 years.

9.2 Determination of the need for re-application of an impregnant will be subject to the assessment of testing carried out as part of the periodic management and inspection of structures in service. When significant changes in half-cell potentials are observed, and critical levels are approached over significant areas of the concrete element, then consideration may be given to re-application of an impregnant. Care must be taken to ensure compatibility with the initially applied treatment. Reference should be made to Clause 5.3, and the testing procedures adopted by the Overseeing Organisation.

10. OTHER CONCRETE SURFACE TREATMENTS

10.1 The policy on concrete surface coatings is that they are not to be applied, unless there is an overriding engineering justification to do so. Where coatings are proposed, and impregnants are also to be used (by virtue of this Standard), then the Maintenance Organisation should ensure that there is compatibility between the materials. It is essential to ensure that the vapour transmissibility and hydrophobic properties of the impregnant are not adversely affected, and that the performance of the coating, particularly long-term adhesion, is effective.

10.2 BA57 refers to other materials and methods where research has provided evidence of enhanced durability against chloride induced corrosion. Where these materials and methods have been used, pore lining impregnants shall be used in accordance with this Standard.

11. REFERENCES

1. Health and Safety at Work etc Act 1974.
Factories Act 1961.
Health and Safety legislation relevant to Overseeing Organisation.
Section 4 Approved Code of Practice (ACOP): Management of Health and Safety at Work.

Northern Ireland

Workplace (Health, Safety and Welfare) Regulations (NI) 1993
Confined Spaces Regulations (NI) 1999

2. Methods to determine chloride concentrations in in-situ concrete, Transport Road Research Laboratory, Contractor Report 32.

3. BRE Information Paper IP 21/86, Determination of chloride and cement of hardened concrete.

12. ENQUIRIES

All technical enquiries or comments on this Standard should be sent in writing as appropriate to:

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G W ALLISTER
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APPENDIX 1 - TESTING REGIMES USED BY THE HIGHWAYS AGENCY

A1.1 This Appendix contains information about the testing regimes applicable to structures owned by the Highways Agency, as a basis for decision making about impregnation of structures in service over 10 years old, and forms part of an ongoing management process for such structures.

A1.2 Certain reinforced concrete elements require site testing for half-cell potentials to check whether they satisfy the criteria for impregnation, and for chloride contents to establish which members need monitoring after impregnation. Prestressed or precast concrete members do not require testing before impregnation. For marine structures, all exposed concrete elements require assessment.

A1.3 Site testing for half-cell potentials and chloride contents should be confined to concrete elements listed in A1.7(a). These members are subjected to salt traffic spray and/or possible leakage from deck joints. To ensure that impregnation is only carried out on members where reinforcement corrosion is not yet occurring, the test criteria in A1.7(c) should be satisfied.

A1.4 Impregnation may not be successful in preventing corrosion in all cases where half-cell potential measurements are numerically less than -350mV (eg-300mV) and chloride ion concentrations in test areas are greater than 0.3 per cent by weight of cement. However the cost of impregnation is low compared with concrete repairs and can be justified economically if the rate of corrosion is either halted or slowed down and major remedial works delayed by a few years. Elements in this condition are classified as ‘fair’ (see Figure A1.1). These elements should be monitored during Principal Inspections for changes in half-cell potential measurements which indicate the onset of corrosion. For this purpose provision should be made for permanent connections to the reinforcement at convenient locations. It should be noted that, after impregnation, a shift in half-cell potential measurements may occur.

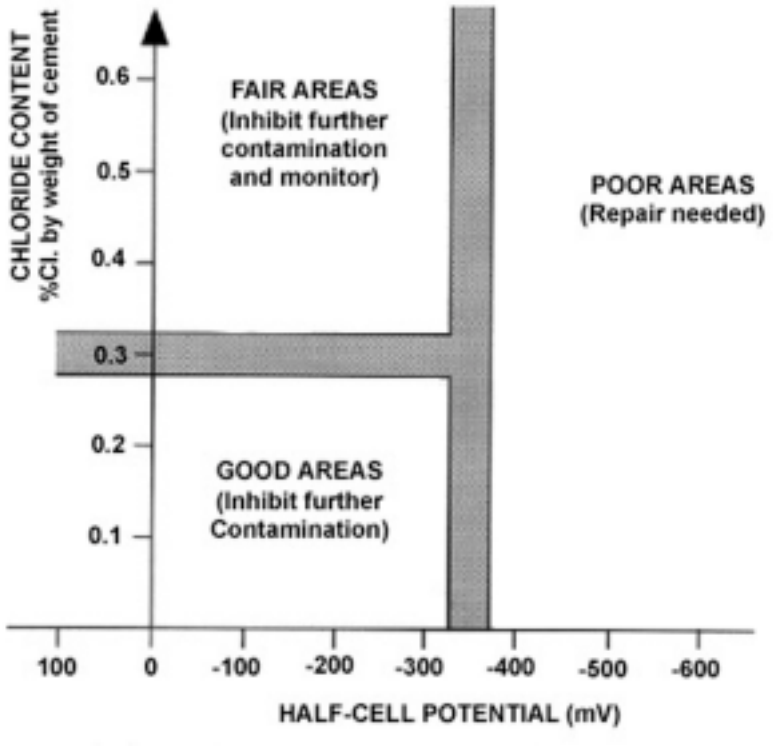


Figure A1.1: Thresholds for Impregnation and Monitoring Structures in Service

A1.5 If tested members do not satisfy the criteria for impregnation, then the Maintenance Organisation should decide if non-tested areas selected for impregnation should alone be treated.

A1.6 Site testing of structures in service should be carried out during Principal Inspections where possible.

A1.7 Site Test Criteria

(a) The following concrete elements shall satisfy the criteria for half-cell potential in A1.7(c) before being considered for impregnation:

(i) Piers

(ii) Columns

(iii) Crossheads

(iv) Abutments

(v) Wingwalls and retaining walls

(vi) Parapets

(vii) Parapet plinths

For marine structures all exposed concrete elements require assessment.

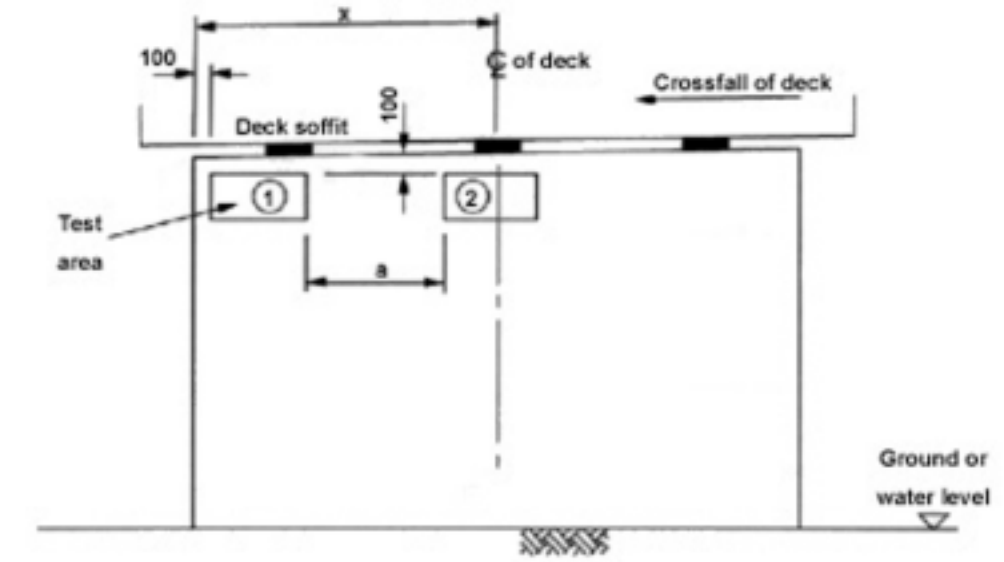
(b) Site sampling shall only be carried out by specialist testing firms, and laboratory testing by laboratories which have been approved by the United Kingdom Accreditation Service (UKAS), or by equivalent accreditation bodies, for the required laboratory tests.

(c) Impregnation of reinforced concrete piers, columns, crossheads, abutments, wingwalls, retaining walls, concrete parapets and parapet plinths shall be carried out if, for each element, 95% of half-cell potential measurements are numerically less than -350mV relative to a copper/copper sulfate reference electrode. The figure of -350mV represents the critical numerical value above which there is a high risk of corrosion occurring.

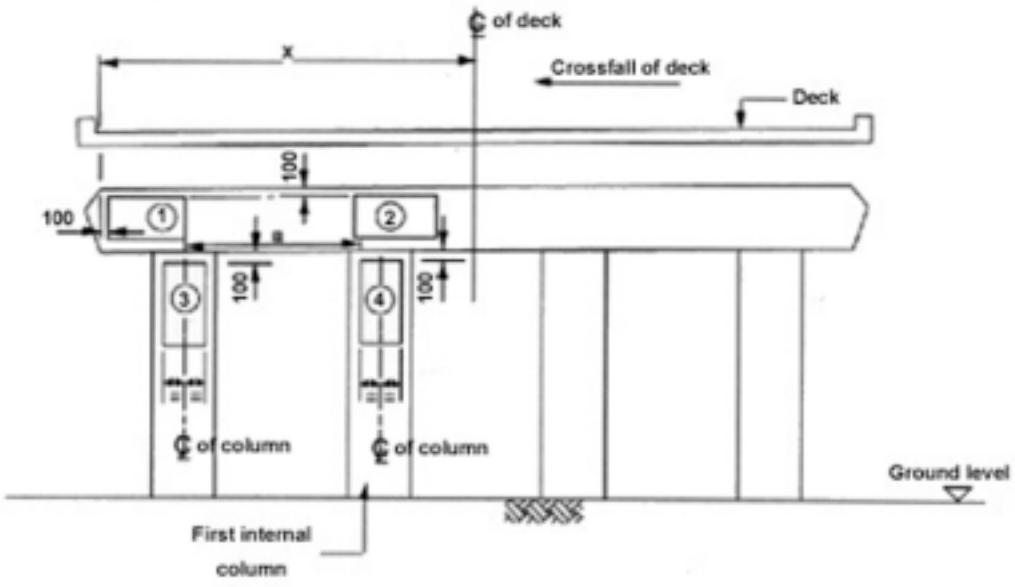
(d) For reinforced concrete piers, columns, crossheads and abutments with a deck joint above, the test areas shall be located in areas where any staining from joint leakage has occurred and generally in accordance with Figure A1.2. For reinforced concrete piers, columns and abutments without a deck joint above but subjected to salt spray from passing traffic, or in a marine environment, the test areas shall be as shown in Figure A1.3. Where these members have a deck joint above and are also subjected to spray, both test areas shall apply. For reinforced concrete wingwalls and retaining walls subjected to spray, the test area shall be as for leaf piers and abutments in Figure A1.3, except that the test area shall be repeated every 5m along a horizontal line. For all members described above, the test area shall be 2m by 1m unless otherwise specified. Within each test area, depth of cover and half-cell potential measurements shall be taken on a 500mm grid and dust samples for chloride analysis taken as described in A1.7(g).

(e) For reinforced concrete parapets subjected to salt spray from passing traffic, the test areas shall be on the traffic face. The test areas shall be 2m x 1m or 2m x 0.5m or other convenient specified dimension, 100mm below the top edge of the concrete parapet and repeated every 5m along a horizontal line. The spacing may be varied to suit the particular structure and element, the objective being to determine the variation of condition within an element. Within each test area, depth of cover and half-cell potential measurements shall be taken on a 500mm grid and dust samples for chloride analysis taken as described in A1.7(g).

(f) For reinforced concrete parapet plinths subjected to salt spray from passing traffic, the test areas shall be on the top surface over the width of the plinth. These shall be 1m long and be repeated every 5m along the length of the plinth. The spacing may be varied to suit the particular structure and element, the objective being to determine the variation of condition within an element. Within each test area depth of cover and half-cell potential measurements shall be taken and dust samples for chloride analysis taken as described in A1.7(g).



LEAF PIERS AND ABUTMENTS

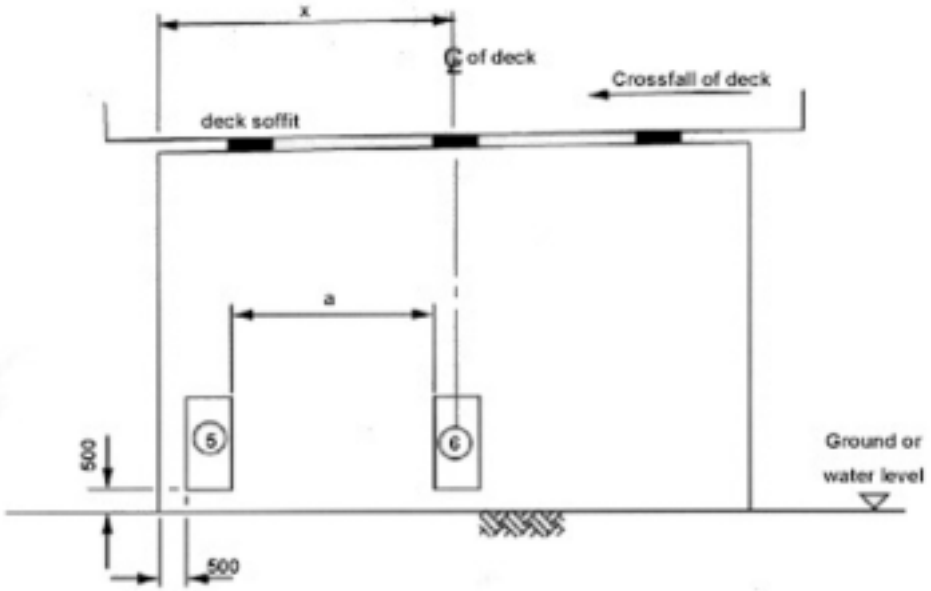


COLUMNS AND CROSSHEAD

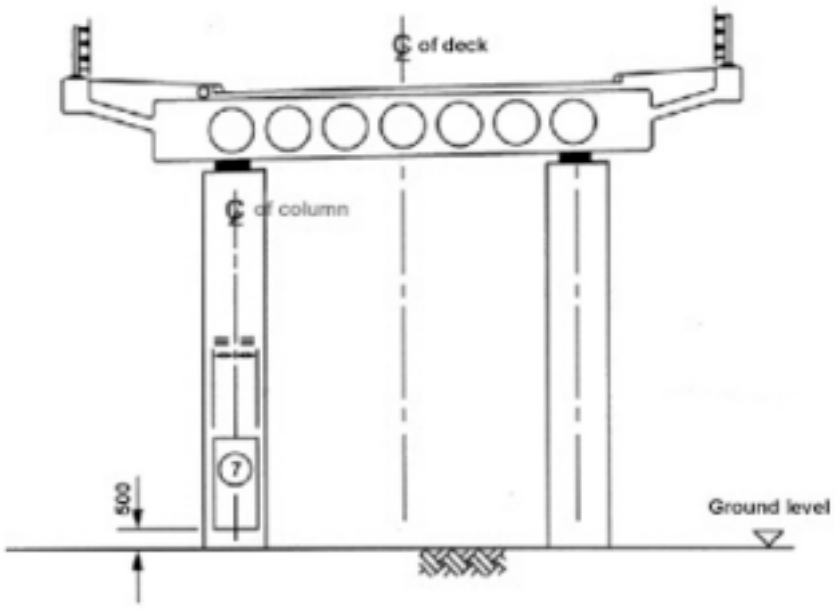
NOTES

1. If x > 8m then 'a' = 4m. If x < 5m then 'a' = 1m. Otherwise area 2 shall lie on the centre line of the bridge deck.
2. Test areas shall be 2m x 1m unless otherwise specified.
3. Diagrams not to scale.

Figure A1.2: Location of Test Areas for Reinforced Piers, Abutments, Columns and Crossheads With a Deck Joint Above



LEAF PIERS AND ABUTMENTS



COLUMNS

NOTES

1. If x > 8m then 'a' = 4m. If x < 5m then 'a' = 1m. Otherwise area 6 shall lie on the centre line of the bridge deck.
2. Test areas shall be 2m x 1m unless otherwise specified.
3. Diagrams not to scale.

Figure A1.3: Location of Test Areas for Reinforced Piers, Abutments, Columns and Crossheads Subject to Salt Spray from Traffic

(g) Within each test area two dust samples for chloride analysis shall be taken from positions of numerically high half-cell potentials. Dust samples shall be removed from reinforced concrete members using a 20 to 25mm diameter drill bit and the dust collected by a method described in Reference 3 or other suitable method. Samples shall be collected from drillings over a depth of 20mm at the level of the reinforcement. Samples shall be sealed in plastic bags labelled with the location, depth and name of operator. All holes drilled shall be made good to the satisfaction of the Maintenance Organisation.

(h) Analysis of chloride content in reinforced concrete members shall be done on site by the "Quantab" method as described in BRE Information Paper IP 21/86 [Reference 3], except that: calcium carbonate shall be used to neutralise the solution [Reference 2]. Where many analyses are to be undertaken it will be quicker and may be more economical to use a battery-operated pH meter with a chloride ion selective electrode to read chloride concentrations directly [Reference 2]. Other site testing methods approved by the appropriate regulatory bodies in other member states are also acceptable. The average of the chloride ion analysis results for the two dust samples shall be taken as representative of the chloride ion concentration for the test area at the level of the reinforcement.

(i) Cement content shall be assumed to be 315 kg/m^3 unless positive evidence of a different cement content is available.

(j) Where members have been tested and impregnated under A1.7(c), and chloride ion concentrations are greater than 0.3 per cent by weight of cement in any of the test areas, these members shall be monitored for half-cell potentials during future Principal Inspections. Other ongoing management strategies shall also be considered.

APPENDIX 2 - NEW TEST METHODS DEVELOPED BY TRL, TO BE INCLUDED IN EUROPEAN STANDARDS, TO DETERMINE THE PERFORMANCE AND ACCEPTANCE OF PORE-LINING IMPREGNANTS

TEST 1: DRYING TEST FOR SURFACE IMPREGNANTS (prEN 13579)

A2.1 Scope

This Appendix includes details of a draft European Standard which specifies a test method to evaluate the effect of hydrophobic impregnation on the drying rate coefficient of impregnated specimens.

A2.2 Normative references

This Appendix incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this Appendix only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1766, *Products and systems for the protection and repair of concrete structures - Test methods - Reference concretes for testing*.

EN 13580, *Products and systems for the protection and repair of concrete structures - Test methods - Water absorption and resistance to alkali for hydrophobic impregnations.*

A2.3 Symbols

Symbol	Explanation	Unit
C_n	Consumption of impregnant for each face of test cube during treatment	g/m^2
C_m	Mean consumption of impregnant during treatment	g/m^2
d_0	Weight of a test cube prior to placing in environmental cabinet	g
d_1	Weight of a test cube after initial conditioning in environmental cabinet	g
d_2	Weight of a test cube at end of drying test	g
DRC	Drying Rate Coefficient	%
D_t	Drying rate of a treated test cube	g/m^2 × h
D_{tm}	Mean drying rate of three treated test cubes	g/m^2 × h
D_u	Drying rate of an untreated test cube	g/m^2 × h
D_{um}	Mean drying rate of three untreated test cubes	g/m^2 × h

Symbol	Explanation	Unit
M'_t	Estimated moisture content of each test cube after conditioning	%
M_m	Mean saturated surface dry moisture content of 3 oven dry test cubes	%
M_{ssd}	Saturated, surface dry moisture content of a test cube, calculated	%
W'_{od}	Estimated weight of a test cube in oven dry condition	g
W_{od}	Weight of a test cube in oven dry condition	g
W_{ssd}	Weight of a test cube in saturated surface dry condition	g
W_t	Actual weight of test cube after conditioning	g
W_{t1}	Weight of test cube immediately prior to treatment	g
W_{t2}	Weight of test cube immediately after treatment	g

A2.4 Principle

The principle of the test method described in this Appendix is to compare the rate of drying of treated and untreated test cubes from the same batch of concrete. The ratio of the rates is defined as the drying rate coefficient.

A2.5 Apparatus

A2.5.1 Nine moulds for concrete cubes (100 mm x 100 mm x 100 mm).

A2.5.2 Soft brush.

A2.5.3 Absorbent paper towel

A2.5.4 Balance with an accuracy of 0,01 g.

A2.5.5 Support for test cubes on bench in laboratory or in fume cupboard to allow air to circulate around all 6 faces.

A2.5.6 Laboratory or chamber maintained at constant temperature (21 ± 2) °C and relative humidity of (60 ± 10) %.

A2.5.7 Forced air circulation oven to run at (105 ± 5) °C.

A2.5.8 Desiccator cabinet containing silica gel.

A2.5.9 Fume cupboard.

A2.5.10 One 150 mm diameter petri dish with 2 spacers glued to bottom of dish to support the test cubes during treatment.

A2.5.11 Suitable environmental cabinet which maintains temperature at (30 ± 2) °C and relative humidity of (40 ± 5) %.

A2.5.12 Two suitable air tight boxes containing saturated potassium sulphate solution for storing specimens. Note that treated and untreated test cubes must be stored in separate boxes.

A2.6 Preparation of test specimens

Nine 100 mm concrete test cubes shall be cast from a single batch of Type C (0,45) concrete and cured for 28 days according to EN 1766. No oil or release agent will be permitted on the surface of the moulds (A2.5.1). After removal from the curing tank, the test cubes shall be cleaned with tap water using a soft brush (A2.5.2) to remove any loose material. The surface of the test cubes shall not be grit blasted. The test cubes shall be surface dried with an absorbent paper towel (A2.5.3) and then weighed (W_{ssd}) using the balance (A2.5.4).

Six test cubes (No. 1 - 6), suitably supported to allow air to circulate around each of the 6 faces (A2.5.5), shall be conditioned on a bench in the laboratory (temperature (21 ± 2) °C and relative humidity (60 ± 10 %) (A2.5.6) for 7 days and reweighed (W_t). The remaining three test cubes (No. 7 - 9) shall be dried in an oven at (105 ± 5) °C (A2.5.7) for 7 days, cooled in a desiccator cabinet containing silica gel (A2.5.8) and reweighed (W_{od}).

The saturated surface dry moisture content (M_{ssd}) of the 3 oven dry test cubes (No. 7 - 9), shall be calculated using the following formula:

$$M_{ssd} = \frac{W_{ssd} - W_{od}}{W_{od}} \cdot 100 \text{ in \% by weight}$$

The estimated oven dry weight (W'_{od}) of each of the remaining 6 test cubes (No. 1 - 6) shall be calculated using the formula:

$$W'_{od} = \frac{W_{ssd}}{1 + \left(\frac{M_m}{100} \right)} \text{ in g}$$

where M_m in % by weight is the mean saturated surface dry moisture content of the 3 oven dry test cubes (No. 7 - 9).

The estimated moisture content (M'_t) of each of the test cubes after conditioning shall be calculated from the weight, W_t:

$$M'_t = \frac{W_t - W'_{od}}{W'_{od}} \cdot 100 \text{ in \% by weight}$$

The test cubes (No. 1 - 6) shall be weighed daily during conditioning from the fourth day until the weight W_t obtained is equivalent to a moisture content of (5,0 ± 0,5) %.

A2.7 Treatment

Three test cubes from the batch shall be treated in a fume cupboard (A2.5.9) with the fan on immediately after conditioning.

Each cube shall be treated by dipping each face in the impregnant. Immediately prior to treatment of each face, the cube shall be weighed (W_{t1}). 60 ml of the material shall be measured into a petri dish 150 mm in diameter (A2.5.10). One side of the cube, supported on the 2 mm plastic spacers, shall be dipped in the material for (120 ± 5) s and then removed. Excess liquid on the cube shall be allowed to drain back into the dish and the cube immediately reweighed (W_{t2}). The excess material in the dish is then to be discarded. This procedure shall be repeated for first side of the other two cubes.

The consumption (C_n) of the material for each face of the cube shall be calculated as follows:

$$C_n = \frac{W_{t2} - W_{t1}}{0{,}01} \text{ in grams by square meters}$$

The above procedure shall be repeated on the remaining six faces of each of the cubes and the average consumption for each cube shall be calculated.

The mean consumption (C_m) for the three test cubes shall be calculated.

If the consumption is below the manufacturer's recommended value the time of dipping can be extended.

If it is not practical to treat test cubes by this method, the treatment should be carried out in accordance with the manufacturer's instructions.

The cubes shall be stored, suitably supported to allow air to circulate around all 6 faces, in the fume cupboard for (48 ± 1) h after the start of treatment with the fan off.

A2.8 Test procedure

General

The drying test shall be carried out on 3 treated and 3 untreated test cubes prepared as in sections A1.6 and A1.7 above.

The rate of drying of three treated and three untreated test cubes shall be determined by measuring their weight loss in an environmental cabinet. The treated and untreated test cubes must be tested at different times to avoid cross contamination.

The drying tests on the untreated test cubes shall be started immediately after the conditioning. The drying test on the treated test cubes shall be started 48 h after treatment.

Untreated test cubes

The 3 untreated test cubes shall be weighed (d_0) and placed in a cabinet with a controlled environment of (30 ± 2) °C and (40 ± 5) % R. H. (A2.5.11) immediately after conditioning and reweighed (d_1) after (6,0 ± 0,1) h. The drying test shall be continued for further (18,0 ± 0,1) h. The test cubes shall again be weighed (d_2) and the drying rate (D_u) of each test cube shall be calculated as:

$$D_u = \frac{d_1 - d_2}{18 \cdot 0{,}06} \text{ in } \frac{g}{m^2 \cdot h}$$

NOTE In practice, $d_0 = W_t$.

Treated test cubes

The 3 treated test cubes shall be weighed (48 ± 1) h after the start of treatment (d_0) and then placed in the cabinet with a controlled environment of (30 ± 2) °C and (40 ± 5) % R. H. The test cubes shall be reweighed after (24,0 ± 0,1) h (d_1). This weight (d_1) shall be less than the weight (W_t) of the test cube after conditioning and immediately prior to treatment; if $d_1 > W_t$ then the test cubes shall be weighed after further periods in the cabinet until $d_1 < W_t$. The drying test shall then continue for further (24,0 ± 0,1) h. The test cubes shall then be reweighed (d_2) and the drying rate (D_t) of each test cube shall be calculated:

$$D_t = \frac{d_1 - d_2}{24 \cdot 0{,}06} \text{ in } \frac{g}{m^2 \cdot h}$$

The drying rate coefficient (*DRC*) shall be calculated as:

$$DRC = \frac{D_{tm}}{D_{um}} \cdot 100 \text{ in \%}$$

where D_{tm} is the mean drying rate of the three treated test cubes and D_{um} is the mean drying rate of the untreated test cubes.

If there is a requirement to determine the water absorption and alkali resistance of the impregnant as specified in prEN 13580, it is permitted to use the test cubes from the drying test. In this case, the treated and untreated test cubes shall be stored in separate air tight boxes over a saturated solution of potassium (A2.5.12) sulfate immediately after the end of the drying test until required for further testing.

A2.9 Test report

The test report shall contain at least the following information:

a) a reference to the European Standard;

b) name and address of the test laboratory;

c) identification number and date of the test report;

d) name and address of the manufacturer or supplier of the product(s);

e) name and identification marks or batch number of the product(s);

f) date of supply of the product;

g) date of preparation of the test specimens and any deviation from the prescribed method of preparation;

h) numbering of cubes;

i) details of the concrete mix design;

j) conditions of storage of prepared specimens prior to test;

k) the mean saturated surface dry moisture content of the test cubes;

l) the mean moisture content of the test cubes after conditioning;

m) the mean consumption of the impregnant;

n) the drying rate coefficient;

o) date of test and details of the test equipment used;

p) any deviation from the test method specified;

q) date of the report and signature;

r) any other observations.

A2.10 Requirements

In order for an impregnant to be acceptable for use on Highways Agency structures it must be tested on cubes from two separate batches of concrete cast at different times and the mean result from the two batches must satisfy the criteria given below:

Drying Rate Transmission Coefficient	DRC	>30%

Annex a
(informative)

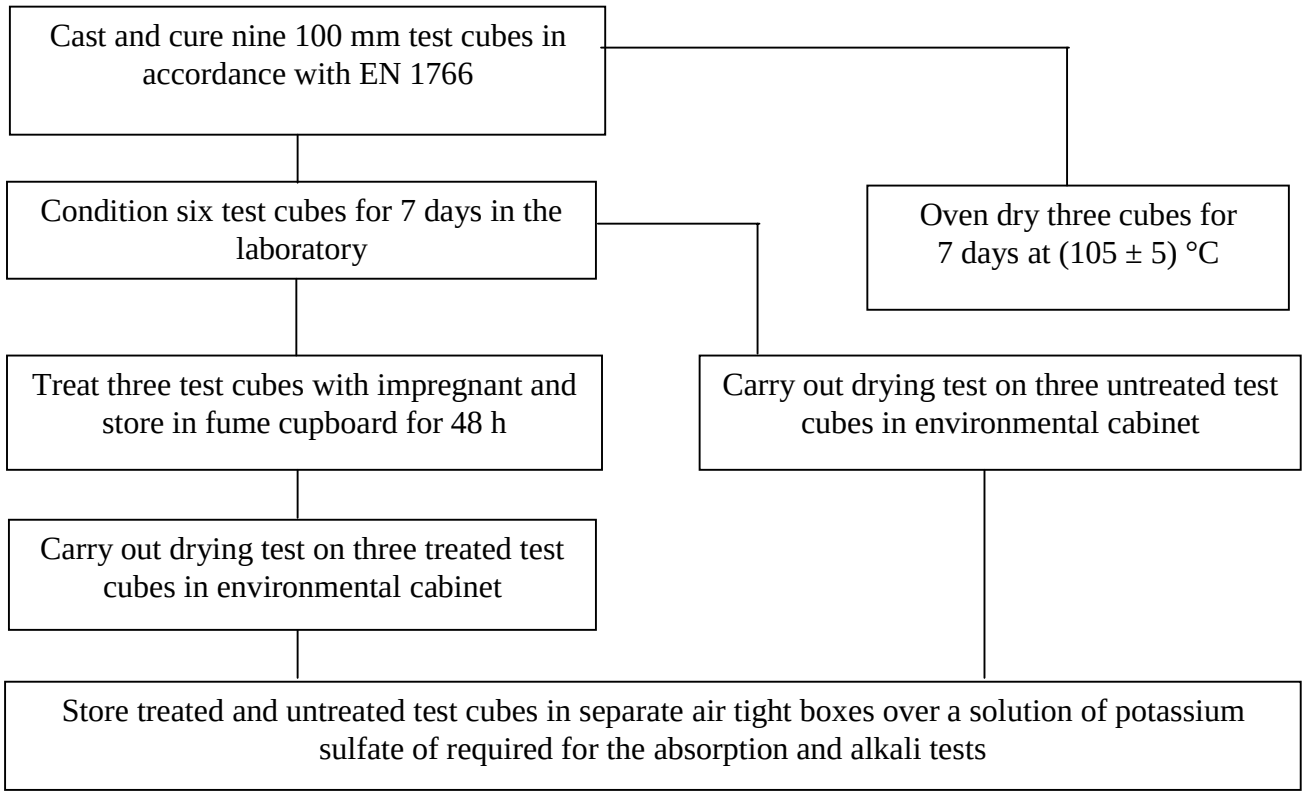


Figure A2.1: Flow Chart of Test Procedure for Drying Test

TEST 2: WATER ABSORPTION AND RESISTANCE TO ALKALI TESTS FOR SURFACE IMPREGNANTS (prEN13580)

A2.11 Scope

This Appendix includes details of a draft European Standard which specifies a test method to evaluate the effect of a hydrophobic impregnation. It deals with the rate at which treated concrete absorbs water and the alkali resistance of that surface treatment. The method primarily relates to the protection of concrete structures.

A2.12 Normative references

This Appendix incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this Appendix only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 1766, *Products and systems for the protection and repair of concrete structures – Test methods – Reference concretes for testing.*

prEN 13579, *Products and systems for the protection and repair of concrete structures – Test methods – Drying test for hydrophobic impregnation.*

A2.13 Symbols

Symbol	Explanation	Unit
AR	Absorption ratio	%
$AR_{(alk)}$	Absorption ratio after exposure to alkali	%
C_m	Mean consumption of impregnant during treatment	g/m^2
C_n	Consumption of impregnant for each face of test cube during treatment	g/m^2
i_1	Weight of a test cube at start of immersion test	g
i_2	Weight of a test cube at end of immersion test	g
I_t	Rate of increase in weight of a treated test cube	$g/(m^2 \times h^{0,5})$
$I_{t(alk)}$	Rate of increase in weight of a treated test cube after exposure to alkali	$g/(m^2 \times h^{0,5})$
I_{tm}	Mean rate of increase in weight of three treated test cubes	$g/(m^2 \times h^{0,5})$
$I_{tm(alk)}$	Mean rate of increase in weight of three treated test cubes after exposure to alkali	$g/(m^2 \times h^{0,5})$
I_u	Rate of increase in weight of an untreated test cube	$g/(m^2 \times h^{0,5})$
I_{um}	Mean rate of increase in weight of three untreated test cubes	$g/(m^2 \times h^{0,5})$
M'_t	Estimated moisture content of each test cube after conditioning	%

Symbol	Explanation	Unit
M_m	Mean saturated surface dry moisture content of 3 oven dry test cubes	%
M_{ssd}	Saturated surface dry moisture content of a test cube	%
W'_{od}	Estimated weight of a test cube in oven dry condition	g
W_{od}	Weight of a test cube in oven dry condition	g
W_{ssd}	Weight of a test cube in saturated surface dry condition	g
W_t	Actual weight of test cube after conditioning	g
W_{t1}	Weight of test cube immediately prior to treatment	g
W_{t2}	Weight of test cube immediately after treatment	g

A2.14 Principle

Impregnants applied to the surface of the concrete reduce the ingress of water and salt solutions into concrete. The principle of the test method described in this standard is to compare rate of uptake of water of treated and untreated test cubes from the same batch of concrete. The ratio of the rates is defined as the absorption ratio. The long-term durability is assessed by measuring the water absorption after a defined exposure to alkali.

A2.15 Apparatus

A2.15.1 Nine moulds for concrete cubes (100 mm x 100 mm x 100 mm).

A2.15.2 Soft brush

A2.15.3 Absorbent paper towel

A2.15.4 Balance with an accuracy of 0,01 g.

A2.15.5 Support for test cubes on bench in laboratory or in fume cupboard to allow air to circulate around all 6 faces.

A2.15.6 Laboratory or chamber maintained at constant temperature (21 ± 2) °C and relative humidity of (60 ± 10) %

A2.15.7 Forced air circulation oven to run at (105 ± 5) °C.

A2.15.8 Desiccator cabinet containing silica gel.

A2.15.9 Fume cupboard.

A2.15.10 Two suitable air tight boxes containing saturated potassium sulphate solution for storing specimens. Note that treated and untreated test cubes must be stored in separate boxes.

A2.15.11 One 150 mm diameter petri dish with 2 spacers glued to bottom of dish to support the test cubes during treatment

A2.15.12 Demineralised water (conductivity < 50 µS).

A2.15.13 Six 5 l beakers with suitable spacers to support test cubes.

A2.15.14 Potassium-hydroxide solution (5,6 g/l).

A2.15.15 Cling film.

A2.16 Preparation of test specimens

Nine 100 mm concrete test cubes shall be cast from a single batch of Type C (0.45) concrete and cured for 28 days according to EN 1766. No oil or release agent will be permitted on the surface of the moulds (A2.15.1). After removal from the curing tank, the test cubes shall be cleaned with tap water using a soft brush (A2.15.2) to remove any loose material. The surface of the test cubes shall not be grit blasted. The test cubes shall be surface dried with an absorbent paper towel (A2.15.3) and then weighed (W_{ssd}) using the balance (A2.15.4).

Six test cubes (No. 1 - 6), suitably supported to allow air to circulate around each of the 6 faces (A2.15.5), shall be conditioned on a bench in the laboratory (temperature (21 ± 2) °C and relative humidity (60 ± 10) %) (A2.15.6) for 7 days and reweighed (W_t). The remaining three test cubes (No. 7 - 9) shall be oven dried at (105 ± 5) °C (A2.15.7) for 7 days, cooled in a desiccator cabinet containing silica gel (A2.15.8) and reweighed (W_{od}).

The saturated surface dry moisture content (M_{ssd}) of the 3 oven dry test cubes (No. 7 – 9), shall be calculated using the following formula:

$$M_{ssd} = \frac{W_{ssd} - W_{od}}{W_{od}} \cdot 100 \text{ in percentage by weight}$$

The estimated oven dry weight (W'_{od}) of each of the remaining 6 test cubes (No. 1 - 6) shall be calculated using the formula:

$$W'_{od} = \frac{W_{ssd}}{1 + \left(\frac{M_m}{100}\right)} \text{ in grams}$$

where

M_m is the mean saturated surface dry moisture content of the 3 oven dry test cubes (No. 7 - 9), in percentage by weight.

The estimated moisture content (M'_t) of each of the test cubes after conditioning shall be calculated from the weight, W_t

$$M'_t = \frac{W_t - W'_{od}}{W'_{od}} \cdot 100 \text{ in percentage by weight}$$

The test cubes (No. 1 - 6) shall be weighed daily during conditioning from the fourth day until the weight W_t obtained is equivalent to a moisture content of (5,0 ± 0,5) %.

A2.17 Treatment

Three test cubes from the batch shall be treated in a fume cupboard (A2.15.9) with the fan on immediately after the conditioning. The 3 untreated test cubes shall be placed in an airtight box (A2.15.10) over a saturated solution of potassium sulphate until required for the absorption test.

Each cube shall be treated by dipping each face in the impregnant. Immediately prior to treatment of each face, the cube shall be weighed (W_{t1}). 60 ml of the material shall be measured into a petri dish 150 mm in diameter (A2.15.11). One side of the cube, supported on the 2 mm plastic spacers, shall be dipped in the material for (120 ± 5) s, and then removed. Excess liquid on the cube shall be allowed to drain back into the dish and the cube immediately reweighed (W_{t2}). The excess material in the dish is then to be discarded. This procedure shall be repeated for first side of the other two cubes.

The consumption (C_n) of the material for each face of the cube shall be calculated as follows:

$$C_n = \frac{W_{t2} - W_{t1}}{0{,}01} \text{ in grams by square metres}$$

The above procedure shall be repeated on the remaining faces of each of the cubes and the average consumption for each cube shall be calculated.

The mean consumption (C_m) for the three test cubes shall be calculated.

If the consumption is below the manufacturer's recommended value the time of dipping can be extended.

If it is not practical to treat test cubes by this method, the treatment should be carried out in accordance with the manufacturer's instructions.

The cubes shall be stored, suitably supported to allow air to circulate around all 6 faces, in the fume cupboard (A2.15.9) for (48 ± 1) h after the start of treatment with the fan off. The treated cubes shall then be stored over a saturated potassium sulphate solution in an airtight box.

Note that it is essential that the treated and untreated cubes are stored in separate boxes.

A2.18 Test procedure

The tests shall either be carried out on 3 treated and 3 untreated test cubes, prepared as described in sections 6 and 7 above or on test cubes that have been used previously for the drying test as described in prEN 13579. In both cases, the absorption test shall commence 14 days after treatment.

Sufficient demineralised water (Conductivity < 50 µS) (A2.15.12) shall be placed into each of the 6 beakers (A2.15.13) so that each test cube supported on a spacer will be fully covered with a head of (25 ± 5) mm. The three treated and the three untreated test cubes shall each be weighed (i_1) and immersed in demineralised water. The treated and untreated test cubes shall be removed from the water after (24,0 ± 0,1) hours and (1,00 ± 0,02) hour respectively, surface dried with an absorbent cloth and reweighed (i_2).

The rate of increase in weight for each treated test cube (I_t) shall be calculated from the equation:

$$I_t = \frac{i_2 - i_1}{\sqrt{24} \cdot 0{,}06} \text{ in } \frac{g}{m^2 \cdot h^{0,5}}$$

and for each untreated test cube from the equation:

$$I_u = \frac{i_2 - i_1}{\sqrt{1} \cdot 0{,}06} \text{ in } \frac{g}{m^2 \cdot h^{0,5}}$$

The absorption ratio (*AR*) shall be calculated:

$$AR = \frac{I_{tm}}{I_{um}} \cdot 100 \text{ in percentage}$$

where

I_{tm} is the mean rate of weight gain of the three treated test cubes ; and

I_{um} is the mean rate of weight gain of the untreated test cubes.

Immediately after the immersion test, the three treated test cubes shall be placed in individual beakers containing sufficient potassium hydroxide solution (5,6 g/l) (A2.15.14) to fully cover a test cube supported on a spacer with a head of (25 ± 5) mm. The beakers are securely covered with cling film (A2.15.15) and left for (21 ± 0,1) days. The test cubes shall be removed from the beakers and dried, suitably supported on a bench to allow air to circulate around each of the 6 faces, in the laboratory, until their weight is within ± 2 g of their weight prior to the start of the immersion test (i_1). A second immersion test shall be carried out and the rate of increase in weight of each treated test cube after the alkali test $I_{t(alk)}$ calculated. The absorption ratio (AR_{alk}) shall be calculated by:

$$AR_{alk} = \frac{I_{tm(alk)}}{I_{um}} \cdot 100 \text{ in percentage}$$

where

$I_{tm(alk)}$ is the mean rate of weight gain of the three test cubes after immersion in alkali, in grams.

A2.19 Test report

The test report shall contain at least the following information:

a) a reference to the European Standard;

b) name and address of the test laboratory;

c) identification number and date of the test report;

d) name and address of the manufacturer or supplier of the product(s);

e) name and identification marks or batch number of the product(s);

f) date of supply of the product;

g) date of preparation of the test specimens and any deviation from the prescribed method of preparation;

h) numbering of cubes;

i) details of the concrete mix design;

j) conditions of storage of prepared specimens prior to test;

k) the mean saturated surface dry moisture content of the test cubes;

l) the mean moisture content of the test cubes after conditioning;

m) the mean consumption of the impregnant;

n) the absorption ratio before and after exposure to alkali;

o) date of test and details of the test equipment used;

p) any deviation from the test method specified;

q) date of the report and signature;

r) any other observations.

A2.20 Requirements

In order for an impregnant to be acceptable for use on Highways Agency structures it must be tested on cubes from two separate batches of concrete cast at different times and the mean result from the two batches must satisfy the criteria given below:

Absorption Ratio	AR	<7.5%
Absorption Ratio after immersion in alkali	$AR_{(alk)}$	<10%

Annex B
(informative)

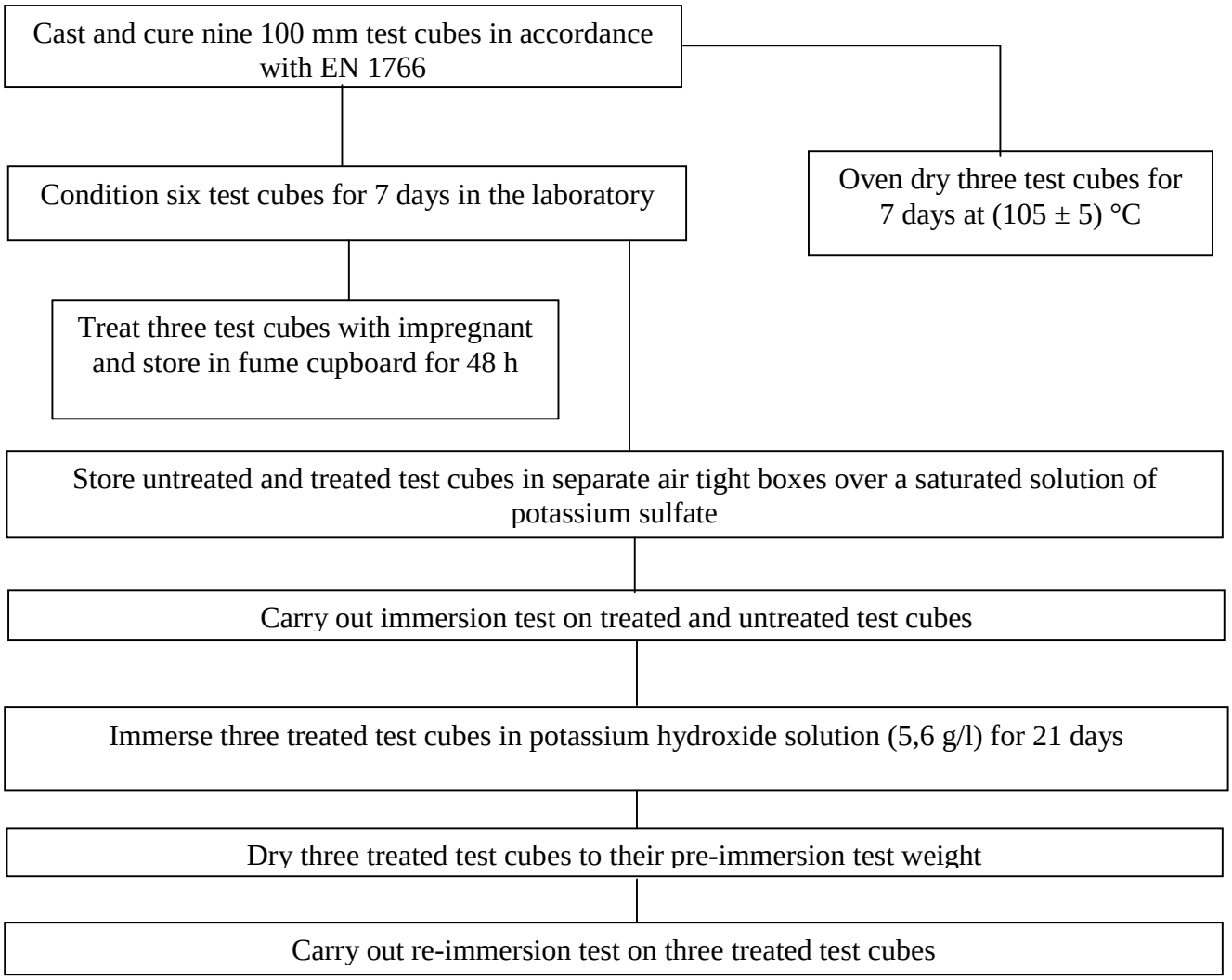


Figure A2.2: Flow chart of test procedure for absorption and resistance to alkali test