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Transport Infrastructure Ireland

TII Publications

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Criteria and Material for the Impregnation of Concrete Highway Structures

Withdrawn

DN-STR-03008
December 2000

DN Design

Standards

About TII

Transport Infrastructure Ireland (TII) is responsible for managing and improving the country's national road and light rail networks.

About TII Publications

TII maintains an online suite of technical publications, which is managed through the TII Publications website. The contents of TII Publications is clearly split into 'Standards' and 'Technical' documentation. All documentation for implementation on TII schemes is collectively referred to as TII Publications (Standards), and all other documentation within the system is collectively referred to as TII Publications (Technical). This system replaces the NRA Design Manual for Roads and Bridges (NRA DMRB) and the NRA Manual of Contract Documents for Road Works (NRA MCDRW).

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Document Attributes

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NRA DMRB and MCDRW References

For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

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NRA ADDENDUM TO

BD 43/90

CRITERIA AND MATERIAL FOR THE IMPREGNATION OF CONCRETE HIGHWAY STRUCTURES

Standard BD 43/90 - Criteria and Material for the Impregnation of Concrete Highway Structures - is applicable in Ireland with the following amendments:

GENERAL

1. The Standard provides specification requirements for use in public purchasing contracts. It does not lay down legislation requirements for products and materials used in road construction in Ireland.

2. At several locations:

   For: "Departmental Standard"
   Read: "Standard";

   For: "highway"
   Read: "road".

SPECIFIC

1. Page 1, Paragraph 3.1:
   Delete Paragraph 3.1 and replace with:
   "The provisions of the various statutory or National Road Authority's requirements for safety shall be observed. These include the Safety, Health and Welfare at Work Act 1989 [1], the Factories Act, 1959 [2] with its associated Regulations, the Safety, Health and Welfare at Work (Construction) Regulations 1995 [7], the National Road Authority's own requirements, and the Railway Authorities' requirements for work on or near running lines."

2. Page 1, Paragraph 3.2, line 1:
   For: "Health and Safety Executive"
   Read: "Health and Safety Authority".

3. Page 2, Paragraph 5.2(b), line 2:
   For: "the National Measurement Accreditation Service (NAMAS)"
   Read: "the Irish Laboratory Accreditation Board (ILAB)".

4. Page 3, Paragraphs 5.2(d) to (f):
   Delete Paragraphs 5.2(d) to (f) and replace with:
   "(d) Reinforced concrete members being considered for impregnation shall be tested to ascertain the half-cell potentials, chloride concentrations and depths of cover. The location and extent of testing shall be determined to suit the particular circumstances.
   (e) As a guide, testing should be undertaken in areas where exposure to chloride salts is likely to be greatest. Typical areas include upper areas of abutments or piers where staining indicates that the

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deck joint may have leaked, or the traffic faces of substructures or parapets which may have been subject to traffic spray.

(f) It is recommended that half-cell potentials and depth of cover be measured on a 500mm grid over each test area. Dust samples for chloride analysis should be taken at appropriate intervals as described in Paragraph 5.2(g)."

5. Pages 4 and 5, Figures 1 and 2:
Delete Figures 1 and 2.
[Note: Figures 1 and 2 were prepared for a study of 200 concrete bridges for the UK Department of Transport. They were intended for a statistically random sample and are not appropriate for identifying the worst areas of contamination.]

6. Page 6, Section 6:#
Delete text and replace with:
"6. SPECIFICATION FOR SURFACE IMPREGNATION
6.1 The material for the surface impregnation of concrete shall be silane or siloxane in accordance with Clause 1709 of the NRA Specification for Road Works [8]. It shall be applied in accordance with that clause."

Page 8, Section 7:
Delete text and replace with:
"7. NOTES FOR GUIDANCE
7.1 For advice on the specification for the surface impregnation of concrete, refer to Clause NG 1709 of the NRA Notes for Guidance on the Specification of Road Works [9]."

7. Page 9, Section 8, Reference [1] and [2]:
Delete References [1] and [2] and replace with:
"[1] Health, Safety and Welfare at Work Act 1989.
[2] Factories Act 1959";

8. Page 9, Section 8:
Add the following references:
"[7] Safety, Health and Welfare at Work (Construction) Regulations 1995.
[8] NRA Manual of Contract Documents for Road Works, Volume 1: Specification for Road Works.
[9] NRA Manual of Contract Documents for Road Works, Volume 2: Notes for Guidance on the Specification for Road Works."

10. Page 10, Section 9:
Delete text and replace with:
"9.1 All technical enquiries or comments on this Standard should be sent in writing to:

Head of Project Management and Engineering
National Roads Authority
St Martin's House
Waterloo Road
Dublin 4"]

……

E O'CONNOR
Head of Project Management and Engineering

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BD 43/90

DEPARTMENT OF TRANSPORT

HIGHWAYS AND TRAFFIC

DEPARTMENTAL STANDARD BD 43/90

CRITERIA AND MATERIAL FOR THE IMPREGNATION OF CONCRETE HIGHWAY STRUCTURES

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SUMMARY:

This standard gives criteria and specification clauses for the protection of concrete highway structures against reinforcement corrosion.

SUBJECT AREA:

Bridges and Structures

Printed and Published by

THE DEPARTMENT OF TRANSPORT

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NORTHERN IRELAND ADDENDUM

TO

DEPARTMENTAL STANDARD BD43/90

CRITERIA AND MATERIAL FOR THE IMPREGNATION OF CONCRETE HIGHWAY STRUCTURES

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Departmental Standard BD43/90 - Criteria and Material for the Impregnation of Concrete Highway Structures - becomes applicable for use in Northern Ireland with the following amendments:-

1. Page 9, Reference 3 should be withdrawn as it does not apply to Northern Ireland.

BD 43/90

CRITERIA AND MATERIAL FOR THE IMPREGNATION OF CONCRETE HIGHWAY STRUCTURES

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1. INTRODUCTION

1.1 This Departmental Standard gives criteria and specification clauses for the impregnation of reinforced and prestressed concrete members of highway structures to prevent chloride induced reinforcement corrosion from de-icing salts and marine environments.

1.2 It should be read in conjunction with Departmental Advice Note BA 33/90, Impregnation of Concrete Highway Structures.

2. SCOPE

2.1 This Departmental Standard shall apply to reinforced and prestressed concrete members in new construction and in existing structures. Structures in service less than 6 years old do not require to meet site test criteria before impregnation. For structures in service more than 6 years old, certain members are required to meet site test criteria.

3. SAFETY

3.1 The provisions of the various statutory or Authority's requirements for safety shall be observed. These include the Health and Safety at Work etc Act 1974 [1], the Factories Act 1961 [2] with its associated Regulations and the Department's own requirements for work on its properties, and the Railway's requirements for work on or near running lines.

3.2 The Engineer shall consult the Environmental Health Officer, the Health and Safety Executive, Water Authority and any other interested parties as soon as the scale and location of the work is known so that any precautions considered necessary can be arranged.

4. NEW CONSTRUCTION AND STRUCTURES IN SERVICE LESS THAN 6 YEARS OLD

4.1 The Engineer shall decide on the members to be impregnated. Guidance is given in BA 33/90. Structures in these categories do not require testing before impregnation.

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5. STRUCTURES IN SERVICE MORE THAN 6 YEARS OLD

5.1 General

(a) The Engineer shall decide on the members to be impregnated. Guidance is given in BA 33/90.

(b) Members to be treated shall be free from rust staining, cracking and spalling.

(c) Certain reinforced concrete members 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 concrete members do not require testing before impregnation.

5.2 Site Test Criteria

(a) The following members shall satisfy the criteria for half-cell potential in Clause 5.2(c) before being considered for impregnation:-

(i) Piers
(ii) Columns
(iii) Crossheads
(iv) Abutments
(v) Wingwalls and retaining walls
(vi) Parapets
(vii) Parapet plinths

(b) Site sampling and testing shall only be carried out by specialist testing firms or laboratories which have been approved by the National Measurement Accreditation Service (NAMAS) for laboratory testing or by equivalent accreditation bodies.

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

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(d) For reinforced piers, columns, crosssheads 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 1. For reinforced 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 2. 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 2, 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 5.2(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. 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 5.2 (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. 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 5.2 (g).

(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 [4] 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 Engineer.

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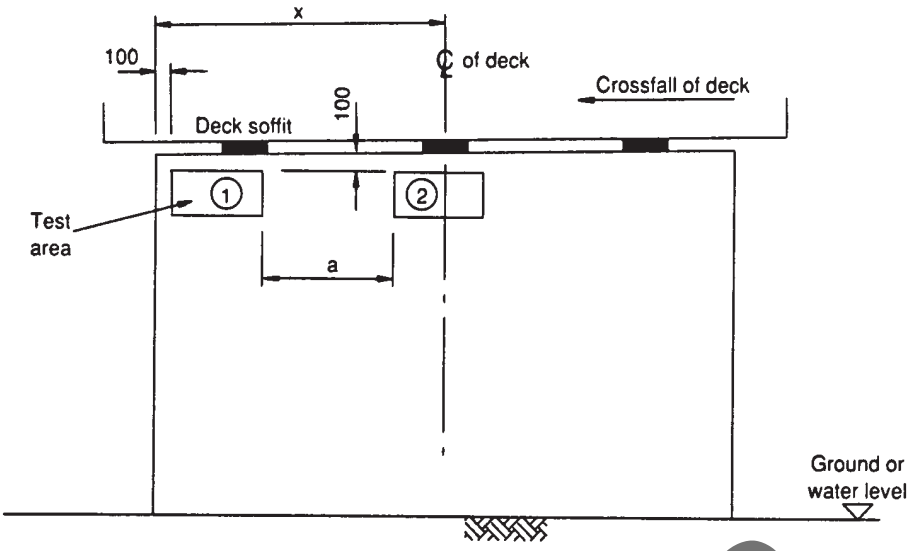
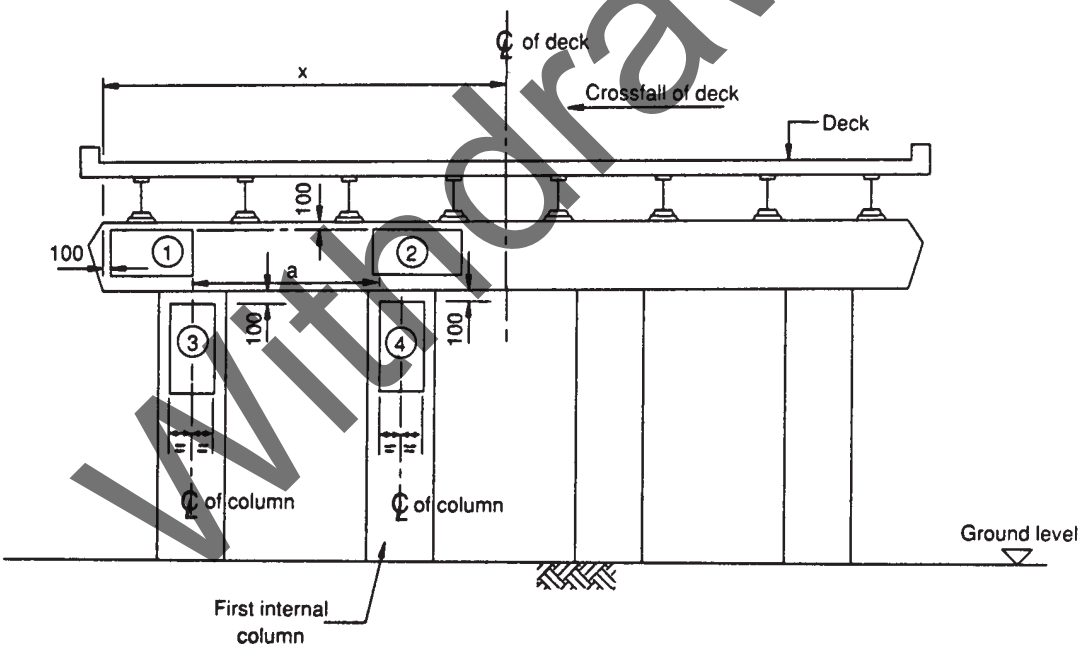


LEAF PIERS AND ABUTMENTS



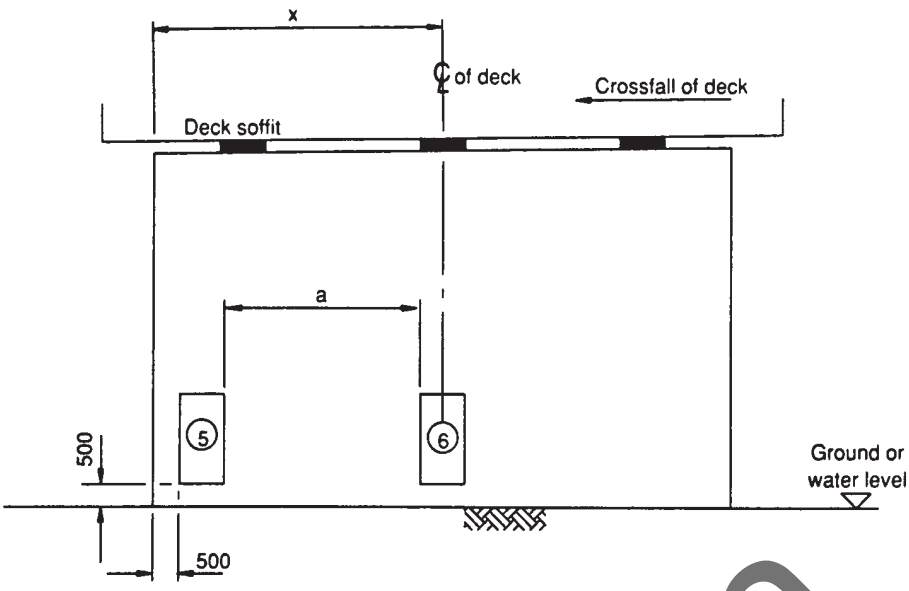
COLUMNS AND CROSSHEAD

Withdrawn

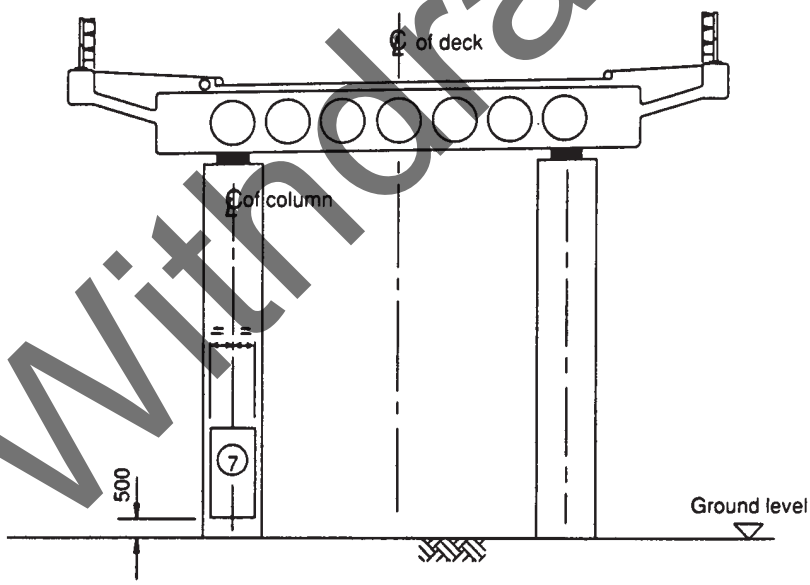
NOTES

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

Figure 1: 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 centerline of the bridge deck.
2. Test areas shall be 2m x 1m unless otherwise specified.
3. Diagrams not to scale.

Figure 2: LOCATION OF TEST AREAS FOR REINFORCED PIERS, ABUTMENTS AND COLUMNS SUBJECT TO SALT SPRAY FROM TRAFFIC

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(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 [5], except that: calcium carbonate shall be used to neutralise the solution [4]. 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 [4]. 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 Clause 5.2(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 Principal Inspections.

6. SPECIFICATION FOR SURFACE IMPREGNATION

6.1 General

(a) Impregnation shall be applied to those surfaces described in the Contract in accordance with the manufacturer's instructions unless otherwise agreed by the Engineer.

6.2 Material

(a) The material for impregnation shall be Monomeric alkyl (isobutyl)-trialkoxy-silane with a minimum active content of 95% delivered to site in sealed containers. The 5% fraction shall not contain hydrocarbon solvents. In respect of specific gravity and refractive index the material shall comply with the values stated in the manufacturers product specification.

(b) The Contractor shall provide with each delivery a certificate that the material in that delivery complies with Clause 6.2(a). No material shall be used in the Works until this certificate of compliance has been accepted by the Engineer.

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(c) The material shall be stored in a dry frost free environment protected from direct heat.

(d) The containers shall remain sealed until their contents are required for use. The contents of any opened container shall be used within 48 hours or discarded.

6.3 Equipment

(a) A continuously circulating pumped system at a nozzle pressure of 0.06 - 0.07 N/mm^2 shall be used to apply the material. Water shall be prevented from entering any part of the equipment.

6.4 Surface Condition

(a) Areas to be treated shall where necessary 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.

(b) Surfaces shall be free from loose or deleterious matter and residues of curing membranes and release agents. The Contractor shall demonstrate to the Engineer that any harmful residual effects from the application of curing membranes are not present before impregnation commences. Existing structures shall be hand brushed with a stiff bristle brush to remove surface deposits.

(c) Water jetting shall not be used as a means of surface preparation.

6.5 Application

(a) Impregnation shall be carried out as a series of continuous operations in a sequence agreed by the Engineer.

(b) Impregnation shall be carried out at not less than 28 days after the concrete has been placed, or 14 days where concrete repairs have been completed.

(c) The material shall be applied by continuous spray technique giving saturation flooding, working from the lowest level upwards. Two applications shall be made each at a coverage of 300 ml/m^2 with an interval between each of at least six hours.

(d) Impregnation shall not be carried out in the following conditions:-

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(i) When the shade temperature is below 5°C;

(ii) When the temperature of the concrete surface is greater than 25°C.

(e) Elastomeric bearings, painted steel surfaces, exposed bituminous materials and joint sealants adjacent to members to be impregnated shall be masked-off before impregnation.

(f) Members shall be protected from rain and traffic spray during application and for at least six hours after completion.

7. NOTES FOR GUIDANCE

NG 6.2(d) Silane hydrolises with moisture in the atmosphere. The contents of any opened containers should be used within 48 hours or discarded.

NG 6.3(a) The type of nozzle used and spraying distance should be in accordance with the manufacturer's instructions.

NG 6.4(a) 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.

NG 6.4(b) The Engineer should ensure that curing membranes, where they have been used have fully degraded before impregnation is carried out.

NG 6.5(c) During application, saturation flooding should give a run-down of approximately 150 mm and treated areas will initially have a "wet-look".

NG 6.5(e) Isobutyl silane has a temporary softening effect when it comes into contact with elastomeric bearings, painted steel surfaces, and bituminous materials and joint sealants, and these items should be protected during application.

Withdrawn

8. REFERENCES

1. Health and Safety at Work etc Act 1974.

2. Factories Act 1961.

3. Trunk Road Management and Maintenance Notice TRMM 2/88, Trunk Road and Motorway Structures - Records and Inspection.

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

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

6. Departmental Advice Note BA 33/90, Impregnation of Concrete Highway Structures.

Withdrawn

9. ENQUIRIES

Technical enquiries arising from the application of this Standard should be addressed to the TAA for that scheme. General technical enquiries or comments should be addressed to:

Head of Bridges Engineering Division
Department of Transport
St Christopher House
Southwark Street
LONDON SE1 OTE

Quoting reference:
BE 28/14/026

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