THE HIGHWAYS AGENCY BA 33/90

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT
FOR NORTHERN IRELAND

Impregnation of Concrete Highway Structures

Summary: This Advice Note gives guidance on the protection of concrete members on highway structures against reinforcement corrosion.

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BA 33/90

IMPREGNATION OF CONCRETE HIGHWAY STRUCTURES

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1. INTRODUCTION

1.1 Penetration of concrete by chloride ions from de-icing salts and marine environments 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 protect them against chloride attack before they come into service. For structures already in service, impregnation of reinforced and prestressed concrete members where corrosion is not yet occurring will protect them from further attack. Impregnation involves treating the concrete surface to form a water-repellent-but-vapour-permeable layer which protects the concrete from the ingress of water and salt and provides added protection against reinforcement corrosion.

1.2 The criteria and specification clauses for impregnation of reinforced and prestressed concrete highway structures are given in Departmental Standard BD 43/90.

2. SCOPE

2.1 This Advice Note gives guidance on impregnation of reinforced and prestressed concrete members of highway structures for new construction, for structures in service less than 6 years old, and structures in service more than 6 years old that satisfy certain site test criteria.

3. SAFETY

3.1 The provisions of the various statutory or Authority's requirements for safety should be observed. The main safety aspects with regard to work on the Department's properties are traffic signing, working near trafficked roads and running lines and precautions in handling the material for impregnation.

4. IMPREGNATION

4.1 Impregnation is carried out by spraying concrete surfaces with a hydrophobising material that achieves maximum penetration of the concrete and reacts with the silicates and moisture present. This produces a water-repellant but vapour-permeable layer that inhibits the ingress of water and chloride ion.

Effectiveness of this layer is determined by the quality of the hydrophobisation and the strength and permanence of the bond between the silane molecule and the substrate. Impregnation is known to be 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.

4.2 The depth of penetration will vary depending on concrete quality and moisture content. The application rates given in BD 43/90 are assumed to be appropriate for normal coverage using approved equipment. To obtain feedback, a record should be kept of the quantity of material used on treated areas and forwarded through the Regional Office to BE Division.

5. STRUCTURES TO BE IMPREGNATED

5.1 General

Structures to be impregnated are in the following categories:-

(a) New construction.

(b) Structures in service less than 6 years old.

(c) Structures in service more than 6 years old.

5.2 New Construction

New structures should be protected against de-icing salts before they come into service. New construction in a marine environment should be impregnated at the earliest opportunity.

5.3 Structures in Service less than 6 years old

These 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 is not considered necessary unless there are visual signs to the contrary ie rust staining, cracking and spalling. Where silicate based curing membranes have been used, it is possible that degradation of the membrane has not fully occurred. This may cause difficulties during application and reduce the effectiveness of impregnation. In these cases it may be necessary to carry out further impregnation at a later date.

5.4 Structures in Service more than 6 years old

Site testing for half-cell potentials and chloride contents should be confined to members specified in BD 43/90. These members are subjected to salt traffic spray and/or possible leakage from deck joints. Prestressed concrete members are not required to satisfy site test criteria before impregnation. To ensure that impregnation is only carried out on members where reinforcement corrosion is not yet occurring, the test criteria in BD 43/90 should be satisfied.

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. Members in this condition are classified 'fair' (see Figure 1).

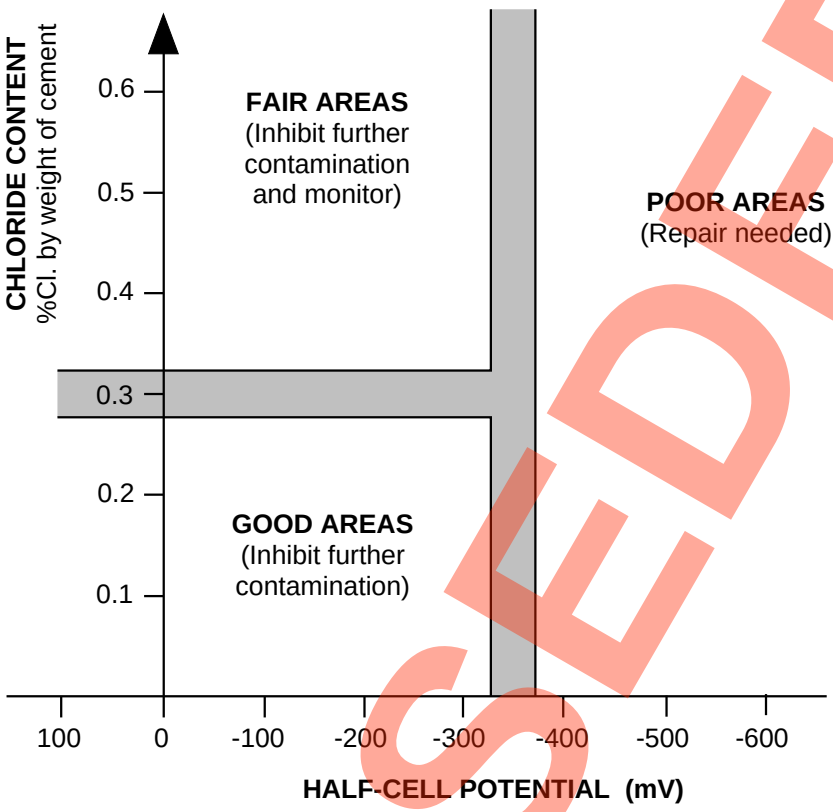

Figure 1 : THRESHOLDS FOR IMPREGNATION AND MONITORING STRUCTURES IN SERVICE MORE THAN 6 YEARS OLD

These members should be monitored during Principal Inspections for changes in half-cell potential measurements which indicate the on-set 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.

If tested members do not satisfy the criteria for impregnation then the Engineer should decide if non-tested areas selected for impregnation should alone be treated.

5.5 Programming

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

6. MEMBERS TO BE IMPREGNATED

6.1 Because of the wide variety of structural types and span arrangements etc, all parts of a structure are not equally at risk from chloride attack. Generally 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 members. It is highly desirable to treat all exposed reinforced and prestressed concrete surfaces subjected to salt traffic spray and/or possible leakage from deck joints. The following is intended as a guide:-

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

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

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

(d) Structures in marine environments and columns and soffits over brackish water.

(e) Where possible concrete parapets and parapet plinths (all inclinations) and those areas not protected with deck waterproofing.

(f) Deck beams and soffits directly over the carriageway.

(g) Parts of wingwalls within 8 metres of the edge of carriageway.

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

6.2 A record should be made of the members treated on the Maintenance Manual for new construction, and on the Structures File (refer to TRMM 2/88) for all structures. A suitable way would be to indicate on a drawing the treated members, and record of manufacturers batch number of silane used.

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. All inspection records including forms BE 11/85 and BE 14/85 (refer to Trunk Road Management and Maintenance Notice TRMM 2/88) 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 must be repaired or replaced. Damp patches on soffits may indicate that the deck waterproof membrane has failed. If further investigation shows the waterproof 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 2, can prevent water running across soffits and contaminating large areas. Encrusted surface deposits ie algae should be removed by wire brushing. Water jetting should not be used.

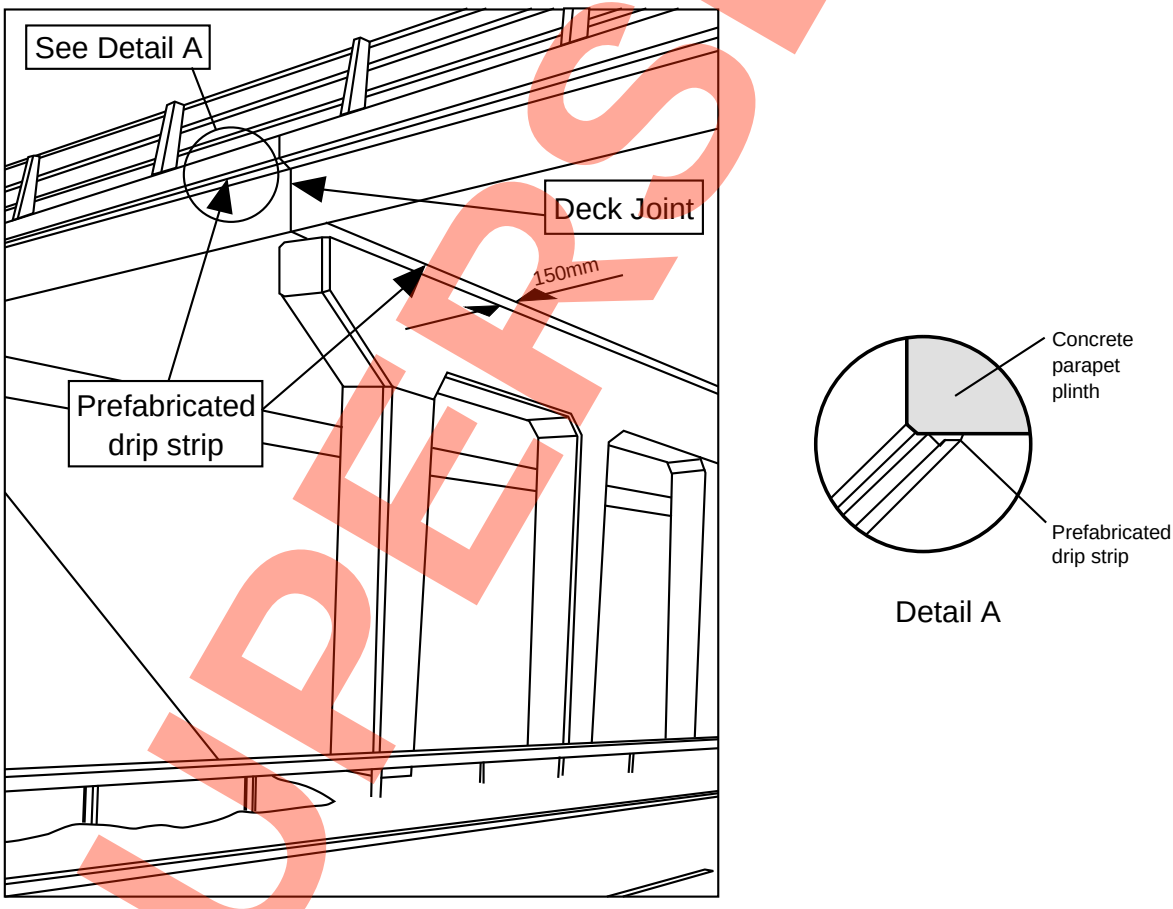

Figure 2 : EXAMPLE OF PREFABRICATED DRIP STRIPS ON BRIDGE DECK SOFFITS

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. Departmental Standard BD 43/90, Criteria and Material for the Impregnation of Concrete Highway Structures.

9. ENQUIRIES

Technical enquiries or comments about this Advice Note should be sent in writing to:

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