VOLUME 1 **HIGHWAY STRUCTURES: APPROVAL PROCEDURES AND GENERAL DESIGN**

SECTION 3 **GENERAL DESIGN**

PART 7

BD 57/01

DESIGN FOR DURABILITY

SUMMARY

The existing Standard and Advice Note (BD 57 and BA 57) have been updated to include:

a) Lifting of the moratorium on internal grouted post-tensioned construction (excluding internal grouted post-tensioned segmental structures).

b) Improvements to durability that can be made by the use of controlled permeability formwork, dense near surface concrete, corrosion inhibitors and other materials such as lightweight aggregate concrete, and stainless steel reinforcement.

c) To include references to thaumasite sulfate attack.

d) To rationalise references and terminology.

INSTRUCTIONS FOR USE

This revised Standard is to be incorporated in the Manual.

1. This document supersedes BD 57/95, which is now withdrawn.

2. Remove BD 57/95, which is superseded by BD 57/01, and archive as appropriate.

3. Insert BD 57/01 in Volume 1, Section 3, Part 7.

4. 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

THE NATIONAL ASSEMBLY FOR WALES
CYNULLIAD CENEDLAETHOL CYMRU

THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

Design for Durability

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Contents

Chapter

1. INTRODUCTION

1.1 It has been found that the durability of many bridges in the Overseeing Organisations' stock has been limited by decisions made at the design stage in relation to the bridge configuration and the choice of details. These decisions were often limited to a design philosophy in which minimising the initial capital cost was paramount. The Overseeing Organisations are keen to promote the concept of design for durability, thereby shifting the emphasis to a lowest whole-life cost design philosophy.

1.2 This Standard is to be read in conjunction with BA 57 (DMRB 1.3.8), which gives further advice and background information on the topics covered herein. Wherever practicable, the recommendations of BA 57 shall be applied to all bridge designs.

1.3 The existing Standard and Advice Note (BD 57 and BA 57) published in 1995 have been updated to include:

a) Lifting of the moratorium on internal grouted post-tensioned construction (except for segmental construction).

b) Improvements to durability that can be made by the use of controlled permeability formwork, dense near surface concrete, corrosion inhibitors and other materials such as lightweight aggregate concrete and stainless steel rebar.

c) To include references to thaumasite sulfate attack.

d) To rationalise references and terminology.

1.4 Where this Standard is applied for the design of precast concrete elements which are procured through a contract incorporating the Specification for Highway Works (MCHW 1), products conforming to equivalent standards and specifications of other member States of the European Economic Area will be acceptable in accordance with the terms of the 104 and 105 Series of Clauses of that Specification. Any contract for the procurement of precast concrete elements which does not include these Clauses must contain a suitable clause of mutual recognition having the same effect regarding which advice should be sought.

Purpose

1.5 The purpose of this Standard is to give requirements which, when used in conjunction with the existing framework of the Overseeing Organisations' design Standards for highway structures, will improve the durability and minimise the whole-life costs of new highway structures.

Scope

1.6 The requirements of this Standard apply to the design of all the Overseeing Organisations' bridges including retaining walls and abutments. Whilst this Standard has not been written specifically to be applicable to footbridges, pipe bridges and sign and signal gantries, most of the principles may be applied to such structures.

Implementation

1.7 This Standard is to be implemented forthwith for all schemes currently being prepared provided that, in the opinion of the Overseeing Organisation, this would not result in significant additional expense or delay progress. Design Organisations should confirm its application to particular schemes with the Overseeing Organisation.

Enforcement

1.8 Where reference is made in this Standard to "adequate" or "suitable" provisions, the Overseeing Organisations shall determine whether the requirements of this Standard have been met. In this regard the decision of the Overseeing Organisations is final.

2. IMPROVED DURABILITY - THE CONCEPTUAL STAGE

Structural Continuity

2.1 Continuous structures have proved to be more durable than structures with simply supported decks, primarily because deck joints have allowed salty water to leak through to piers and abutments. In principle all bridges shall therefore be designed as continuous over intermediate supports unless special circumstances exist. Such continuity may be either full continuity of the whole deck structure or partial continuity of usually the deck slab alone.

2.2 There are serious inspection construction and maintenance problems associated with in-span discontinuities, generally referred to as half-joints. They shall therefore not be provided in bridge decks unless the agreement of the Overseeing Organisation is obtained.

2.3 In principle bridges with lengths not exceeding 60m and skews not exceeding 30° shall in addition be designed as integral bridges, with abutments connected directly to the bridge deck without movement joints for expansion or contraction of the deck. Where the designer considers that either this form of construction, known as integral construction, or a continuous structure is not appropriate, for instance where large differential settlements are anticipated or where an exceptionally high end restraint could result in unacceptable stress or deformation in the deck, articulated construction may be used with the agreement of the Overseeing Organisation.

2.4 Where clearance considerations permit, structures of the buried type shall be considered for all bridges. It should be noted that for longer bridges, the cost penalties of the use of buried structures may exceed their benefits. In doubtful cases, the Overseeing Organisation shall adjudicate whether normal or buried construction is preferable.

Plain Concrete

2.5 When designing concrete structures, consideration shall be given to all possible means of reducing or eliminating the use of corrodable reinforcement. This includes the use of plain (mass) concrete for abutments, wing walls and retaining walls. The use of arch structures where ground conditions permit may also be considered. Options open to designers include the use of precast unreinforced voussoirs (with or without natural stone facing), unreinforced concrete arches incorporating shrinkage reducing additives and similar structures with proprietary or other crack inducers at quarter points. Where the benefits of using plain concrete are marginal the Overseeing Organisation shall adjudicate whether plain or reinforced concrete shall be used.

2.6 The requirements of BS 5400: Part 4, Clause 7.5.9, and of BD 28 (DMRB 1.8), need not apply to plain concrete structures, provided that they are suitably clad or treated to conceal thermally-induced cracking. The fixings of any cladding elements shall be made using non-corrosive materials.

Access

2.7 Adequate provision for access shall be made for the following purposes:

a) cleaning and painting

b) maintenance

c) jacking, removal/replacement of bearings

d) inspection of closed cell and box members.

In providing such access, all the requirements of the Health and Safety legislation and other relevant requirements shall be fully observed; provision for access in excess of the minimum requirements shall be adopted wherever possible. Access shall be provided from below deck level, to avoid access through deck surfaces.

2.8 Public use of any of the access facilities provided for bridge inspection and maintenance shall be prevented by the provision of suitable barriers, covers etc. Colonisation of accessible areas by plants, animals and birds shall be discouraged by suitable measures. This does not affect the possible specific provision of bird or bat boxes etc for nature conservation and related purposes, but such provision shall be consistent with the need to keep all access areas clean and free of debris.

2.9 Abutment galleries shall be provided below all bridge deck expansion and rotational joints. The width and headroom clearance of galleries shall preferably be at least 1000 x 1800 mm respectively, and shall never be less than 800 x 1500 mm. All abutment galleries shall be provided with adequate permanent ventilation to the outside atmosphere, and an adequate level of natural illumination, usually via the ventilation openings.

Grouted Duct Post-tensioning

2.10 For the time being segmental post-tensioned concrete bridges with an internal grouted system shall not be used. Segmental bridges incorporating external post-tensioned systems, and non-segmental with either external or internal systems may be constructed.

Proprietary Manufactured Structures

2.11 When a proprietary manufactured structure is to be provided by the Contractor, the maintenance policy for the structure shall be included in the Approval in Principle form, (AIP).

Foundations and Buried Concrete Structures

2.12 To ensure that foundations and other buried concrete structures are durable, it is essential to ensure that the ground conditions are thoroughly investigated. It is important to correctly classify the sulfates and sulfides present in the soil and groundwater. In England all new buried or partially buried concrete construction shall comply with the requirements of Interim Advice Note 25 ‘Measures to minimise the risk of sulfate attack (including thaumasite): New construction and structures under construction’, and the DETR publication ‘The thaumasite form of sulfate attack. Risks, diagnosis, remedial works and guidance on new construction’ published in January 1999. These documents contain recommended measures which will minimise the risks of all forms of sulfate attack. The measures include the control of concrete mixes, together with additional protection, and utilising a risk based strategy, depending on the structural performance level required. Highway structures requiring a 120 year design life shall be classed in the ‘High Performance Level’. Where shorter design life is required lower performance levels may be considered at the discretion of the Overseeing Organisation.

3. DETAILED REQUIREMENTS

Reinforcement Cover

3.1 In designing cast in-situ concrete members, the cover to reinforcement used in design and indicated on the drawings, shall be the nominal cover derived from BS 5400: Part 4 Table 13, increased by at least 10mm (refer to paragraph 5.2, BA 57).

External Prestressing

3.2 Post-tensioned structures using external or unbonded tendons shall be detailed such that inspection of all individual tendons and their eventual replacement is possible without restricting traffic on the highway.

Drainage and Waterproofing

3.3 Systems for the drainage of surface water from bridges shall be so detailed that water is not allowed to fall freely from the bridge deck. Closed drainage systems with facilities for rodding and other necessary maintenance shall be used. Drainage systems shall be sufficiently robust to withstand damage during cleaning, and shall be resistant to all commonly occurring chemical spillage. Drainage details which are integral with the structure shall be avoided where possible. Downpipes cast into piers shall not be used. Drainage water from bridge decks shall never be discharged into the drainage layers behind abutments.

3.4 Access openings on bridges shall be provided with adequately sealed and properly drained hatches or covers where necessary. However access from the upper surfaces of bridge decks shall be avoided. Adequate ventilation and drainage holes shall be provided to all closed cell or box sections. In closed sections where access for inspection is provided, adequate provision for artificial lighting shall be made, preferably with some minimum provision for illumination by natural light.

4. REFERENCES

1 British Standards

BS 5400: Part 4: 1990. British Standard Code of Practice for the Design of Concrete Bridges. BSI.

2 The Design Manual for Road and Bridges (DMRB)

BD 28 (DMRB 1.3), Early Thermal Cracking of Concrete.

BA 57 (DMRB 1.3.8), Design for Durability.

IA 25 Measures to minimise the risk of sulfate attack (including thaumasite): New construction and structures under construction

3 Manual of Contract Documents for Highway Works. (MCHW)

Volume 1: Specification for Highway Works, (MCHW 1).

4 DETR publication

The thaumasite form of sulfate attack. Risks, diagnosis, remedial works and guidance on new construction published in January 1999.

5. ENQUIRIES

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

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