TRANSPORT SCOTLAND (Agency of the Scottish Government)
TRUNK ROAD NETWORK MANAGEMENT (Bridges)
TS INTERIM AMENDMENT No 23 Revision 3 – IMPLEMENTATION OF BS 8500-1:2006
CONCRETE – COMPLEMENTARY BRITISH STANDARD TO BS EN 206-1

Foreword

Efforts have been made during the compilation of this document to make reference to the most current editions of codes and standards. However, documents and current theory can be ever-evolving and this should be bourne in mind when specifying concrete or making reference to this document.

1.0 INTRODUCTION

BS 8500-1:2006 (BSI, 2006a) and BS 8500-2:2006 (BSI, 2006b) are the UK's National Annex documentation complementary to BS EN 206-1:2006 (BSI, 2006,c). Concrete, specified in compliance with BS 8500-1, will be in compliance with BS 8500-2 and BS EN 206.

This TS Interim Amendment (TS IA) gives revised guidance on the use of BS 8500-1:2006 for the design and construction of durable concrete highway structures on trunk roads in Scotland. This TS IA Revision 3 supersedes Revision 2 of this document.

The foreword to BS 8500-1:2006 identifies the principal changes which include:

- Revised guidance on resisting chloride induced corrosion
- Guidance on specifying durable concrete for structures with a minimum working life of 100 years
- Revised guidance on chloride class for post tensioned and pre-stressed concrete structures
- Revisions to incorporate changes in BRE Special Digest 1 *'Concrete in Aggressive Ground'* (BRE, 2005)
- BS 8500-1 has been restructured to aid clarity

BS 8500-1 permits designers and specifiers greater choice and flexibility in determining the appropriate mix for particular applications than was given previously However, this flexibility requires a greater understanding of the specification process and of the implications in specifying concrete mixes and proposing changes.

1.1 Intended Working Life

A particular change in BS 8500-1:2006 from previous versions is the introduction of Table A.5 which provides limiting values for durable concrete structures with an intended working life of at least 100 years.

1.2 Chloride Class for post-tensioned concrete structures

A chloride class needs to be specified for designed, designated and prescribed concretes. BS 8500-1:2006 provides advice on the chloride class required for post tensioned concrete structures. For internal environments, i.e. in building structures, a chloride class of Cl 0.40 is advised. For bridges and strategic structures in severe chloride environments, a class less than Cl 0.40 is appropriate and the designer is referred to the project specification. In cases of doubt the designer should use Cl 0.10 (0.10% Cl by mass of cement) or refer to Specification of Highway Works (SHW), Series 1700.

1.3 Concrete in Aggressive Ground

The principles and guidance from the third edition of BRE Special Digest 1 *'Concrete in Aggressive Ground'* (BRE, 2005) have been incorporated into BS 8500-1:2006. BRE Special Digest 1 incorporates significant changes from previous editions including a revision of the ground assessment procedure, revisions to the recommendations for maximum w/c ratio and

minimum cement content, allowances for external sources of carbonates contributing to the thaumasite form of sulfate attack and general updating of references and terminology throughout. Specific guidance for concrete in aggressive ground is given in section 5.0 below.

2.0 TS METHODOLOGY FOR ACHIEVING DURABLE CONCRETE

The following sections of this TS IA describe the methodology for achieving durable concrete highway structures and particular changes to the requirements of BS 8500-1:2006 to be used for the design and construction of highway structures on trunk roads in Scotland.

2.1 Designing for Durability

Designing for durability may require a higher strength class of concrete than is required for structural design purposes. Designers should take care to identify all exposure classes to which a structure will be subjected and, when dealing with multiple exposure classes, compare limiting values for concrete composition and properties relevant to all the identified exposure classes. The concrete mix should be selected to suit the most onerous limiting values, taking into account the minimum strength and other requirements demanded by the project or design.

For highway structures the most onerous exposure class for structural concrete above ground level will generally be XD3, although XS3 may apply in a marine environment. The specified concrete mix (considering all the relevant exposure classes) should be used throughout the structure (or major element of a structure) with the concrete cover for less onerous exposure classes being varied accordingly.

Some structures or elements of structures will require particular consideration and judgement on the part of the designer regarding the exposure classes to be adopted for given details based on the principles and information provided in Table A.1 of BS 8500-1, in particular for the following:

- Culverts
- Subways
- Large horizontal exposed surfaces
- Exposed edges of decks (see 3.1.1 below)
- Deck edge cantilevers (see 3.1.1 below)
- Retaining walls (different exposure classes on each face)

2.2 Minimum Requirements for Structural Concrete with Embedded Reinforcement

All structural concrete shall be designed concrete with an intended working life of at least 100 years. All structural concrete shall have a minimum strength class of C32/40, a maximum w/c ratio of 0.45 and shall incorporate combinations of Portland Cement (CEM I) with either fly ash or ground granulated blastfurnace slag (ggbs) with a minimum cement/combination content of 360 kg/m^3.

CEM IIIB with ggbs addition > 65% is not advisable for wearing surfaces, XF4 (BS 8500-1), and is not permitted under SHW 1702. CEM IIIB shall not be used unless prior approval is obtained from the Overseeing Organisation via a Departure from Standard. Consideration of other cement combinations, not listed in the SHW 1700, will only be considered through an Application for Departure from Standard.

2.3 Minimum Cover, Nominal Cover and Fixing Precision Δ_C

Nominal cover is defined in BS 8500-1:2006 as *'the minimum cover plus an allowance in design for deviation, Δ_C to accommodate fixing precision'*. Δ_C is defined as *'allowance in design for deviation of the cover to reinforcement'*. Δ_C is, therefore, a fixing precision that allows for inaccuracies in the dimensions of the formwork and in bending and fixing of the reinforcement. This allowance is typically between 5 and 15 mm for surfaces cast against formwork.

In most insitu concrete construction applications, Δ_C will be 15 mm unless a higher fixing precision can be justified or is necessary in special cases. However, where a higher fixing precision is adopted, additional measures for quality control are required as detailed below.

For factory produced pre-cast concrete construction, where there is usually a higher degree of quality control and production, a fixing precision of 5 mm may be more appropriate. However, certificates of compliance should be provided from the precast concrete supplier to demonstrate that such a high fixing precision is justified and achieved.

For thin insitu concrete sections, such as deck slabs of less than 250 mm thickness, a higher fixing precision may also be appropriate and necessary. However if this is adopted it should be expressly stated within contract documentation and drawings. Additional checks would be required on site to ensure compliance and methods to achieve this should be detailed in the contractor's site practices and agreed method statements. Contractors should provide certificates of compliance and a detailed record of measured covers before concrete is placed.

The following fixing precision for reinforcement Δ_C shall be adopted:

Insitu concrete generally	Δ_C = 15 mm
Precast concrete generally (factory controlled)	Δ_C = 5 mm
Insitu concrete slabs 150 mm or less thick	Δ_C = 5 mm
Insitu concrete slabs between 150 and 250 mm thick	Δ_C = 10 mm
Insitu concrete slabs over 250 mm thick	Δ_C = 15 mm

It is good practice to carry out thorough checks of cover prior to concreting operations. Checking of cover after formwork has been stripped to ensure compliance is a mandatory requirement of SHW Clause 1714. Records shall be submitted within 3 working days of the formwork being stripped to the Engineer's Representative on site.

The previous requirement for an additional cover of 10 mm for insitu concrete construction in cl 3.1 of BD 57 has been replaced by guidance on revised nominal cover, i.e. minimum cover plus fixing precision, in accordance with BS 8500, SHW, SHW NG and this TS IA .

2.4 Protective Surface Treatment

The requirements of BD 43/03 *'The Impregnation of Reinforced and Pre-stressed Concrete Highway Structures using Hydrophobic Pore-lining Impregnants'* are still relevant. The requirements of SHW 1709 should be met. The currently available solvent based or pure silanes still pose potential risks in terms of skin and eye irritation or potential damage to vegetation or the aquatic environment. The use of water or cream based materials alleviates the dangers to some extent. All the product manufacturers/ suppliers specify similar measures to be taken to protect applicators from potential harm such as the use of gloves, eye protection, and avoidance of inhalation or ingestion of the materials. They also advise against discharge of the material into the environment.

Doubt remains over the effectiveness of crystal-growth pore blocking materials and therefore they should not be used.

3.0 EXPOSURE CLASSES

3.1 Corrosion Induced by Chlorides (XD and XS Exposure Classes)

3.1.1 Applicability of Exposure Class XD1

Table A1 of BS 8500-1:2006 gives examples of XD1 exposure including bridge soffits more than 5m vertically above the carriageway. In most situations this will be adequate, notably:

- Precast concrete beams
- Concrete sheltered between concrete beams or steel girders

However, there may be situations where more severe exposure classes should be considered; such as the underside of insitu concrete cantilever deck edges of road over road bridges, where the soffits may be affected by salt spray from the road carried by the bridge as well as from the road crossed, or the edges of pseudo-slab bridges constructed using precast pre-stressed bridge beams. In these cases exposure class XD3 should be specified. For pseudo-slab bridges constructed using inverted 'T' beams, the edge beams may need to be protected by an insitu concrete 'apron' or in the case of bridges constructed using 'M' or 'Y' beams, the outer faces of 'UM' or 'YE' beams, where used, may need to be provided with increased cover.

3.1.2 Concrete Beneath Waterproofing

The exposure classification of reinforced or pre-stressed concrete beneath waterproofing has been assessed as XC3 (BSI, 2006a, Table A.1). However, should waterproofing be breached, concrete will also be subject to chloride laden water and not carbonation. Therefore, reinforced or pre-stressed concrete beneath waterproofing shall also be designed for Exposure Class XD1.

3.1.3 Permanent Formwork

Section A.3 of BS 8500-1:2006 describes a rationale for dealing with the role of permanent formwork in determining cover:

i. Where participating reinforced concrete plank permanent formwork systems are proposed, in most normal situations exposure class XD1 should be applied to the concrete plank itself for cover requirements and concrete quality. A minimum cover of aggregate size + 5 mm, i.e. normally 25 mm, should also be provided from the upper surface of the concrete plank to the reinforcement in the insitu concrete slab above to allow rebar to be fully surrounded by concrete.

ii. Where a thoroughly tested and fully sealed ribbed glass reinforced polymer (grp) non-participating permanent formwork system is selected, the exposure class XD1 should be applied to the insitu concrete above the permanent formwork for cover requirements and concrete quality. Where the grp ribs protrude into the concrete the cover should be measured from the horizontal grp/concrete interface (this is varied from the current requirement in BA 36/90 where cover is measured from the top of

the grp rib) provided that a minimum cover of aggregate size + 5 mm, i.e. normally 25 mm, is also provided between the top of the rib and the nearest reinforcement to allow rebar to be fully surrounded by concrete.

3.1.4 Extrapolation of Limiting Values from Table A.5

'Models to predict concrete requirements for long-life structures in chloride environments do not give identical predictions and extrapolating performance from existing structures also has many practical problems. Consequently, there is a degree of uncertainty with recommendations for an intended working life of at least 100 years in chloride (XD) and sea water (XS) environments.' (BSI, 2006a). For this reason, extrapolation of limiting values by designers/specifiers shall not be permitted.

3.2 Corrosion Induced by Carbonation (XC Exposure Classes)

BS 8500-1:2006 Table A.5 states that limiting values for mixes which meet the requirements for XD or XS Exposure Classes will also meet the requirements for XC Exposure Class. However, Table A.5 quotes much lower strengths, qualities and allowable covers for XC classes which are unlikely to be suitable for highway structures. For elements of highway structures subject to XD or XS classes on one face and XC class on another face, the concrete mix should be kept consistent and the minimum cover for the face subject to XC Exposure Class can be varied but should not be less than the maximum aggregate size + 5 mm, i.e. normally 25 mm and the minimum cover according to the Exposure Class, as noted in Table A.5.

3.3 Freeze-thaw Attack (XF Exposure Classes)

3.3.1 Air Entrainment

BS 8500-1:2006 Table A.5 Note E and Clause A.4.3 state that when using air entrainment to resist freeze-thaw attack, the minimum compressive strength class may be reduced to C28/35 for corrosion induced by chlorides (Exposure Classes XD2, XD3, XS1, XS2 & XS3). However, this is unlikely to be sufficiently high strength class suitable for highway structures. Therefore, the option to reduce the strength class when using air entrainment is not permitted. Concrete producers must ensure the mix design satisfies the requirements of all the limiting values, including strength.

Air entrained concrete with a minimum strength class of C32/40 or non-air-entrained concrete with a minimum strength class of C40/50 shall be adopted for all structural concrete above ground level.

3.3.2 Freeze-thaw Resisting Aggregates

All structural concrete above ground level shall incorporate freeze-thaw resisting aggregates.

4.0 REQUIREMENTS FOR STRUCTURAL CONCRETE

The range of permissible cement types and combinations is given in Table A.6 of BS 8500-1 (BSI, 2006a), and presented below:

Table A.6 **Cement and combination types** [A]

Broad designation [B]	**Composition**	**Comprises cement and combination types (see BS 8500-2:2006, Table 1)**
CEM I	Portland cement	CEM I
SRPC	Sulfate-resisting Portland cement	SRPC
IIA	Portland cement with 6% to 20% fly ash, ground granulated blastfurnace slag, limestone, or 6% to 10% silica fume [C]	CEM II/A-L, CEM II/A-LL, CIIA-L, CIIA-LL, CEM II/A-S, CIIA-S, CEM II/A-V, CIIA-V, CEM II/A-D
IIB-S	Portland cement with 21% to 35% ground granulated blastfurnace slag	CEM II/B-S, CIIB-S
IIB-V	Portland cement with 21% to 35% fly ash	CEM II/B-V, CIIB-V
IIB+SR	Portland cement with 25% to 35% fly ash	CEM II/B-V+SR, CIIB-V+SR
IIIA [D], [E]	Portland cement with 36% to 65% ground granulated blastfurnace slag	CEM III/A, CIIIA
IIIA+SR [E]	Portland cement with 36% to 65% ground granulated blastfurnace slag with additional requirements that enhance sulfate resistance	CEM III/A+SR [F], CIIIA+SR [F]
IIIB [E], [G]	Portland cement with 66% to 80% ground granulated blastfurnace slag	CEM III/B, CIIIB
IIIB+SR [E]	Portland cement with 66% to 80% ground granulated blastfurnace slag with additional requirements that enhance sulfate resistance	CEM III/B+SR [F], CIIIB+SR [F]
IVB-V	Portland cement with 36% to 55% fly ash	CEM IV/B(V), CIVB

A) There are a number of cements and combinations not listed in this table that may be specified for certain specialist applications. See BRE Special Digest 1 [1] for the sulfate-resisting characteristics of other cements and combinations. See IP 17/05 [7] for the use of high ggbs content cements and combinations in secant piling applications.
B) The use of these broad designations is sufficient for most applications. Where a more limited range of cement or combinations types is required, select from the notations given in BS 8500-2:2006, Table 1.
C) When IIA or IIA-D is specified, CEM I and silica fume may be combined in the concrete mixer using the *k*-value concept; see BS EN 206-1:2000, **5.2.5.2.3.**
D) Where IIIA is specified, IIIA+SR may be used.
E) Inclusive of low early strength option (see BS EN 197-4 and the "L" classes in BS 8500-2:2006, Table A.1).
F) "+SR" indicates additional restrictions related to sulfate resistance. See BS 8500-2:2006, Table 1, footnote D.
G) Where IIIB is specified, IIIB+SR may be used.

4.1 Concrete Mixes for Durable Structural Concrete Above Ground Level

Designer/Specifiers should refer to Table 1 (overleaf) to choose a concrete mix for particular concrete elements. Transport Scotland permissible mixes and typical applications have been referenced.

Table 1 Permissible Cement Combinations and Minimum Strength Requirements

TS Application	Minimum Strength Class	TS Permitted Cement Combinations (refer to Table A.6)						
		CEM I	II A	IIB-S	IIB-V IIB + SR	IIIA IIIA + SR	IIIB IIIB +SR	IVB-V
Footway/Verge Infill Concrete	C28/35AF		√	√	√	√	†	√
In situ reinforced concrete	C32/40 a.e. or C40/50		√	√	√	√	†	√
Site cast precast reinforced concrete	C32/40 a.e. or C40/50		√	√	√	√	†	√
Factory cast precast rc elements, e.g. box culverts, reinforced soil retaining wall panels etc.	C32/40 a.e. or C40/50	√ (C40/50 only)	√	√	√	√	†	√
In situ pre-stressed post tensioned concrete	C40/50		√	√	√	√	†	√
Factory cast pre-stressed concrete bridge beams	C40/50 or C50/60	√	√	√	√	√	†	√

Notes
† IIIB cement combination may be considered through Application for Departure from Standard
AF Air Entrained, Fibre Reinforced

Tables 2 and 3 give minimum covers for permissible concrete mixes given in Table 1 for XC, XD and XS Exposure Classes. These tables have been derived from Tables A.1 and A.5 of BS 8500-1:2006. .

An absolute minimum cover, C_{min} = 30mm is a requirement for all concrete regardless of aggregate size below 20mm.

Table 2 Minimum Covers According to Exposure Class and Concrete Mix, C32/40

C32/40		**Mix 1**	**Mix 2**	**Mix 3**	**Mix 4**	**Mix 5**	**Mix 6**	**Mix 7**	**Mix 8**	**Mix 9**
Mix Proportions										
Min cement content (kg/m³)		360	360	380	360	360	380	360	380	380
Max w/c		0.40	0.45	0.45	0.40	0.45	0.45	0.40	0.40	0.45
Permissible Cement Types		CEM I, IIA, IIB-S,			IIB-V, IIB-V + SR, IIIA, IIIA + SR			IIIB†, IIIB† + SR, IVB-V		
	Exposure Class	Minimum cover (mm), excl Δ_c								
	XC1	30	30	30	30	30	30	30	30	30
	XC2	30	30	30	30	30	30	30	30	30
	XC3/4	40	40	40	40	40	40	45	45	45
	XD1	45	45	45	45	45	45	45	45	45
	XD2	45	45	45	45	45	45	45	45	45
	XD3	65	65	65	55	55	55	50	45	50
	XS1	55	55	55	45	45	45	45	45	45
	XS2	55	55	55	45	45	45	45	45	45
	XS3	75	75	75	55	55	55	50	45	50

Notes
† IIIB cement combination will be considered through Application for Departure from Standard
Designers to select the appropriate permissible cement type in accordance with the accepted TS application in Table 1.

Table 3 Minimum Covers According to Exposure Class and Concrete Mix, C40/50

C40/50		**Mix 11**	**Mix 12**	**Mix 13**	**Mix 14**	**Mix 15**	**Mix 16**
Mix Proportions							
Min cement content (kg/m³)		360	380	360	380	360	380
Max w/c		0.45	0.40	0.45	0.40	0.45	0.40
Permissible Cement Types		CEM I, IIA, IIB-S,		IIB-V, IIB-V + SR IIIA, IIIA + SR		IIIB†, IIIB† + SR, IVB-V	
	Exposure Class	Minimum cover (mm), excl Δ_c					
	XC1	30	30	30	30	30	30
	XC2	30	30	30	30	30	30
	XC3/4	30	30	30	30	35	35
	XD1	35	35	35	35	35	35
	XD2	40	40	40	40	40	40
	XD3	65	60	55	50	50	45
	XS1	55	50	40	40	40	40
	XS2	55	50	40	40	40	40
	XS3	70	65	55	50	50	45

Notes
† IIIB cement combination will be considered through Application for Departure from Standard
Designers to select the appropriate permissible cement type in accordance with the accepted TS application in Table 1.

Operating Companies using 4G Term Contracts may refer to Table 4 in order to compare standard mixes with those in TS IA 23.

Table 4 Comparison of 4G OC Contract Standard Mixes with TS IA 23 Mixes

Standard Mix	**STR1**	**STR2**	**FOU1**	**FOU2**	**FOU3**	**FOU4**	**FOU5**
DC-Class	DC-1 DC-2z DC-3z DC-4z	DC-1 DC-2z DC-3z DC-4z	DC-1 DC-2 DC-2z DC-3z DC-4z	DC-2 DC-2z DC-3 DC-3z DC-4z	DC-3 DC-3z DC-4z	DC-3 DC-4 DC-4z	DC-3 DC-3z DC-4 DC-4z DC-4m
Max w/c	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Min c (kg/m³)	360	380	360	380	360	380	360
Strength	C32/40	C40/50	C32/40	C32/40	C32/40	C32/40	C32/40
Permissible cements	IIB-V, IIIA	IIA, IIB-S	IIB-V + SR	IIB-V + SR, IIIA + SR	IVB-V	IVB-V	IIIB + SR
TS IA 23 Mix reference	Mix 4	Mix 12	Mix 4	Mix 4	Mix 7	Mix 8	Mix 7

Notes
All mixes in Table 4 have an aggregate size of 20mm.

5.0 ALKALI SILICA REACTION

Concrete can deteriorate as alkaline pore fluids react with reactive aggregates in a process known as Alkali-Aggregate Reaction (AAR). The most common form of AAR is Alkali-Silica Reaction (ASR) and this form is the only known type in the UK. SHW Cl 1704.5 gives requirements to control ASR.

6.0 REQUIREMENTS FOR STRUCTURAL CONCRETE IN AGGRESSIVE GROUND

Details of ground conditions including total potential sulfate, groundwater pH, ACEC-class and DC-class for which the foundation concrete mix is to be designed shall be recorded in the Approval in Principal submission.

6.1 Permissible Concrete Mixes for Durable Structural Concrete Below Ground

The following tables give mix proportions, preferred cement/combination and additional protective measures required for each DC-class. The tables have been derived from and should be read in conjunction with Tables A.2, A.9, A.10 and A.11 of BS 8500-1:2006 and the requirements of this TS IA 23.

Designers need to classify the ground conditions and determine the exposure conditions for the substructure elements. The limiting values for substructure concrete elements can be determined using BS 8500 or the tables below. The limiting values for substructure concrete mixes should be determined along with any requirements stipulated to meet the exposure class conditions, XC, XD, XS and XF.

Designers should also refer to BRE SD1 (BRE, 2005) for further advice.

Designers should consider all water on site to be mobile.

Section thickness ≤ 140 mm is not permitted.

Where the hydraulic gradient across a concrete element > 5, the DC-class should be increased by 1 or an additional number of APM's should be applied. Concrete elements with specified APM3 do not require an additional APM.

Where the section thickness > 450 mm AND surface chemical attack is acceptable, the DC-class will not be reduced for unreinforced concrete elements. Designers should ensure that there is sufficient cover for reinforced concrete elements throughout the intended working life, to allow for estimated surface degradation.

Table 5 Selection of DC-class and APM's

ACEC-class	DC-class	APM'S Required
AC-1	DC-1	
AC-2	DC2	
AC-2z	DC-2z	
AC-3z	DC-3z	
AC-3	DC-3	+ 1no. APM of choice
	DC-4	
AC-4z	DC-4z	
AC-4	DC-4	+ 1no. APM from APM2-APM5
AC-4m	DC-4m	+ 1no. APM from APM2-APM5
AC-5z	DC-4z	+ APM3[B]
AC-5	DC-4	+ APM3[B]
AC-5m	DC-4m	+ APM3[B]

Additional protective measures (APMs)

APM	Definition
APM1	Enhanced concrete quality
APM2	Use of controlled permeability formwork
APM3	Provide surface protection
APM4	Provide sacrificial layer
APM5	Address drainage of site

Notes

B where APM is not practical, another APM may be selected

'z' indicates that the concrete has primarily to resist acid conditions and may be made with cements/combinations from any Group

'm' relates to ACEC-classes 4 and 5 with higher levels of magnesium (> 1.2g/l in water/soil extract and/or > 1.0g/l in groundwater)

The maximum w/c ratio = 0.45; minimum cement content = 360 kg/m³. If aggregates other than 20 mm aggregates are used, designers and concrete producers should refer to Table A.11 of BS 8500-1 for guidance on minimum cement content.

Table 6 Mix design Limiting Values for Substructure Concrete

Limiting Values for Concrete Mix				Permissible Cement Combinations	Notes
Minimum Strength	DC-class	Max w/c	Min cement content (kg/m³)		
C32/40	DC-1	0.45	360	All in Table A.6 (BSI, 2006a)	
	DC-2	0.45	360	All in Table A.6 (BSI, 2006a) + IIQ-A, excluding IIA-L, IIA-LL	
		0.45	360	IIA-L, IIA-LL,	Cement strength ≥ 42.5
		0.40	380	IIA-L, IIA-LL,	Cement strength ≥ 32.5
	DC-2z	0.45	360	All in Table A.6 (BSI, 2006a)	
	DC-3	0.45	360	IIIB +SR, IVB-V	
		0.40	380	IIB-V +SR, IIIA + SR, SRPC	
	DC-3z	0.45	360	All in Table A.6 (BSI, 2006a)	
	DC-4	0.45	360	IIIB + SR	
		0.40	380	IVB-V	
		0.35	380	IIB-V +SR, IIIA + SR, SRPC	
	DC-4z	0.45	360	All in Table A.6 (BSI, 2006a)	
	DC-4m	0.45	360	IIIB + SR	

6.2 Cover for Structural Concrete in Foundations

All buried substructure concrete must be coated with two coats of bituminous paint & backfilled in accordance with Specification of Highway Works Notes for Guidance 1704.

Cover for concrete in foundations shall be as follows:

	Minimum cover (mm), excl Δ_c
Structural concrete cast against blinding or cast against formwork and subsequently backfilled	40 mm
Structural concrete cast directly against the soil	60 mm

Notes

1. Δ_c should be taken as a minimum of 15 mm.
2. Where structural concrete in foundations could be subject to exposure classes XD or XS, cover requirements could be more onerous than the above and should be checked against Tables 2 & 3, with Δ_c taken as 25 mm for concrete cast against blinding or cast against formwork and subsequently backfilled, and 50 mm for concrete cast against soil.

7.0 INTERACTION WITH EUROCODE 2

Designers should exercise care and discretion in applying design Standards with respect to concrete properties, cover and cracking. The most onerous requirements of SHW & SHW NG and this TS IA shall take precedence over BS 8500 minimum requirements relating to concrete materials and cover.

For the purposes of calculating crack widths in accordance with BS EN 1992-2:2005, the nominal cover, c_{nom} i.e. $c_{min} + \Delta_c$, derived from BS 8500-1:2006 and this TS IA, should be used. Crack widths should be limited to those detailed in Table NA.2 of the National Annex to BS EN 1992-2:2005 (BSI, 2007) and Clause 8.2 of Published Document, PD 6687-2:2008 (BSI, 2008).

8.0 STAINLESS STEEL REINFORCEMENT

The use of stainless steel reinforcement instead of carbon steel will enhance durability and reduce future maintenance risk associated with those elements of road structures most at risk from chloride attack. Designers will need to examine whether the additional expenditure is warranted by the enhanced durability. Although the unit cost of stainless steel can vary typically between four and ten times the cost of carbon steel reinforcement, the cost of stainless steel reinforcement will represent a small percentage of the overall cost of the structure. In general, the use of stainless steel in locations such as parapet edge beams, in substructures, in splash zones next to carriageways or in marine environments, below movement joints on associated bearing shelves and superstructures subject to spray, can be justified.

Where stainless steel reinforcement is specified in lieu of high yield steel reinforcement, a cost benefit and value for money exercise should be considered in accordance with SHW NG 1712. Designers should either liaise with the relevant Transport Scotland Bridge Manager or develop their costings in an Approval In Principle (AIP) document for consideration.

Specification of stainless steel grade reinforcement must be in accordance with Table B.1 of BS 6744 (2009) but the design ethos of BA 84/02 should also be applied. BA 84/02 predates the current version of BS 6744 and is in the process of undergoing review and amendment.

9.0 APPROVAL IN PRINCIPAL

In all situations the use of this Interim Amendment and the applicable exposure classes for particular structural elements shall be recorded in Technical Approval AIP documentation in accordance with BD2. Fully justified Departures from Standard submissions will be required if the guidance provided in this TS IA and BS 8500-1:2006 is not to be followed.

10.0 IMPLEMENTATION

The requirements of this TS IA are to be used with immediate effect on all Scottish trunk road projects with the exception of minor maintenance activities, schemes already under construction and those currently being prepared where a requirement to use this TS IA would result in significant additional cost or delay. In each of these cases, guidance should be sought from the relevant Transport Scotland Unit Bridge Manager.

11.0 FURTHER INFORMATION

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