

Interim Advice Note 95/07

**Revised guidance regarding the
use of BS8500(2006) for the
design and construction of
structures using concrete**

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This IAN supersedes IAN 74/06

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Background

Interim Advice Note 52/04 implemented major revisions to the 1700 series Specification for Highway Works (SHW) and Notes for Guidance (NFG) for structural concrete, to ensure that they are generally compatible with, and complement 'BS EN 206-1 Concrete – Part 1: Specification, performance, production and conformity', and the complementary British Standards 'BS 8500-1:2002 Method of specifying and guidance for the specifier' and 'BS8500-2 Specification for constituent materials and concrete'.

Late in 2006 updated and revised versions of BS8500-1 and BS8500-2 were issued. Interim Advice note 74/06 gave advice which was consistent with the thinking behind the revised standard, prior to the revision being published. This Interim Advice Note updates guidance to the designer and highlights some of the major changes in the 2006 revision of the standard. Some of the guidance previously given in IAN 74/06 is repeated in this document to aid clarity. IAN 74/06 is withdrawn.

The forwards to both parts of BS8500 published in 2006 identify the principal changes to each document. The listed changes include:

- Revised guidance on resisting chloride induced corrosion,
- Guidance on concrete quality for 100 year working life structures,
- Revised guidance on chloride class for post tensioned structures
- Revisions to recognise the changes in BRE Special Digest SD1 (2005) 'Concrete in aggressive ground'.
- BS8500-1 has been restructured to aid clarity

The changes could be summarised as being an update, but do not represent a comprehensive change of philosophy.

Exposure Classes

Table A1 (Annex A.2 Exposure classes related to environmental conditions) of BS8500-1 (2006) provides updated examples of exposure classes. The revision is generally in keeping with the information given on defined areas of bridges included in Table 13 of BS5400 part 4. The approach taken remains non-prescriptive and designers should take care to identify all exposure classes. When dealing with multiple exposure classes designers should compare limiting values for concrete composition and properties relevant to all the identified exposure classes.

Some structures and elements will require particular judgement and thought on the part of the designer as to the exposure classes to be adopted, for particular concrete surfaces, based on the principles and information provided in table A1 of BS8500-1.

In particular attention is drawn to:

- Culverts
- Subways
- Large horizontal exposed surfaces
- Exposed edges of decks (see below)
- Cantilever deck edges (see below)
- Retaining walls (different exposure classes on each face)

Table A1 of BS8500-1(2006) now gives informative examples of XD1 exposure including bridge soffits more than 5m vertically above the carriageway. In most situations this will be adequate, notably for:

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

As with all exposure determinations, care should be taken to adequately assess all potential exposure conditions. 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.

Concrete below an effective waterproofing system on bridge decks should be considered as XC3 (table A1, BS8500-1) and aligns with the note to clause 105 in EN1992-2:2005 Eurocode 2 'Design of concrete bridges – Concrete bridges – Design and detailing rules'. It should be noted that exposed faces of bridge deck concrete may determine the concrete mix design requirements.

Designers attention is drawn to section A.3 of BS8500-1(2006) which describes a rationale for dealing with the role of permanent formwork in determining cover. Clarification of cover requirements in relation to BA36/90 'The use of permanent formwork' remains unchanged from the previous Interim Advice Note 74/06.

- 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, in terms of cover requirements and concrete quality. A minimum of 20mm cover 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, in terms of 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 BA36/90 where cover is measured from the top of the grp rib), provided that at least 20mm is also provided between the top of the rib and the nearest reinforcement, to allow rebar to be fully surrounded by concrete.

In all situations, the use of this Interim Advice Note and the applicable exposure classes for particular structural elements shall be recorded in Technical Approval AIP documentation in accordance with BD2. These are matters to be agreed with the Technical Approval Authority and will not require departure from standard submissions, unless the guidance provided in this Interim Advice Note and BS8500(2006) are not to be followed. In these circumstances thoroughly justified departures will be required.

The principles and guidance from the third edition of BRE Special Digest SD1 (2005) 'Concrete in aggressive ground' is now incorporated in BS8500(2006). The 2005 edition incorporates some significant changes including a revision of the ground assessment procedure, revisions to the maximum w/c ratio and minimum cement content recommendations, allowances for external sources of carbonates contributing to thaumasite sulfate attack and general updating of references and terminology throughout.

Chloride Class for post-tensioned concrete structures

A chloride class needs to be specified for designed, designated and prescribed concretes. BS8500-1(2006) adds extra advice on the chloride class required for post tensioned concrete structures. For internal environments 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 SHW clause 1704 and shall use Cl 0,1 (0.1% Cl by mass of cement).

Cover

BS 8500-1(2006) confirms the use of the term 'Nominal cover' which includes a minimum cover figure plus an allowance in design for deviation Δ_c (see below), otherwise known as a fixing tolerance.

The minimum cover (for the purposes of providing protection of the reinforcing steel from the environment) and designed concrete properties can be determined from Tables A.4 (50 year working life) and A.5 (100 year working life), A.8 (freeze-thaw), A.9/A10/A.11 (Chemical Attack - also BRE SD1(2005)) of BS 8500-1(2006).

'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.' Quoted from BS8500-1(2006).

While design drawings should give nominal cover to reinforcement, durability design is based on minimum cover. It would be prudent to add notes to the drawing to indicate that the covers shown do include a figure for deviation, and what the assumed figure is, to allow contractors the opportunity to decide on arrangements for fixing in order to achieve steel positioning between the minimum and maximum (nominal) covers permitted.

Fixing tolerances for reinforcement Δ_c

Guidance on fixing tolerances remain unchanged from the previous Interim Advice Note ('allowance in design for deviation' from EN 1992-1(2004)) is provided for different forms of construction.

BS 8500-1 suggests that reinforcement fixing tolerances should be between 5 and 15mm. In most insitu concrete construction applications this should be 15mm, unless a lesser tolerance can be justified or is necessary in special cases (however, where lesser fixing tolerances are adopted then additional measures for quality control are required as detailed below). Certificates of compliance should be sought from precast concrete supplier to ensure that a lower tolerance (e.g. 5mm) is justifiable and achieved.

For thin insitu concrete sections such as deck slabs of less than 250mm thickness a lower fixing tolerance 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 contractors site practices and agreed method statements. Contractors shall provide certificates of compliance and a detailed record of measured covers before concrete is placed.

It is recommended that the following fixing tolerances should be adopted:-

In situ concrete generally	$\Delta_c = 15\text{mm}$
Precast concrete generally (factory controlled)	$\Delta_c = 5\text{mm}$
In situ concrete slabs 150mm or less thick	$\Delta_c = 5\text{mm}$
In situ concrete slabs between 150 and 250mm thick	$\Delta_c = 10\text{mm}$
In situ concrete slabs over 250mm thick	$\Delta_c = 15\text{mm}$

It is noted that it is good practice to carry out thorough checks of cover prior to concreting operations, and after formwork has been stripped to ensure compliance. It should be noted that this is required in SHW clause 1714.

Intended Working Life

A particular change in BS8500(2006) from previous versions is the introduction of table A.5 which provides information for selecting minimum cover and designed concrete properties for structures with a working life of at least 100 years. While the table A.5 has been developed on the basis of best available current knowledge, it uses the extrapolation of empirical modelling of deterioration processes. This leads to a greater degree of uncertainty with the recommendations for XD and XS environments than that associated with the 50 year recommendations (table A.4). However use of concrete complying with the requirements of an intended working life of at least 100 years will be accepted for highway structures with a design life of 120 years.

It is also noted that the requirements of BD43 'The impregnation of reinforced and pre-stressed concrete highway structures using hydrophobic pore-lining impregnants' also applies, and BD/BA57 'Design for durability', although the additional cover of 10mm for in situ concrete construction, in clause 3.1 of BD57 has been waived, providing that BS8500, May 2004 SHW/NFG and this IAN are adopted.

Interaction with BS5400

Designers should exercise care and discretion in applying design standards, in respect of concrete properties, cover and cracking. BS8500(2006), May 2004 SHW/NFG and this document all take precedence over BS5400 requirements for concrete materials issues and cover Table 1 of BS5400 dealing with crack widths is still relevant.

For the purposes of calculating crack widths, as part of the design process, in accordance with Table 1 of BS5400, the nominal cover (including any additions for long service life) derived from BS8500-1 should be utilised, however it is recommended that the fixing tolerance (Δ_c) is deducted from the nominal cover in order to undertake reinforcement design based on the limiting crack widths.

Implementation

This Interim Advice Note should be implemented on all schemes in the design stage. In most cases this will only entail a very quick check/comparison of cover and concrete requirements, and it is unlikely that changes to designs are required, as there are few major deviations from previously issued guidance. Where changes to designs are deemed necessary or prudent,

discussion and agreement is required with the Highways Agency Project Sponsor and the SSR PGSG(SD) Technical Approval Authority.

It is also intended to update the Specification for Highway Works and the Notes for Guidance in due course.

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