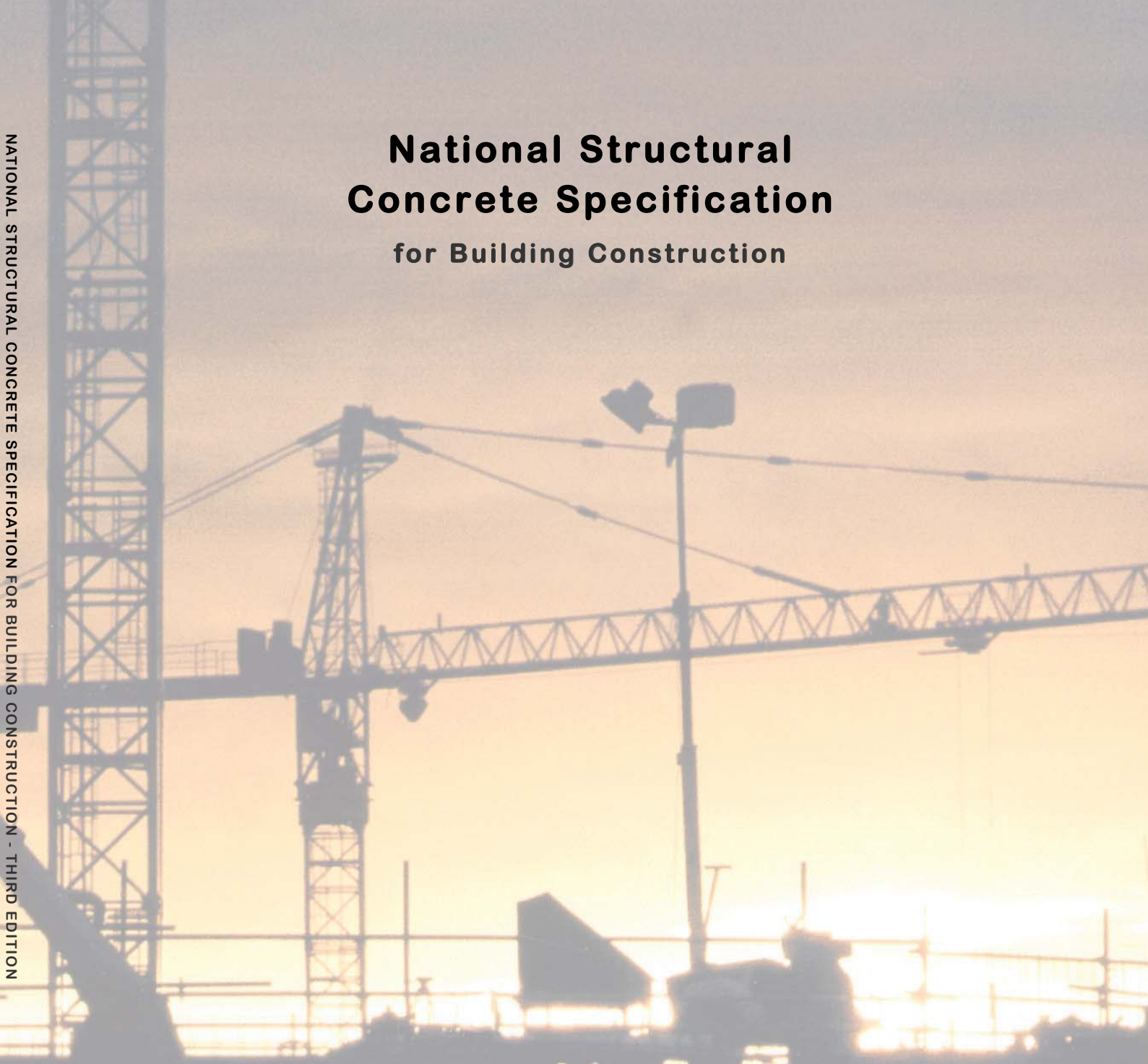
NATIONAL STRUCTURAL CONCRETE SPECIFICATION FOR BUILDING CONSTRUCTION - THIRD EDITION

National Structural Concrete Specification

for Building Construction



Third Edition

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National Structural Concrete Specification

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This Specification was prepared with the guidance of a Project Steering Group comprising:

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Building Research Establishment (BRE)
British Cement Association (BCA)
The Concrete Centre (TCC)

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CONSTRUCT and the authors thank the numerous organisations from all sections of the industry whose views and comments have been sought and carefully reviewed for inclusion.

* On Second Edition Technical Committee only
** On Third Edition Technical Committee only

Contents

The page numbers for Guidance Notes are shown alongside those for the relevant sections of Parts 1 and 2 for easy cross-referencing.

Foreword

The Third Edition of the National Structural Concrete Specification for Building Construction (NSCS) has been prepared to provide a revised Section 4 - Concrete and concreting in accordance with BS 8500: *Concrete – Complimentary British Standard to* BS EN 206-1 and BS EN 206: *Concrete – Specification, performance production and conformity*. It is needed because the ready-mixed concrete industry changed from using BS 5328 - *Concrete* to using BS 8500 on 1st December 2003. BS 5328 was then withdrawn and there was no overlap period when both standards were in use.

The change from using BS 5328 - *Concrete* to using BS 8500 by the ready-mixed industry on 1st December 2003 meant that a need exists for specification to the new standard. It was felt that a further edition of the NSCS was required at this stage to cater for the introduction of European standards and terminology.

Apart from Section 4 of the Standard Specification (Part 1), Project specification (Part 2) and the Guidance Notes the rest of the edition is as the Second Edition. The review panel for the specification expect to produce a fourth edition co-ordinated with other Eurocodes when they are all available – in this edition comments and feedback on the use of the second and third editions will be incorporated throughout the specification.

The NSCS still has the same objectives as a definitive, simple and straightforward specification without unnecessary constraints. This is seen as essential in the drive to increase efficiency in the construction of concrete buildings whilst maintaining or improving their quality.

The NSCS is arranged in two parts; Part 1, Standard specification, and Part 2, Project specification, together with Guidance notes covering both parts. The Guidance Notes do not form part of the formal construction specification.

The **Standard specification** (Part 1) provides a stand-alone base specification with standard clauses on materials, workmanship and construction for the production of consistent and well-constructed reinforced concrete structures. Part 1 can be split into sections for distribution to the relevant trades for construction.

The **Project specification** (Part 2) provides for information and requirements specific to the project. It records, by exception, any amendments to Part 1 considered necessary by the designer and is also the part of the specification where information is provided by the tenderer. This enables tender documents or the contract for construction to incorporate Part 2 only, because it refers explicitly to Part 1 as its base document.

The Guidance notes form a companion document to Part 1 and Part 2 and give background information together with explanations of why certain clauses have been adopted. The information is intended to be of use to both the designer and contractor.

Under the NSCS approach the Engineer remains responsible for using normal skill, care and diligence to design the structure and the Specialist Concrete Contractor (SCC) builds what is shown on the drawings to a specified standard of workmanship. The SCC is expected to exercise in the performance of duties such skill, care and diligence as may be expected of an experienced contractor used to working on projects of similar size, scope and complexity to the project under consideration. It is assumed that the execution of the provisions of the NSCS is entrusted to appropriately qualified and experienced organisations. Prescriptive restraints have been avoided to enable the Specialist Concrete Contractor's experience to be used to achieve efficient construction.

The NSCS is authoritative, simple and straightforward and the benefits of its use will best be achieved by continuing the collaboration between contractors, specifiers and designers which arose during its development. The NSCS provides for agreement to be reached between the SCC and Engineer on project-specific items that affect the pricing of the works.

A clear, less prescriptive specification resulting from a single national standard for concrete structures will help innovation, efficiency and competition, thus better meeting the needs of clients and the public. All parties involved in the construction process from the client to the subcontractor are expected to benefit. Clients will receive better, less costly construction. Designers will no longer have to devise their own specifications. Contractors will be able to identify more clearly the risks and requirements of the project and will have more freedom to innovate and develop their own solutions. Such an approach is particularly appropriate given the contractual arrangements currently being employed.

A review panel will keep the document up to date in the light of comments and feedback received from all parts of the industry. Any inaccuracies and ambiguities found or proposals for future editions should be submitted to CONSTRUCT.

Scope

General

The NSCS remains laid out in terms of process rather than in terms of materials and workmanship. British Standards are referenced rather than reproduced. Where the NSCS is at variance with British Standards, the NSCS is to be used.

The NSCS covers requirements for the construction of concrete building structures of in-situ concrete, precast concrete, and hybrid concrete systems. It is especially relevant for structures designed to BS 8110 and EN 1992 (EC2). Where the NSCS is to be used for structures in extreme environments, those produced by specialist construction techniques or those of a specialist design nature, Part 2, Project specification, should include the appropriate particular requirements.

The NSCS is written with safety in mind but does not specify health and safety requirements as these are covered by legal regulations that apply to all construction and are outside the scope of this specification.

Where specifications, standards or regulations are referenced, readers should ensure that they refer to the latest editions.

NSCS Part 1. Standard specification

Specific obligations are placed on the Specialist Concrete Contractor, the Employer and the Engineer. In some cases these will be different organisations; sometimes any or all will be represented by the same organisation. However, their responsibilities remain as required under the Contract.

NSCS Part 2. Project specification

This part is to be read in conjunction with NSCS Part 1 and outlines project information specific to a particular project and additional to the requirements of NSCS Part 1.

Part 2 covers the exchange of information necessary between the Employer and Specialist Concrete Contractor at both tender stage and contract stage. The relevant sections of Part 2 should be completed at the appropriate stage.

Part 2 allows the Engineer responsible for the design the freedom to incorporate specific Clauses to vary the standard Clauses of Part 1. It is emphasised that NSCS Part 1 has been produced as a non-prescriptive specification and therefore any amendments through NSCS Part 2 should be as few as possible.

The pro-forma layout of Part 2 acts as an aide memoire to the disclosure of relevant information for most types of project.

To aid the task of preparing a Project specification, permission is hereby expressly given for users of this document to copy any part or the whole of Part 2, Project specification, without infringement of copyright. A data disc is enclosed to enable easy electronic completion and distribution.

NSCS. Guidance notes

The Guidance notes are for information only and do not form part of the Specification. They provide background information on the content of the Supplement Parts 1 and 2 and explain why certain Clauses have been adopted. They include reference to the terminology changes used in the new Standards, which may be strange for UK users and are designed to be ‘dipped into’ and read with the relevant clauses in Parts 1 and 2. As a result there is some intentional duplication.

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PART 1. STANDARD SPECIFICATION

Definitions

In this Specification, the following definitions apply.

Agreement, acceptance
When by or of the Contract Administrator (CA), these terms shall have the following limitations:

(a) When given in respect of samples of materials, workmanship or proposals for methods of construction submitted in accordance with this Specification, shall not be interpreted as denoting any degree of satisfaction with the materials used in, or the execution of, the structure.

(b) When given in respect of drawings, documents, or schemes called for by the Specification or proposed by the SCC, it is only for conformity with the design concept and design information given in the Contract Documents, or contained in subsequent instructions from the CA.

Contract administrator (CA)
The named individual or company engaged to act for and on behalf of the Employer for the purposes of accepting proposals from the SCC, issuing technical information to the SCC and monitoring the work of the SCC.

Design calculations
The calculations produced generally by the Engineer, and by the SCC for some specialist work.

Drawings
General arrangement drawings (GAs): Plans and sections indicating the layout and dimensions of each floor of the structure. The drawings will be in sufficient detail to allow the formwork to be constructed and will show or reference all inserts, cast-in items and holes. GAs may also indicate the locations of concrete grades and finishes.

Design information drawings: Drawings showing the design information required to enable reinforcement detail drawings to be produced.

Reinforcement detail drawings: Drawings showing the layout of the various types of reinforcement used in the construction of the structure.

Reinforcement schedules: Schedules giving the details of each reinforcing bar to be cast into the concrete.

Builders work drawings: Drawings showing coordinated builders work (holes, cast-in services, fixings etc.)

Erection drawings: Drawings or sketches indicating any special requirements or methods that the SCC must use to erect the structure in a safe manner.

As-built drawings: Drawings indicating what was built.

Temporary works drawings: Drawings showing necessary falsework, formwork and propping used to construct the structure in a safe manner.

Employer
The individual or company placing the contract with the SCC.

Engineer
The individual or organisation responsible for the design of the structure.

Falsework
The temporary structure used to support a permanent structure until it is self supporting.

Formwork
The part of the falsework used to give the required shape, finish and support to the poured concrete.

NSCS
National Structural Concrete Specification for Building Construction, comprising Parts 1 and 2.

Precast concrete
Concrete elements cast in formwork and fabricated at a location separate from the final position in the structure.

Prestressed concrete
Concrete that is subjected to pre-tensioning or post-tensioning.

Reference panels
Full-size concrete panels of Type A and Type B finishes manufactured by CONSTRUCT and available for inspection at various locations around the UK.

SCC
The Specialist Concrete Contractor constructing the structure.

Site
The designated place where the SCC will construct the structure.

Spacers
All chairs, blocks, supports and devices of a special nature required to hold the reinforcement in the correct position during concreting.

Structure
The concrete structure comprising any or all of the following elements: columns, walls, slabs, beams, bracing, stairs, foundations and sundry items designed by the Engineer.

Temporary works coordinator
The named individual of the SCC responsible for coordinating the temporary works for construction of the structure.

SECTION 1
Materials, workmanship and construction

1.1 GENERAL

1.1.1 **Quality of materials**

All materials used in the structure shall comply with NSCS and current versions of standards referred to therein. The CA may specify samples for testing and the SCC shall arrange for such samples to be supplied, identified, stored and tested and the results delivered to the CA in accordance with the relevant British Standards.

1.1.2 **Standard of workmanship**

The standard of workmanship shall be in accordance with this Specification, the relevant clauses of BS 8110 and all statutory requirements.

Proprietary products and materials shall be used in accordance with the manufacturer's written instructions.

1.1.3 **Modifications**

The SCC shall obtain the agreement of the CA to any modifications to the requirements of this Specification in writing before any work is started.

1.1.4 **Coordinated information**

The SCC shall ensure that coordinated information is submitted to the CA for agreement before work is started on site.

1.1.5 **Acceptance procedures**

i) An acceptance procedure for the issue of construction information shall be agreed with the CA before construction of any work.

ii) Information shall be supplied/agreed as stipulated in this Specification to an agreed timescale and the CA shall comment on the information within five working days of receipt.

iii) Acceptance or agreement by the CA shall have no effect unless given in writing. No such acceptance or agreement shall in any way relieve or diminish the obligations of the SCC under the Contract.

1.1.6 **Setting out the structure**

The SCC shall set out the structure to the given setting out information.

1.1.7 **Construction loads**

During construction the SCC shall ensure that the structure is not subjected to loads which will cause short-term or long-term distress and shall take account of the maturity of the concrete at the time of loading.

1.1.8 **Water-resisting construction**

i) Where water-resisting construction is specified all construction and materials shall meet the recommendations of BS 8102 and details shall be submitted by the SCC to the CA for agreement.

ii) Where water-resisting construction with a waterproofing system is specified, the SCC shall submit to the CA before starting work written confirmation from the waterproofing system supplier that the proposed concrete mix, placing methods, release agents, curing compounds, movement joint details, surface finishes, reinforcement support methods and loads will not adversely affect the performance of the waterproofing system.

1.2 QUALITY ASSURANCE

1.2.1 **Quality management system**

The SCC shall operate an agreed quality management system to BS EN ISO 9000 unless otherwise agreed with the CA, which shall be accessible for audit.

1.2.2 **Documentation**

All documentation shall be available for inspection during the contract period.

1.3 TESTING

1.3.1 **Test results**

The SCC shall supply three copies of all test results to the CA as soon as they are available.

1.3.2 **Additional inspections and tests**

If the CA requires more inspection and testing to be carried out than that specified it shall be at the SCC's expense if the results do not meet the Specification requirements. Otherwise all costs shall be additional to the contract.

1.3.3 **Test nonconformity**

i) Any test results which do not meet the specified criteria shall be reported to the CA. In the light of this nonconformity, the SCC shall propose a course of action to the CA for agreement, within one week of reporting the results. The material to which the test nonconformity applies shall be deemed to be unacceptable unless further testing or analysis proves otherwise and all associated costs shall be borne by the SCC. Any remedial work shall be at the SCC's expense.

ii) A course of action shall be agreed within a further week.

1.4 DRAWINGS AND REINFORCEMENT SCHEDULES

1.4.1 **British Standards, numbering and revisions**

Drawings shall comply with the following requirements:

i) Drawing standards shall be as set out in BS EN ISO 4157: Parts 1–3: 1999.
Revisions and status shall be clearly shown, including dates when revisions were made. A circle or cloud around revisions to drawings should identify revisions made for the latest revision number or letter used. Such revisions should be described in a brief narrative form on the drawing corresponding to the latest revision number or letter.

ii) A register of drawings received and issued by the SCC shall be maintained and available for the CA at any time. The register shall clearly identify the following information: name of company which produced the drawing, drawing number with revision number or letter, dates received and issued by the SCC.

iii) The method of circulation, number of drawings to be issued and schedule of dates when drawings will be issued for comment and when comments will be returned shall be agreed with the CA.

1.4.2 **As-built drawings**

The SCC shall provide sufficient information to the CA to allow coordination of the production of as-built drawings.

1.4.3 **Reinforcement schedules**

The SCC shall be responsible for the accuracy of any reinforcement schedules produced by the SCC. Scheduling of reinforcement shall be in accordance with BS 8666 and BS EN ISO 4066.

1.4.4 **Builders work drawings**

Sufficient information shall be provided to enable builders work drawings to be produced.

1.4.5 **Erection drawings**

Any special stability requirements during erection must be clearly indicated. The SCC will normally be responsible for the production of these drawings, but they may be produced for the SCC.

SECTION 2
Falsework and formwork

2.1 STANDARDS

Design and construction of falsework and formwork shall be in accordance with the following where applicable:

- BS 5975 *Code of practice for falsework.*
- *Formwork: a guide to good practice (Concrete Society, second edition 1995)*
- Construct *Guide for flat slab formwork and falsework (Concrete Society, 2003)*
- CIRIA Report 136 *Formwork striking times – criteria, prediction and methods of assessment (CIRIA, 1995)*
- BS 8110: *Structural use of concrete. Part 1 Code of practice for design and construction.*

2.2 TYPES OF MATERIAL

i) Formwork materials shall suit the method of construction to be used and the surface finish required for the final work.

ii) Permanent formwork may be used subject to the agreement of the CA.

2.3 RELEASE AGENTS

i) The SCC shall choose release agents to suit the method of construction and the finish required, and shall take note of the requirements of subsequent trades.

ii) All release agents used shall be non-staining, non-injurious to the finished concrete and shall not be adversely affected by the weather.

2.4 FORMWORK USE

i) Formwork shall be constructed so as to contain the concrete, to give the required surface finish to the concrete and to adequately support the concrete in the desired final position throughout the period of use.

ii) Where structural concrete relies on permanent or temporary support from the ground, the SCC shall ensure that the support is adequate for concrete operations.

iii) Formwork shall be clean and clear of all debris, free water and ice before concrete is placed.

iv) Concrete shall not be cast directly against existing construction or faces of excavations without the prior agreement of the CA.

2.5 BLOCK OUTS AND CAST-IN ITEMS

i) The SCC shall clear out block out items after concreting.

ii) The SCC shall set out and fix all cast-in items shown or referenced on the drawings.

iii) Any clashes between holes, cast-in items and reinforcement shall be resolved before any concrete is placed.

2.6 FORMWORK TIES

i) Through-ties may be used to support vertical faces of formwork other than in water-resisting construction or as agreed with the CA.

ii) No ferrous metals shall be left in the concrete cover zone when formwork has been struck.

iii) The SCC shall make good any holes left exposed to view in the faces of the concrete to the agreement of the CA.

iv) In water-resisting construction, methods of fixing formwork which result in holes through the concrete section when formwork is removed shall not be used.

v) In water-resisting construction, ties used shall be of a type to maintain water resistance of the construction.

2.7 STRIKING

i) The concrete shall be supported in the required position until it has adequate strength, as determined by the SCC, to support its own weight and any construction loads, without short-term or long-term distress.

ii) Formwork may be struck at a time determined by the SCC, considering the concrete strength at the time of removal, the ambient conditions and the curing and protection of the concrete that is to be used when the formwork has been removed.

iii) Formwork shall be removed carefully to avoid damaging the concrete surface. Any damage so caused shall be made good by the SCC to the acceptance of the CA.

iv) The exact sequence of propping/repropping and backpropping through the structure shall be set out in a method statement prepared by the SCC, shall be agreed with the CA in advance, and shall have no damaging effect on the permanent structure.

2.8 CONSTRUCTION JOINTS AND POUR SIZES

i) The SCC shall position and form construction joints to suit the structure and so as not to cause any short-term or long-term distress to the structure, all to the agreement of the CA.

ii) The SCC shall carefully prepare construction joint surfaces to expose the coarse aggregate to provide a key by a method to be agreed with the CA.

iii) Pour sizes, except as agreed otherwise between the CA and SCC, shall be as shown in Table 1.

Table 1: Maximum areas and dimensions of concrete pours for different types of construction.

Construction	Maximum area (m^2)	Maximum dimension (m)
Water-resisting walls	25	5
Water-resisting slabs	100	10
Slabs with major restraint at both ends	100	13
Slabs with major restraint at one end only	250	20
Slabs with little restraint in any direction	500	30
Walls	40	10

2.9 WATER-RESISTING CONSTRUCTION

i) In water-resisting construction, waterstops shall be used in all construction joints and movement joints in accordance with the manufacturer's written instructions. The SCC shall obtain the agreement of the CA for the methods to be used to maintain the waterstops in their correct locations and to prevent damage while the concrete is being placed and during and after removal of the formwork.

ii) The SCC shall submit to the CA for agreement drawings indicating the positions of joints and details of waterstops to be used. Details shall include schedules of all junction pieces, which shall be purpose made, and isometric layouts of waterstops.

iii) Where waterstops within the concrete section are proposed, the SCC shall submit to the CA for agreement details of the methods to be used to ensure full compaction of the concrete around the waterstop.

SECTION 3

Reinforcement

3.1 MATERIALS

3.1.1 General

All reinforcement shall comply with the requirements of BS 4449, BS 4482, BS 4483, BS 8666 as appropriate.
Reinforcement in accordance with BS 4449 shall be ductility class B.

3.1.2 Reinforcement supply and testing

i) The SCC shall submit details of the source and supplier of reinforcement to the CA for agreement.

ii) Unless otherwise agreed by the CA, all reinforcement suppliers shall hold a valid Certificate of Approval for manufacture and/or fabrication issued by the UK Certification Authority for Reinforcement Steel (CARES). The UK CARES Certificate of Approval Number shall be stated on all documentation.

iii) If reinforcing steel is cut and bent by a supplier other than a UK CARES-approved supplier, the fabricator shall operate a quality management system to BS EN ISO 9002, which shall be approved as part of the SCC's quality management system.

iv) All reinforcement shall be delivered in clearly identified, tagged bundles, mats or prefabricated assemblies and shall be stored on site in a manner so as not to be contaminated or otherwise damaged. Fabric shall be stored flat.

v) All dimensions shall be to the reinforcement schedules given in BS 8666 unless otherwise specified.

vi) Reinforcement shall not be dropped from a height, mechanically damaged or shock loaded in any way.

3.1.3 **Spacers**

i) The SCC shall detail, supply and fix all spacers. The materials and workmanship shall be in accordance with BS 8110: Part 1: 1997, Clause 7.3 and BS 7973 *Spacers and chairs for steel reinforcement and their specification*. The SCC shall ensure that the spacers have the required performance characteristics.

ii) In exposed finish work the type of spacer used shall be agreed with the CA before any work is started.

3.1.4 **Couplers**

i) The SCC shall submit details of the source and suppliers to the CA for agreement.

ii) All manufacturers/suppliers shall be registered members of the UK CARES Quality Assurance scheme or equivalent unless agreed otherwise by the CA.

3.1.5 **Continuity strips**

Proprietary continuity strips can be used subject to agreement by the CA.

3.2 WORKMANSHIP

3.2.1 **General**

All reinforcement shall be fixed in position in accordance with the reinforcement detail drawings and reinforcement schedules. Any alterations to the reinforcement shall be carried out only with the prior written agreement of the CA.

At the time of placing concrete, reinforcement shall be clean, free of corrosive pitting, loose rust and mill scale and other substances that may adversely affect bonding with concrete. Light surface rust will be accepted.

All cutting, bending and fixing shall be in accordance with BS 8110: Part 1: 1997, Clauses 7.2 and 7.3.

3.2.2 **Tying and welding**

i) Tying of reinforcement shall be carried out with black annealed mild-steel 16-gauge tying wire. All ends shall be bent away from the concrete face and all loose ends shall be removed before placing the concrete.

ii) Welding of reinforcement shall be in accordance with the requirements of BS 8110: Part 1: 1997, Clause 7.6 and BS 7123 *Specification for metal arc welding of steel for concrete reinforcement*. Welding procedures and welder qualifications shall be subject to the agreement of the CA.

3.2.3 **Projecting reinforcement**

All reinforcement ends left projecting from cast concrete shall be free of release agents and shall be protected against damage and corrosion, although light surface rusting will be accepted.

SECTION 4

Concrete and concreting

4.1 CONCRETE

4.1.1 **General**

i) Concrete shall conform to BS 8500-2 and shall be as specified in NSCS Part 2.

ii) Procedures for producing concrete shall be in accordance with BS EN 206-1:2002 section 9 and BS 8500-2:2002 section 11. Procedures for ensuring conformity of concrete shall be in accordance with BS EN 206-1:2000 and BS 8500-2:2002 section 10.

iii) The SCC shall submit, as appropriate, details of the proposed concretes in accordance with BS EN 206:2000 Clause 7.2 and BS 8500-1:2002 Clause 5.2 to the CA for approval.

iv) The chloride content of the proposed concrete including chlorides contained in the admixtures shall be limited by BS EN 206-1:2000 Clause 5.2.7. The SCC shall provide evidence of conformity.

v) Calcium chloride shall not be included in any concrete.

vi) Precautions shall be taken to restrict the amount of sulfate in the proposed concrete to 4% SO_3 by mass of cement except when using lightweight aggregates and blastfurnace slag aggregates [Note: Guidance is given in BS 8500-1:2002 Annex A.10.4 and A.10.6].

vii) The SCC shall provide evidence of conformity to the provisions to minimise the risk of damage by alkali-silica reaction given in BS 8500-2:2002 Clause 5.2.

viii) No additions or changes to the fresh concrete shall be made after batching, without prior agreement of the CA.

ix) Daily maximum and minimum atmospheric shade temperatures shall be recorded using a calibrated thermometer(s) located close to the structure.

x) Recycled aggregate and recycled concrete aggregate shall conform to BS 8500-2:2002 Clause 4.3 and to the additional requirements given in NSCS Part 2.

4.1.2 **Plant - Ready-mixed concrete**

i) Ready-mixed concrete shall be supplied by a producer from a plant holding current accredited third party certification meeting requirements of BS EN 206-1:2000 Annex C. The SCC shall provide the CA with confirmation of the producer's certification in accordance with BS EN 206-1:2000 Annex C.3.

ii) Details of ready-mixed concrete plants proposed for use shall be submitted by the SCC to the CA. Contingency plans shall be in place before starting work in the event of supplies being interrupted during a pour due to a plant breakdown. Where feasible, details of a suitable back-up plant/supplier should be submitted to the CA for agreement.

4.1.3 **Plant - Other concrete**

For supplies of concrete from sources other than plants holding current third party certification, the SCC shall submit information to the CA that the production and conformity control systems used are in accordance with BS EN 206-1:2000 Clauses 8, 9 and 10.1 and also BS 8500-2:2002 Clauses 10 to 12.

4.1.4 **Supply and transport**

All concrete shall be supplied and transported to the point of discharge from the mixer/agitator truck in accordance with the requirements of BS EN 206-1:2000 Clause 7 and BS 8500-2:2002 Clause12. Delivery ticket information shall be in accordance with BS EN 206-1:2000 Clause 7.3 and BS 8500-2:2002 Clause 9.1 as relevant and shall be completed and available before discharging concrete into the structure. All delivery tickets shall be retained by the SCC until the structure is handed over to the Employer. Where a ticket is marked 'non conforming' a copy shall be passed to both the SCC and the CA within 24 hours of placing the concrete.

4.2 CONCRETING

4.2.1 **Placing and compaction**

i) Concrete shall be placed and compacted in the structure in accordance with BS 8110: Part 1: 1997, Clause 6.2.2.

ii) Concrete shall be placed and fully compacted so as to avoid cold joints and honeycombing and to minimise segregation, excessive blemishes or other defects in the hardened concrete.

iii) Kickerless construction shall be in accordance with *Kickerless construction* (British Cement Association, 1996). Where kickers are used, they shall be monolithic with the slab, of sound construction and at least 100 mm high.

iv) For water-resisting construction kickers shall be cast 150 mm high and monolithic with the slab.

v) Arrangements for premature stoppage of a pour shall be agreed and in place before work starts. Should premature stoppage of a pour occur, the SCC shall agree with the CA the extent and timing of any necessary remedial work before resumption of placing.

4.2.2 **Concreting in extreme weather**

i) For concreting in cold weather, the recommendations of BS 8110: Part 1: 1997, Clause 6.2.4 shall be followed and further guidance may be found in BS 8500-1:2002 Annex A.11.1.

ii) For concreting in hot weather the recommendations of BS 8110: Part 1: 1997, Clause 6.2.5 shall be followed and further guidance may be found in BS 8500-1:2002 Annex A.11.2.

4.3 CURING AND PROTECTION

4.3.1 **Curing**

The surface of the concrete shall be cured to avoid premature drying out. Methods of curing and curing periods shall be in accordance with BS 8110: Part 1: 1997, Clause 6.2.3 and as agreed with the CA. Curing membranes shall be compatible with any finishes to be applied subsequently.

4.3.2 **Protection**

i) All surfaces shall be protected from the effects of adverse weather in accordance with BS 8110: Part 1: 1997, Clause 6.2.3.3. The structure shall be protected against damage.

ii) Damage occurring shall be made good by the SCC. Methods to be used shall be proposed by the SCC for agreement with the CA.

iii) The faces of cast concrete that will be visible in the completed structure shall be protected from rust staining.

iv) If concrete is to be placed in a large volume pour, if a rich concrete is used or if the section is thicker than 500 mm, consideration shall be given to the concrete temperature rise above ambient and to reducing the risk of early thermal cracking. The SCC shall ensure that the temperature of the concrete does not exceed 65°C and that the temperature differential does not exceed the appropriate values given in *Concreting deep lifts and large volume pours* (CIRIA, 1995), Table 2.

Where a risk of thermal cracking is identified, the location of temperature monitoring apparatus and interpretation of the temperatures recorded shall be agreed with the CA prior to installation.

4.4 CONFORMITY AND IDENTITY TESTING DURING CONCRETING OPERATIONS

i) The producer shall carry out sampling and testing for conformity during concreting operations in accordance with BS EN 206-1:2000, Section 8 and BS 8500-2:2002, Section 10. Where the producer identifies a non-conformity that was not obvious at delivery, this shall be reported to the CA and the Employer within 24 hours of the SCC receiving notification.

ii) The SCC shall carry out testing in accordance with BS EN 12350: *Testing fresh concrete* to ensure concrete consistence, and where relevant air content, at delivery is in accordance with this specification.

If water or other material is added to the concrete truck mixer drum before discharge, in accordance with BS EN 206-1:2000 Clause 7.5 additional identity testing for strength shall be carried out where designated or designed concretes are used.

Concrete cubes shall be tested in accordance with BS EN 12390 in a UKAS accredited laboratory, or equivalent, independent of contractual parties.

Where identity testing is required for designed concretes as defined in Part 2 of this specification, the SCC is to inform the producer that identity testing for strength is required. The criteria for acceptance will be that given in BS EN 206 Appendix B.

4.5 INSPECTION

4.5.1 **Inspection before placing**

The SCC shall inspect the formwork, spacers, fixed reinforcement and inserts before placing the concrete and shall only allow concrete to be placed once the work is satisfactory and the CA has had reasonable opportunity for inspection.

4.5.2 **Inspection after placing**

i) After the specified period of curing, the SCC shall inspect the relevant work. If any remedial measures are necessary, the SCC shall submit details to the CA for agreement.

ii) In water-resisting construction, inspection to identify defects which may lead to water penetration shall be carried out jointly with the SCC and CA before backfilling or covering up. Further inspection shall be jointly carried out to identify any water penetration after backfilling.

Any leaks or damp patches shall be repaired by methods proposed by the SCC and agreed with the CA, in accordance with BS 8102: 1990, Clause 8.8 and 8.9 and CP 102: 1973.

4.6 SURFACE FINISHES

4.6.1 **Formed finishes**

Unless a finish is specified, Type A shall be provided.

i) **Basic finish** requires compliance with all relevant clauses of this Specification.

ii) **Type A finish** is as defined by BS 8110: Part 1: 1997, Clause 6.2.7.3 Type A. The resulting finish shall be similar to the regional Reference Panels.

iii) **Type B finish** is as defined by BS 8110: Part 1: 1997, Clause 6.2.7.3 Type B. The resulting finish shall be similar to the regional Reference Panels.

iv) **Type C finish** shall be as specified in NSCS Part 2.

4.6.2 **Unformed finishes**

Unless a finish is specified Type U1 shall be provided.

i) **Type U1 finish.** The concrete shall be levelled to produce a closed uniform surface. No further work shall be carried out.

ii) **Type U2 finish** shall be produced by floating, or a similar process, to produce a level, uniform surface.

iii) **Type U3 finish** shall be produced by trowelling, or a similar process, to produce a dense, smooth surface.

iv) **Type(s) U4 finish** shall be produced by further working of either U1, U2 or U3 type of finish, as specified in NSCS Part 2.

4.6.3 **Surface cracking**

The SCC shall take all reasonable actions to minimise surface cracking. Unless otherwise specified isolated cracks of width up to 0.3 mm will be accepted in localised areas.

Cracking that will allow corrosion of reinforcement, unsightliness, unacceptable water leakage, impair durability or reduce structural adequacy shall be rectified by the SCC as agreed with the CA.

SECTION 5

Precast concrete

5.1 GENERAL

This section deals with additional considerations for structures partly or wholly of precast construction.

5.2 MANUFACTURE AND SUPPLY

5.2.1 **General**

i) The SCC shall submit details of the proposed concrete plant to the CA for agreement before starting work.

ii) The precast concrete plant shall operate an agreed quality management system to BS EN ISO 9000, unless otherwise agreed with the CA. This system shall include appropriate methods of checking the work to ensure that the precast components are constructed in accordance with all the contractual requirements. The relevant Standards applicable to the project shall be identified in the Quality Plan, where not specified elsewhere in the documentation.

iii) Before any precasting is carried out the SCC shall agree with the CA all details of manufacture, supply and testing.

iv) Permitted dimensional deviations shall be in accordance with BS 8110: Part 1: 1997, Clauses 6.2.8.3 to 6.2.8.6 inclusive and 6.2.8.8. Before manufacture the SCC shall ensure that adequate allowances have been made for all construction tolerances to ensure proper final fit up of the structure.

Reference shall also be made to BS 8110: Part 1: 1997, Clause 5.2.4.

v) The SCC shall keep records of the unit mark, the composition of the unit, the date of manufacture, the date of release from the mould and the curing regime. These records shall be kept on site and made available for inspection.

5.2.2 **Reinforcement**

Cages shall be made up and securely fixed in accordance with the reinforcement detail drawings to provide adequate rigidity and to ensure that the specified cover and fit within the mould are achieved.

i) Reinforcement up to 12 mm in diameter that projects from the face of the units may be bent to facilitate the casting or demoulding of the unit subject to agreement for each case. The reinforcement shall not be rebent to its final position in the structure before the concrete has achieved two-thirds of its specified characteristic strength.

ii) For concrete surfaces to be exposed in the finished structure spacer blocks shall not be used unless agreed with the CA.

5.2.3 **Steam curing**

Precast units may be steam-cured at atmospheric pressure subject to the agreement of the CA and to the following conditions:

i) The total chloride ion content of the concrete from the aggregate, water and any admixtures shall not exceed 0.1% of the weight of cement.

ii) Steaming shall not be started until at least two hours after completion of casting.

iii) The temperature in the enclosure surrounding the units shall not exceed 60°C when measured close to the surface of the units.

iv) The SCC shall take adequate precautions to prevent the units being damaged by an excessive rate of cooling.

v) Curing, with or without steam, shall be continued until the concrete has reached at least two-thirds of its specified characteristic strength.

5.2.4 **Demoulding**

For precast concrete units cast under factory conditions the minimum period before removing the formwork shall be at the discretion of the SCC on the basis of the assessed compressive strength of the unit.

No unit shall be lifted from the base on which it was cast before the concrete has attained its design demoulding strength and in no case less than 8 N/mm^2, and is strong enough to prevent the unit from being damaged, overstressed or distorted, having due regard to the demoulding equipment to be used.

5.3 MARKING

i) Each precast unit shall be clearly marked before delivery in accordance with the drawings to indicate its weight, location and orientation in the structure in order to facilitate correct erection.

ii) All marks shall be positioned so that they are hidden from view or may be removed without marking the concrete surface.

5.4 STORAGE

i) If precast units cannot be delivered to site and installed directly into their final positions, the SCC shall arrange suitable storage to ensure that no deterioration or damage occurs. Storage shall be on firm supports clear of the ground. The SCC shall submit storage proposals to the CA.

ii) Storage instructions for precast units shall include the storage position, the allowable support points, the maximum height of any stack and any protective measures required.

iii) Unit faces to be exposed in the finished construction shall be protected from mechanical damage, dirt, staining, rust marks or other disfiguration.

5.5 HANDLING AND ERECTION

i) The SCC shall determine the need for any additional reinforcement or fittings that may be necessary for handling the units until they are incorporated into the structure. The SCC shall make provisions for temporary works purposes and shall make good any inserts, holes etc. used for lifting or other temporary works purposes.

Any inserts or fixings required by the SCC to be cast in the concrete and permanently exposed either externally or within the cavity of the building envelope shall be of stainless steel unless agreed otherwise by the CA. In other conditions, any protective treatment shall be as agreed with the SCC.

ii) The SCC shall ensure that any precast concrete unit to be incorporated into the structure is kept stable in its erected position until such time as the element can safely carry the construction loads without distress. The overall stability of the structure shall be maintained at all times during erection.

5.6 ALIGNMENT OF PRECAST UNITS

Precast units shall be positioned in the frame to the tolerances given in Section 7, Construction accuracy.

Any deviation from the permitted tolerances shall be evaluated by the SCC who shall submit proposals for remedial work for agreement with the CA.

5.7 MORTAR

Mortar for bedding precast units shall be made of cement, sand and water in the proportions, by volume, of:

1 part of CEM IPortland cement
2 parts of sand to BS EN 13139 *Aggregates for mortar.*

The quantity of water required to achieve a mix suitable for the jointing details shown on the drawings shall be determined by the SCC.

No other ingredients shall be added without approval.
Mortar designated as dry-packed shall be of such a consistency that it can be properly compacted by ramming.

5.8 CONCRETE INFILL

The surfaces of precast units shall be thoroughly cleaned and wetted. Concrete shall be placed avoiding segregation, and compacted thoroughly to eliminate voids. Precast units shall be prevented from moving until the concrete infill has gained sufficient strength to ensure stability.

5.9 COMPOSITE CONSTRUCTION

The surfaces of precast units shall be thoroughly cleaned and wetted. Concrete shall be placed avoiding segregation, and compacted thoroughly to eliminate voids. Precast units shall be prevented from moving until the concrete infill has gained sufficient strength to ensure stability.

5.10 CONNECTIONS

Connection details shall be compatible with the design assumptions. Details shall be submitted to the CA by the SCC for agreement.

SECTION 6

Prestressed concrete

6.1 GENERAL

This section deals with additional considerations for structures partly or wholly of prestressed construction.

6.2 STANDARDS AND DESIGN GUIDES

i) Materials and construction shall be in accordance with BS 8110: Part 1: 1997 Section 8 and Annex A. In case of conflict the NSCS takes precedence over BS 8110.

ii) Reference should also be made to Concrete Society Technical Reports 43 *Post-tensioned concrete floors – design handbook* (1994) and 47 *Durable post-tensioned concrete bridges (2002).*

6.3 TYPE OF SYSTEM AND METHOD STATEMENT

The SCC shall submit to the CA for agreement all details of the prestressing system as appropriate before construction and a detailed statement on proposed methods, sequences and timing of operations. Details to be submitted shall include but not be limited to the following:

- Tendons
- Sheathing or ducting
- Anchorages
- Any anti-corrosive or friction-reducing compounds for unbonded systems
- Drainage and bleed details for grouted tendons
- Methods of installation
- Supports
- Stressing
- Grout mix and method of grouting including vent location
- Corrosion protection details
- Fire resistance

6.4 MATERIALS AND EQUIPMENT

6.4.1 **Prestressing tendons**

i) Prestressing tendons shall conform to BS 4486 for bars and BS 5896 for wire or strand. Before delivery to site, documentary evidence shall be submitted to the CA of the manufacturer's ability to comply with the relevant British Standard. Evidence based on an agreed certification scheme will be accepted.

ii) Reference shall be made to BS 8110: Part 1: 1997, Clause 8.4 concerning straightness.

iii) Manufacturer's test certificates for each coil of strand or wire, and each type of bar supplied to site shall be submitted to the CA before installation. Certificates shall contain the information required by BS 4486 or BS 5896. Each coil of wire or bar shall be clearly marked for identification against certificates.

iv) Unbonded tendon coatings shall be in accordance with *Recommendations for the corrosion protection of unbonded tendons* (FIP, 1986).

6.4.2 **Un-tensioned reinforcement**

Un-tensioned reinforcement shall comply with BS 4449.

6.4.3 **Sheaths**

Sheaths shall be formed of material that will not react adversely chemically with concrete, grease or steel. For grouted tendons, ducts shall comply with BS 8110: Part 1: 1997, Annex A, Clause A2. Other duct materials may be used with the agreement of the CA.

6.4.4 **Anchorages**

Anchorages shall comply with BS 4447 and to appropriate sections of BS 8110: Part 1: 1997 in Clauses 8.7.4.1 or 8.7.5.2. The SCC shall provide the CA with quality control documentation for the anchorage.

6.4.5 **Concrete strength at transfer**

Sufficient concrete cubes shall be cast to demonstrate that the required in situ strength of concrete at transfer has been reached. No member shall be stressed until the strength of each of two cubes taken from the concrete used is not less than the specified transfer strength. The test cubes shall be made and tested in accordance with relevant the parts of BS EN 12350 and BS EN 12390 but shall be cured in similar conditions to the concrete to which they relate.

6.4.6 **Grout**

i) Grout material and equipment for grouted tendons shall comply with the appropriate clause of BS 8110: Part 1: 1997 Annex A and *Durable post-tensioned concrete bridges* (Concrete Society, 2002).

ii) Fluid and hardened properties of grout shall be submitted to the CA for agreement before construction. Suitability will generally be established by grouting trials using the procedures in Concrete Society TR 47 and BS EN 445 and BS EN 446. Trials should be on construction similar to the permanent works in terms of:

- Length, type and profile of ducts
- Vent arrangement
- Grout mix.

The SCC shall carry out full-scale grouting trials using the same equipment and procedures as those proposed for the works.

6.4.7 **Tensioning apparatus**

i) Tensioning apparatus shall comply with BS 8110: Part 1: 1997, Clause 8.7.3.

ii) Apparatus shall be operated in accordance with the system manufacturer's written instructions and shall be maintained in good working condition.

iii) All load-measuring equipment shall be tested in accordance with the quality plan of the accredited manufacturer.

6.4.8 **Transportation, storage and handling**

Methods used for transporting, storing and handling tendons shall comply with BS 8110: Part 1: 1997, Clause 8.2 and shall not cause damage to any component of the prestressing system and equipment.

6.5 WORKMANSHIP

6.5.1 **General**

i) Workmanship shall comply with BS 8110, Part 1: 1997, Clauses 8.3, 8.5, 8.6 and 8.7.5 and Annex A and relevant clauses of Concrete Society TR47 where grouted tendons are used. Prestressing operations shall be carried out under the direction of experienced and competent supervisors and all personnel operating tensioning and grouting equipment shall have been certified as competent by the system supplier. All prestressing materials and equipment shall be used in strict accordance with the recommendations of the manufacturer of the stressing system. Cutting to length and trimming of ends shall be by high-speed abrasive cutting wheel.

ii) The SCC shall submit the following to the CA for agreement prior to any work.

- Fully dimensioned drawings, plans and cross-sections of tendon and anchorage layouts indicating tendon profiles at regular intervals along each length, support details, stressing sequences etc. Stressing end and dead end anchorages shall be clearly defined
- Any ordinary reinforcement sizes and locations required to supplement the post-tensioning design and also bursting reinforcement at anchorages to suit anchor type and layout
- Minimum concrete strength at each stage of stressing and anchorage capacities
- Calculations of forces and elongation of tendons with jack pressure-gauge readings at each stressing stage taking into account all short-term and long-term losses including anchorage friction, wedge pull-in, jack losses, duct friction, etc.
- Vent locations for bonded tendons and details of vent closures.

6.5.2 **Safety**

The SCC shall take all necessary precautions to ensure safety during and after stressing operations and during grouting and shall make reference to BS 8110: Part 1: 1997, Clause 8.7.2. Appropriate procedures shall be set out in the SCC's method statement.

6.5.3 **Soffit marking**

Tendon positions shall be marked on the soffit to indicate locations in both plan and elevation within the slab. The system to be used for identification shall be agreed with the CA and shall be recorded on the as-built drawings.

6.5.4 **Anchorages, tendons and sheathing**

i) Anchorages and tendons shall be protected against damage and corrosion at all times. The requirements of BS 8110: Part 1: 1997, Clauses 8.3 and 8.7.5.1 shall be complied with. Under no circumstance shall prestressing steel be subjected to any welding operation, heat treatment or metallic coating after manufacture.

ii) Joints in sheathing shall be sealed. At anchorages, joints shall be sealed to prevent ingress of concrete or egress of grout.

iii) Anchorages and sheathing ducts shall be firmly fixed in place so they are not disturbed during concreting.

iv) Anchorages shall be protected in the final condition in accordance with the recommendations in Section 7.7.3 of Concrete Society TR43 or other details as agreed by the CA.

6.5.5 **Tensioning**

i) Reference shall be made to BS 8110: Part 1: 1997, Clause 8.7.1 and tensioning procedures shall be carried out in accordance with BS 8110: Part 1: 1997, Clause 8.7.5.4 and Section 7.7.5 of Concrete Society Technical Report 43. Stressing ends shall not be cut or removed until the SCC has obtained agreement from the CA that all test requirements have been complied with.

ii) Tensioning shall not start until the SCC has advised the CA, within a time previously agreed, when stressing is due to commence and that the following has been carried out and agreed:

- All required tests have been completed
- A method statement has been agreed
- The structure to be stressed (including any joints) has achieved the specified strength
- Allowance has been made for formwork to accommodate shortening, bending or uplift during stressing
- All tendons are free to move between jacking points and members are free to accommodate the horizontal and vertical movements due to the application of prestress
- Calculations of the total force and extension for each tendon after allowance for anchorage friction, wedge pull-in, jack losses and duct friction have been approved
- Details of any grout mix proposals have been agreed.

iii) Cropping of tendons shall be by mechanical means such as an angle grinder or shearing device, not by burning.

iv) Load–extension graphs shall be plotted for the first tendon of each typical length during stressing.

v) Stressing of tendons shall continue until both the required load and the calculated extension have been reached, provided that both the following conditions have been satisfied.

- The load in the tendon does not exceed 80% of the specified characteristic breaking load during stressing or 75% of the specified characteristic breaking load after anchoring
- The measured extension of the tendon under its specified load differs from the calculated value by more than 10% for tendons less than 20 m long and 6% for tendons greater than 20 m long.

6.5.6 **Anchoring**

When the prestress has been applied to the satisfaction of the CA, the tendons shall be anchored in accordance with the system manufacturer's instructions. If the pull-in of the tendon at completion of anchoring is greater than that agreed, the SCC shall inform the CA.

6.5.7 **Grouting**

i) For grouted tendons, the grouting after tensioning shall comply with BS 8110: Part 1: 1997, Clause 8.9 and Annex A, and Concrete Society Technical Report 47.

ii) All grouting and venting points shall be suitably marked to enable identification of the duct to which they are connected.

6.5.8 **Records**

The SCC shall send to the CA, not more than one week after the transfer of stress, a certificate showing the force and extension in the tendons immediately after they were anchored, the strength and age of test cubes demonstrating that the specified transfer strength had been achieved and the minimum age in hours of the concrete at the time the stress was applied to the member. Cube strengths of the grout, for any grouted tendons, shall also be reported to the CA.

6.5.9 **Final protection of anchorages and tendons**

Anchorages and exposed ends of tendons shall be properly protected against the ingress of water or aggressive agents likely to corrode the steel or anchorages. The SCC shall submit proposals to the CA for agreement. Protection shall include the requirements specified in BS 8110: Part 1: 1997, Clause 8.8

SECTION 7
Construction accuracy

7.1 GENERAL

i) The following clauses give the permitted deviations and location of the structure as defined on the drawings. The location of the reference grids for the overall positioning of the structure shall be agreed by the CA and the SCC before the structure is set out.

ii) The tolerances given in this section are NOT cumulative. The SCC shall carry out regular checks on the structure. If an accumulation of tolerances results in a position which is out of tolerance the SCC shall propose remedial measures for agreement with the CA.

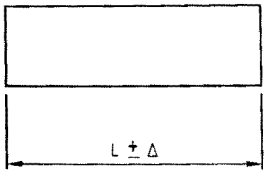
iii) Factory-produced precast concrete components shall be within the tolerances specified in Section 5.2.1 iv.

7.2 SIZE OF ELEMENTS

7.2.1 **Slab thickness**
Permitted deviation on slab thickness shall be as follows:

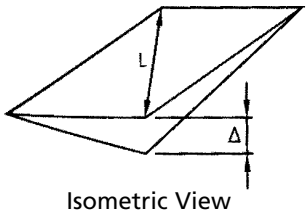
Thickness t	Δ mm
Up to and including 150 mm	± 6 mm
Over 150 mm up to and including 600 mm	± 10 mm
Over 600 mm up to and including 1 m	± 15 mm
Over 1m	± 20 mm

7.2.2 **Formed elements**
The linear dimension of formed elements shall be accurate to within the following distances (where L is length, height or width of element in the direction considered).



L	Δ mm
Up to and including 600 mm	8 mm
Over 600 mm up to and including 1.5 m	10 mm
Over 1.5 m up to and including 8 m	15 mm
Over 8 m up to and including 15 m	20 mm
Over 15 m up to and including 30 m	30 mm
Over 30 m	30 mm + 1 mm per metre or part over 30 m

7.3 TWIST OF ELEMENTS

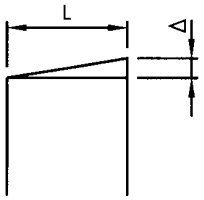


Isometric View

The distance from any one corner to the plane containing the other three corners shall be accurate to within the following:

L	Δ mm
Up to and including 600 mm	6 mm
Over 600 mm up to and including 3 m	10 mm
Over 3 m up to and including 8 m	15 mm
Over 8 m	15 mm + 2 mm per metre or part over 8 m

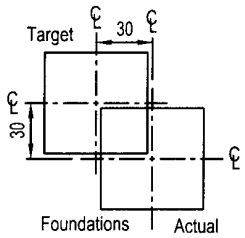
7.4 SQUARENESS OF ELEMENTS



Permitted deviation on squareness shall be as follows:

L	Δ mm
Up to and including 600 mm	6 mm
Over 600 mm up to and including 2 m	10 mm
Over 2 m up to and including 4 m	15 mm
Over 4 m	15 mm + 1 mm per metre or part over 4 m

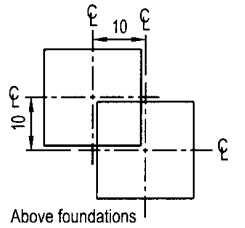
7.5 POSITION ON PLAN



i) The position on plan of any element of the foundation relative to the intended position shall be accurate to within ± 30 mm as illustrated.

ii) The position on plan of any element above the foundation relative to the intended position shall be accurate to within ± 10 mm measured at floor level as illustrated.

POSITION ON PLAN - ANY ELEMENT



iii) The position on plan of slab edges relative to the intended position shall be accurate to within ± 10 mm measured at floor level.

7.6 LEVEL OF ELEMENTS

The following tolerances are for surfaces that will receive further levelling finishes and are 'pre strike'.

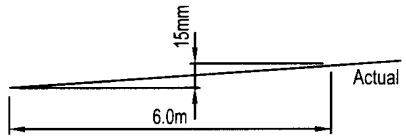
i) Permissible deviation from intended level shall be ± 10 mm and an allowance shall be stated in Part 2 for deflection.

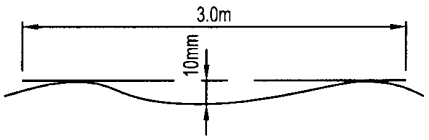
ii) The top surface of any foundation shall be within ± 15 mm of the intended level.

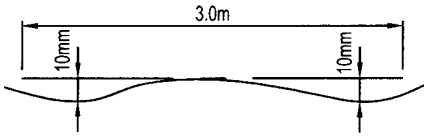
iii) Intersecting beams intended to be at the same level shall be accurate to within +10 mm.

iv) Deviation in level between two points 6 m apart shall be less than 15 mm.

v) Deviation at any point under a 3 m straight edge placed at any position on floor shall be less than 10 mm.

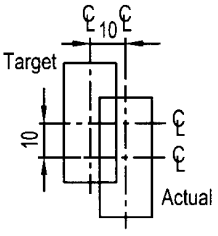






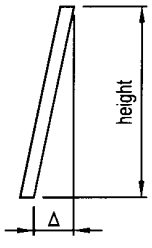
7.7 CAST-IN FIXINGS

No fixing shall be more than 10 mm from the intended position, as illustrated.



7.8 VERTICALITY OF ELEMENTS

Plumb over a height including beams or edges above each other shall be accurate to within the following:



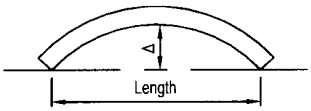
Height	Δ mm
Up to and including 1.5 m	5 mm
Over 1.5 m up to and including 2.5 m	10 mm
Over 2.5 m up to and including 4 m	15 mm
Over 4 m up to and including 8 m	20 mm
Over 8 m	20 mm + 1 mm per metre or part over 8 m (with a maximum of 50 mm)

7.9 BOW OF ELEMENTS

i) Unspecified bow measured between extremities shall not exceed the following:

Length	Δ mm
Extremities up to and including 1.5 m apart	± 5 mm
Over 1.5 m up to and including 3 m apart	± 8 mm
Over 3 m up to and including 5 m apart	± 10 mm
Over 5 m up to and including 8 m apart	± 15 mm
Over 8 m	± 15 mm + 1 mm per metre or part over 8 m (with a maximum of 25 mm)

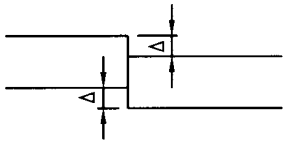
ii) Permitted deviation to specified pre-camber



Specified Δ	Permitted deviation mm
Up to and including 20 mm	± 5 mm
Over 20 mm and up to and including 40 mm	± 10 mm
Over 40 mm	± 15 mm

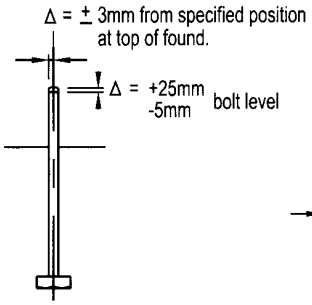
7.10 ABRUPT CHANGES OF CONTINUOUS SURFACES WHERE FINISH IS NOT SPECIFIED

Δ = Permitted up to 3 mm but at construction or movement joints up to 5 mm as measured on the nominal surface of the finish face.

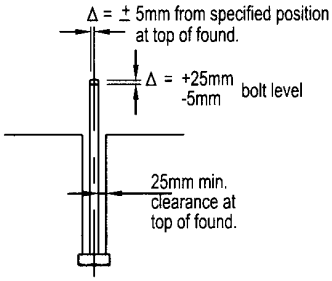


7.11 CAST-IN FOUNDATION BOLTS

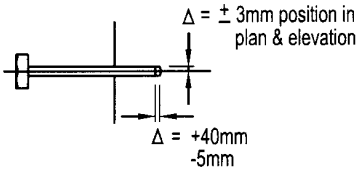
Pre-set foundation bolt or bolt groups when prepared for adjustment. Deviation from specified position.



Pre-set foundation bolt or bolt groups when not prepared for adjustment. Deviation from specified position.



Pre-set wall bolt or bolt groups when not prepared for adjustment. Deviation from specified position.



7.12 COVER TO REINFORCEMENT

Unless otherwise specified, tolerances shall be in accordance with BS 8110: Part 1: 1997, Clause 7.3.

7.13 PRESTRESSED CONCRETE

i) Anchorages shall be located within the following tolerances
Horizontally ± 25 mm
Vertically ± 5 mm

ii) Tendons and sheathing shall be positioned in accordance with BS 8110: 1997, Clause 8.6 and to the following tolerances:
Horizontally in beams ± 50 mm, slabs ± 150 mm
Vertically ± 5 mm except for slab thickness less than 200 mm thick where ± slab thickness shall apply.

REFERENCES

Standards

BS 4447:	Specification for the performance of prestressing anchorages for post-tensioned construction
BS 4449:	Specification for carbon steel bars for the reinforcement of concrete
BS 4482:	Specification for cold reduced steel wire for the reinforcement of concrete
BS 4483:	Steel fabric for the reinforcement of concrete
BS 4486:	Specification for hot rolled and hot rolled and processed high tensile alloy steel bars for the prestressing of concrete
BS 5328:	Concrete (withdrawn)
BS 5896:	Specification for high tensile steel wire and strand for the prestressing of concrete
BS 5975:	Code of practice for falsework
BS 7123:	Specification for metal arc welding of steel for concrete reinforcement
BS 7973:	Spacers and chairs for steel reinforcement and their specification, Part 1: Product performance and specification, Part 2: Fixing and application of spacers and chairs and tying of reinforcement
BS 8102:	Code of practice for protection of structures against water from the ground
BS 8110:	Structural use of concrete, Part 1:Code of practice for design and construction, Part 2: Code of practice for special circumstances
BS 8500:	Concrete – Complementary British Standard to BS EN 206-1, Part 1: Method of specifying and guidance for the specifier, Part 2: Specification for constituent materials and concrete
BS 8666:	Specification for scheduling, dimensioning, bending and cutting of steel reinforcement
BS EN 206:	Concrete, Part 1: Specification, performance, production and conformity
BS EN 445:	Grout for prestressing tendons. Test methods
BS EN 446:	Grout for prestressing tendons. Grouting procedures
BS EN 12350:	Testing fresh concrete (seven parts)
BS EN 12390:	Testing hardened concrete (eight parts)
BS EN 13139:	Aggregates for mortar
BS EN ISO 4066:	Construction drawing - bar scheduling
BS EN ISO 4157:	Construction drawings. Designation systems, Part 1: Buildings and parts of buildings, Part 2: Room names and numbers, Part 3: Room identifiers
BS EN ISO 9000:	Quality management systems. Fundamentals and vocabulary
BS EN ISO 9002:	Quality systems. Model for quality assurance in production, installation and servicing
CP 102:	Code of practice for protection of buildings against water from the ground
EN 1992-1-1.	Eurocode 2: Design of concrete structures, Part 1: General rules and rules for buildings, European Committee for Standardisation, Brussels.

General References

British Cement Association. *Kickerless construction*, 47.023, 1996

CIRIA *Concreting deep lifts and large volume pours*, Report 135, London, 1995

CIRIA *Formwork striking times – criteria, prediction and methods of assessment*, Report 136, London, 1995

CONSTRUCT *Guide for flat slab formwork and falsework*, CS140, Concrete Society, Crowthorne, 2003

FIP *Recommendations for the corrosion protection of unbonded tendons*, Thomas Telford Ltd, 1986

The Concrete Society *Durable post-tensioned concrete bridges*, Technical Report 47, Crowthorne, 1996, New 2nd Edition 2002

The Concrete Society *Formwork: a guide to good practice*, CS030, 2nd Edition, Crowthorne, 1995

The Concrete Society *Post-tensioned concrete floors – design handbook*, Technical Report 43, Crowthorne, 1994

National Structural Concrete Specification

for Building Construction

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PART 2. PROJECT SPECIFICATION

General

i) The specification for the structure shall be the National Structural Concrete Specification for Building Construction (NSCS).

ii) NSCS Part 2 is provided by the Employer and identifies the appropriate information specific to the structure over and above that stated in the NSCS Part 1. Some clauses in Part 1 may be modified by information in Part 2.

SECTION P1
Information to be supplied to the SCC

P1.1 PROPOSED WORKS

Project

Name: .....

Address: .....

Tel. no: ..... E-mail: .....

Employer

Name: .....

Address: .....

Tel. no: ..... E-mail: .....

Contact name: .....

Engineer

Name: .....

Address: .....

Tel. no: ..... E-mail: .....

Contract administrator (CA)

Name: .....

Address: .....

Tel. no: ..... E-mail: .....

Other named Parties to the Contract: .....

.....

.....

.....

Description of the project works (nature of building and intended use, number of floors, column grids, stair and core, stability system, foundations, basements, location of water-resisting construction, special finishes etc.)

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General construction planning requirements:

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P1.2 DESIGN

i) Method and codes used: BS 8110 / EC2 / BS 6399 / EC1 * ** Delete as appropriate*

.....

ii) General loading and other design data

Loading	Units	Location	Location	Location .....
Imposed General				
Partitions				
Total imposed				
Dead load Self				
Partitions				
Flooring				
Screed				
Services				
Ceiling				
Total dead load				
Cladding				
Wind				

Design Data	Units	Location	Location	Location .....
Fire rating				
Durability				
Design life				
Maintenance/ replacement assumptions				
Other [fatigue, thermal, impact, prestress class, etc.]				
Notes				

P1.3 DRAWINGS and CALCULATIONS

Item		Preparation		Tender issue	Acceptance issue		Construction issues	
Type	Type of construc-tion**	Prepared by	Format P: paper E: electronic	Number of copies	Number of copies	Period before construction (weeks)	Number of copies	Period before construction (weeks)
General arrangement drawings	RC	CA	P / E*	[2]			[5]	[11]
	PCC st	CA	P / E*	[2]			[5]	[11]
	PCC sp	CA	P / E*	[2]			[5]	[11]
	PSC	CA	P / E*	[2]			[5]	[11]
Design information drawings	RC	CA	P / E*				[5]	[11]
	PCC st	SCC	P / E*				[5]	[11]
	PCC sp	CA	P / E*				[5]	[11]
	PSC	CA	P / E*				[5]	[11]
Erection drawings	RC	SCC/CA*	P / E*	[2]			[5]	[11]
	PCC st	SCC/CA*	P / E*	[2]			[5]	[11]
	PCC sp	SCC/CA*	P / E*	[2]			[5]	[11]
	PSC	SCC/CA*	P / E*	[2]			[5]	[11]
Design calculations	RC	CA	P / E*					
	PCC st	SCC	P / E*		[3]	[8]	[5]	[5]
	PCC sp	SCC	P / E*		[3]	[8]	[5]	[5]
	PSC	SCC	P / E*		[3]	[8]	[5]	[5]
Specialist drawings†	RC	SCC/CA*	P / E*		[3]	[8]	[5]	[5]
	PCC st	SCC	P / E*		[3]	[8]	[5]	[5]
	PCC sp	SCC	P / E*		[3]	[8]	[5]	[5]
	PSC	SCC	P / E*		[3]	[8]	[5]	[5]
Reinforcement drawings and schedules	RC	SCC/CA*	P / E*		[3]	[7]	[5]	[3]
	PCC st	SCC						
	PCC sp	SCC	P / E*		[3]	[7]	[5]	[3]
	PSC	SCC	P / E*		[3]	[7]	[5]	[3]
Coordinated builders work drawings	All	CA/SCC*	P / E*		[3]	[4]	[5]	[2]
Temporary works drawings and/or calculations	All	SCC	P / E*		[3]	[4]	[5]	[2]
As-built drawings	All	SCC/CA*	P / E*				[3]	[3] months after completion

Notes 1. Default values are shown in [ ]. Changes should be entered leaving the default value to show the change. **2.***Delete as appropriate. **3.** †Enter details as required. **4.**** Types of Construction:- RC: Reinforced concrete. PCC st: Precast concrete standard products.
PCC sp: Precast concrete special purpose-made products. PSC: Prestressed concrete.

P1.4 MATERIALS

P1.4.1 Concrete

Specific requirements for materials: special aggregates, cement sources, etc. ----------

P1.4.2 Other materials

i) The following materials are not permitted: ----------

ii) Items supplied by the Employer: ----------

iii) Use of the following materials requires special consideration: ----------

P1.5 PROJECT REQUIREMENTS

i) The following special requirements apply:

Part 1 Clause reference	Change N: new D: deleted M: modified	Description

ii) The timings given in Part 1 apply to all approvals except as noted below. Default values are shown in [ ]. Changes should be entered leaving the default value to show the change.

Part 1 Clause reference	Item	Requirements
1.1.4	Response by CA to approval request	[1 week]
1.3.1	Copies of test results	[3 No.]
1.3.3	Proposal and response time for work rectification	[1 week & 1 week]
3.2.1	Notice to CA for site changes to reinforcement	[1 day]
4.3.2	Duration of special protection	[Contract]
4.5.1	Notice to CA for concrete pour inspection	[1 day]

P1.6 WATER-RESISTING CONSTRUCTION

The required performance for water-resisting construction is to be achieved by:

i)* The use of materials and details listed below and as shown on construction drawings.

ii)* SCC selection and installation of materials and systems, as appropriate, to achieve a grade ---------- environment using the grade classification in Table 1 in BS 8102:1990, Clause 3.2.4.

** Delete as appropriate*

Detail	Location	Waterstops	Separation membranes	Joint fillers
Manufacturer				
Material				
Type	Slabs - horizontal construction joints			
	Slabs - horizontal movement joints			
	Wall - horizontal slab/wall junction			
	Wall - vertical construction joint			
	Wall - vertical movement joint			

P1.7 SURFACE FINISHES

i) Type A and B reference panel for this project is at: ----------

ii) Special finishes (other than Type A or U1) are required as follows:

Type	Location on site	Similar finish can be seen at	Concrete class	Sample/special requirements

P1.8 CONCRETE

P1.8.1 Designated concrete

In accordance with BS 8500-2:2002

1.	Concrete designation (Ref BS 8500-1:2002 Clause A.4)				
2.	Maximum aggregate Size(mm) Enter 10 or 40 if required)	20	20	20	20
3.	Consistence class – slump (mark one value) – slump (mark one value) – slump (mark one value) – other (enter value)	S1 S2 S3 S4	S1 S2 S3 S4	S1 S2 S3 S4	S1 S2 S3 S4
4.	Special restrictions on cement types (enter reference if required)	None	None	None	None
5.	Special requirements for aggregates (enter reference if required)	None	None	None	None
6.	Use of RCA permitted Maximum mass fraction of total coarse aggregate where allowed enter a higher mass fraction of total coarse aggregate (Ref BS 8500-1 Clause 4.2.3c)	Yes/No 20%	Yes/No 20%	Yes/No 20%	Yes/No 20%
7.	Requirements for accelerated or retarded set	None	None	None	None
8.	Special colour requirements	None	None	None	None
9.	Type and closage of fibres	None	None	None	None
10.	Chloride class (enter Cl0,20 if SRPC is specified or Cl0,10 for prestressed or heat cured concrete)	Cl0,40	Cl0,40	Cl0,40	Cl0,40
11.	Minimum air content	None	None	None	None
12.	Method of placing concrete				
13.	Requirement for finishing concrete	See P.1.7	See P.1.7	See P.1.7	See P.1.7
14.	Design sulfate class	DS-2	DS-2	DS-2	DS-2

Notes

1. All sections of the specification must be completed before it is passed to the producer.
   The person sending the final specification to the producer must send copies of the document to all other parties (CA, Engineer, Employer) as appropriate who have contributed to the specification.
2. Where 'None' is entered in the table this is a default value to ensure that the specification is complete. All those involved in completing the specification need to check if 'None' is appropriate.
3. Guidance on specification of designated concrete can be found in BS 8500-1 section 4.2.

P1.8.2 Designed Concretes

In accordance with BS 8500-2:2002 and BS EN 206-1:2000

1.	Concrete designation				
2.	Strength class (see BS8500-1:2002 table A20)				
3.	Maximum water-cement ratio				
4.	Nominal maximum size of aggregate (mm) (enter 10 or 40 if required)	20	20	20	20
5.	Minimum cement content kg/m^3				
6.	DC-Class where appropriate	N/A	N/A	N/A	N/A
7.	a. Permitted cement types b. Cement group for sulfate resistance c. Cement group for chloride resistance				
8.	Chloride class (enterCl0,20 if SRPC is specified or Cl0,10 for heat cured concrete)	Cl0,40	Cl0,40	Cl0,40	Cl0,40
9.	Target density/density class (for lightweight and heavyweight concrete)	N/A	N/A	N/A	N/A
10.	Consistence class – slump (mark one value) – other (enter value)	S1 S2 S3 S4	S1 S2 S3 S4	S1 S2 S3 S4	S1 S2 S3 S4
11.	Method of placing concrete				
12.	Requirement for finishing concrete	See P.1.7	See P.1.7	See P.1.7	See P.1.7
13.	Special requirements for cements	None	None	None	None
14.	Special requirements for aggregates	None	None	None	None
15.	Type and dosage of fibres	None	None	None	None
16.	Minimum air content	None	None	None	None
17.	Special requirements for temperature of fresh concrete	None	None	None	None
18.	Special requirements for strength development	None	None	None	None
19.	Special requirements for heat development during hydration	None	None	None	None
20.	Special requirements for retarded stiffening	None	None	None	None
21.	Special requirements for resistance to water penetration	None	None	None	None
22.	Special requirements for resistance to abrasion	None	None	None	None
23.	Tensile splitting strength	Not required	Not required	Not required	Not required
24.	Other special technical requirements	None	None	None	None
25.	Additional requirements See BS 8500-1:2000 Clause 4.3.3 Maximum drying shrinkage	0.075%	0.075%	0.075%	0.075%
26.	Identity testing: Identity strength testing required (If yes then details to be added into P1.10 in accordance with BS 8500-1:Section 3 2003)	Yes/No	Yes/No	Yes/No	Yes/No

27.	Use of RA permitted If YES:- Maximum acid – soluble sulphate Method for determination of the chloride content classification with respect to asr Method for determination of alkali content Any limitations on use in concrete, e.g. exposure classes, maximum mass fractions etc.	Yes/No	Yes/No	Yes/No	Yes/No
28.	Use RCA permitted If YES:- Maximum mass fraction of total coarse aggregate. Where allowed enter a higher mass fraction of total coarse aggregate	Yes/No 20%	Yes/No 20%	Yes/No 20%	Yes/No 20%

Notes

1. All sections of the specification must be completed before it is passed to the producer. The person sending the final specification to the producer must send copies of the document to all other parties (CA, Engineer, Employer) as appropriate who have contributed to the specification.
2. Where 'None' is entered in the table this is a default value to ensure that the specification is complete. All those involved in completing the specification need to check if 'None' is appropriate.
3. Guidance on specification of designed concrete can be found in BS 8500-1 Section 4.3.

P1.8.3 Prescribed concrete

In accordance with BS 8500-2:2002 and BS EN 206-1:2000

1.	Concrete name				
2.	Cement type, class and content				
3.	Water/cement ratio				
4.	Aggregate type Coarse Fine				
5.	Maximum chloride content of aggregate				
6.	Maximum aggregate to size (mm) (enter 10 or 40 if required)	20	20	20	20
7.	Special requirements for density	None	None	None	None
8.	Required admixtures - quantity and source of material				
9.	Additional requirements for aggregate	None	None	None	None
10.	Special requirements for temperature of fresh concrete	None	None	None	None
11.	Additional technical requirements (including special sources for constituents)	None	None	None	None
12.	Use of RA permitted If YES:- Maximum acid – soluble sulfate Method for determination of the chloride content. Classification with respect to asr Method for determination of alkali content Any limitations on use in concrete, e.g. exposure classes, maximum mass fractions etc.	Yes/No	Yes/No	Yes/No	Yes/No
13.	Use RCA permitted If YES:- Maximum mass fraction of total coarse aggregate. Where allowed enter a higher mass fraction of total coarse aggregate	Yes/No 20%	Yes/No 20%	Yes/No 20%	Yes/No 20%

Notes

1. All sections of the specification must be completed before it is passed to the producer. The person sending the final specification to the producer must send copies of the document to all other parties (CA, Engineer, Employer) as appropriate who have contributed to the specification.
2. Where 'None' is entered in the table this is a default value to ensure that the specification is complete. All those involved in completing the specification need to check if 'None' is appropriate.
3. Guidance on specification of prescribed concrete can be found in BS8500-1:2002 Section 4.4

P1.8.4 Standardised prescribed concrete

In accordance with BS 8500-2:2002 and BS EN 206-1:2000

1.	Concrete reference				
2.	Designation				
3.	State if concrete is reinforced	Unreinforced	Unreinforced	Unreinforced	Unreinforced
4.	Maximum aggregate size (mm) enter 10 or 40 if required	20	20	20	20
5.	Consistence class – slump (mark one value)	S1 S2 S3 S4	S1 S2 S3 S4	S1 S2 S3 S4	S1 S2 S3 S4
6.	Restrictions on cement types	None	None	None	None
7.	Restrictions on aggregate types	None	None	None	None

Notes

1. All sections of the specification must be completed before it is passed to the producer. The person sending the final specification to the producer must send copies of the document to all other parties (CA, Engineer, Employer) as appropriate who have contributed to the specification.
2. Where 'None' is entered in the table this is a default to ensure that the specification is complete. All those involved in completing the specification need to check if 'None' is appropriate.
3. Guidance on specification of standardised prescribed concrete can be found in BS 8500-1:2002 section 4.5.
4. Standard prescribed concrete produced using sulfate-resisting Portland cement is not intended to produce sulfate resisting concrete.

P1.8.5 Proprietary concrete

In accordance with BS 8500-2:2002 and BS EN 206-1:2000

1.	Concrete name				
2.	Designation				
3.	Producer to confirm concrete conforms to BS8500-1:2002 Annexe A5 for the following exposure classes and intended working life.	Yes	Yes	Yes	Yes
4.	Requirement for finishing concrete	See P.1.7	See P.1.7	See P.1.7	See P.1.7
5.	Information from the specifier to producer See BS EN 206-1:2000 Section 7.1 and BS 8500-1:2002 Section 5.1				
6.	Information required from the producer See BS EN 206-1:2000, 7.2 and BS 8500-1:2002, 5.2				
7.	Third Party certification (enter QSRMC or state other)				

Notes

1. All sections of the specification must be completed before it is passed to the producer. The person sending the final specification to the producer must send copies of the document to all other parties (CA, Engineer, Employer) as appropriate who have contributed to the specification.
2. Guidance on specification of proprietory concrete can be found in BS 8500-1:2002 Section 4.6.

P1.9 CONSTRUCTION PLANNING

Note: the information here is largely reproduced from the Contract Documents to assist the SCC in the preparation of Section P2. The SCC should notify the CA if any discrepancy is identified between the Contract Documents and the Specification.

i) Site details: .....

ii) Positions of datum level and setting-out lines, width and level of access, level of the prepared working area for site traffic, cranes and pumps, and areas available for storage and site accommodation are shown on drawing numbers: .....

iii) Availability of site services and any pre-arranged procedures for sole or shared use: .....

iv) Restrictions on dimensions and/or weights of units to be delivered to site: .....

v) Factors affecting construction sequence, or which may create an unusual hazard: .....

vi) Underground services, overhead cables, adjacent buildings, site obstructions or other constraints on the SCC: .....

vii) Known working restrictions on time or special nuisance (including noise): .....

viii) Requirements/restrictions at the interface between the structure and following trades: .....

ix) Requirements for temporary propping: .....

x) Special requirements for headroom: .....

xi) A programme showing clearly any phased requirements and the earliest and the latest release dates of work to following trades or to the Employer is shown on drawing numbers: .....

xii) Access will be made available to the SCC on: .....

xiii) Other information considered relevant to the SCC: .....

P1.10 FURTHER INFORMATION

Where further information is required to expand data given in Clauses P1.1 to P1.9, list here and attach as necessary, stating the clause to which it relates. .....

SECTION P2

Information to be supplied *by* the SCC
at tender stage unless noted with updated information issued for construction.

P2.1 GENERAL

Project
Name: .....
Address: .....
Tel. no: ..... E-mail: .....

SCC
Name: .....
Address: .....

Contact name: .....
Tel. no: ..... E-mail: .....

Designer's name: .....
Tel. no: ..... E-mail: .....

Temporary works coordinator name: .....
Tel. no: ..... E-mail: .....

Other specialist contractors to be used by SCC:
Name: .....
Tel. no: ..... E-mail: .....

Name: .....
Tel. no: ..... E-mail: .....

Name: .....
Tel. no: ..... E-mail: .....

P2.2 DESIGN

Details of any SCC-designed structure: .....

.....

.....

P2.3 DRAWINGS, CALCULATIONS and REINFORCEMENT SCHEDULES

i) Details of any proposed variation of values in P1.3 and other specification changes: .....

.....

.....

ii) An information requirement schedule, based on the construction programme and this specification is to be issued to the CA within two weeks of SCC being appointed.

P2.4 MATERIALS

i) List any alternative materials proposed by SCC: .....

.....

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ii) List materials to be provided under SCC-specified supply: .....

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P2.5 FALSEWORK and FORMWORK

i) **Construction joints and pour sizes**
SCC to give any alternative sizes proposed.

ii) **Water-resisting construction**
If the SCC is responsible for the detailed design of water-resisting construction the following materials will be used:

Detail	Location	Waterstops membranes	Separation	Joint fillers
Manufacturer				
Material				
Type	Slabs - horizontal construction joints			
	Slabs - horizontal movement joints			
	Wall - horizontal slab/wall junction			
	Wall - vertical construction joint			
	Wall - vertical movement joint			

P2.6 REINFORCEMENT

i) Reinforcement supplier: ---------- * / to be provided 4 weeks before first delivery*
UK CARES certificate: Yes/No*

ii) Coupler details and supplier: ---------- * / to be provided 4 weeks before first delivery*
UK CARES certificate: Yes/No*

** Delete as appropriate*

P2.7 CONCRETE and CONCRETING

i) Accredited third party certification of proposed plant:

---------- * / to be provided 4 weeks before first delivery*

** Delete as appropriate*

ii) Any proposed concrete specification variations: ----------

---

P2.8 CONSTRUCTION PLANNING

i) A construction method statement including pour sequence for each section of work

---

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ii) A detailed construction programme (to be updated during the progress of construction).

---

iii) Quality assurance certification: Yes/No*

** Delete as appropriate*

P2.9 PRECAST CONCRETE

This table is included for the information to be provided for precast concrete works.

Details to be provided		At tender	Y/N	8 weeks before construction	Y/N
Production plant	Details				
	QA certification				
Lifting	Method				
	Equipment details				
	Design of lifting point/devices				
	Location of lifting devices				
Handling	Minimum age				
	Additional reinforcement				
	Storage details				
	Transport storage details				
Erection	Method statement				
	Temporary supports/details				
	Details of protection				
Connections	Details				
	Preparation				
	Grouting/packing				
	Removal of temporary shims etc.				
Concrete	Designation				
Finishes	Samples of finishes				
	Details of spacers				
	Formwork details				

P2.10 FURTHER INFORMATION

Where further information is provided to expand data given in Clauses P2.1 to P2.8, list here and attach as necessary, stating the clause to which it relates.

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GUIDANCE NOTES

Definitions

Contract administrator (CA)
The Contract Administrator may or may not be the Engineer. Where both roles are not taken by the same person or organisation, appropriate arrangements should be in place so that relevant information is referred to and obtained from the Engineer when required – note that the CA is designated as the formal approving authority.

Drawings
General arrangement drawings (GAs): These should include the assumed loadings on elements of the structure (e.g. floor slab loadings).

Builders works drawings: These should include cast-in items, blockouts, holes for mechanical and electrical services and other items that are too small to be shown on the GAs.

Erection drawings: These show the construction sequences and stability required by the design of the permanent structure.

As-built drawings: It is often unclear who is responsible for producing these. This should be clarified at tender stage, and the required content and the party responsible identified in NSCS Part 2. As-built drawings may be different from 'final record' drawings that may be produced, by agreement, by the SCC and could be considered for the Health and Safety Plan. They should contain sufficient information to enable an experienced engineer at a later date to plan structural alterations.

Temporary works drawings: These cover the work necessary for the construction operation and may be prepared by any party.

Employer
This term has a variety of meanings depending on the form of contract. For example, when a main contractor employs the SCC it is the main contractor who will be the Employer. It is not necessarily the Employer as defined in JCT or other contracts.

Engineer
This is the individual or organisation responsible for the structural design of the works and may or may not be the CA, depending on the type of contract. The brief may not require the Engineer to visit the site and inspect the works.

The NSCS has been written so that the CA, whoever it may be, must obtain the agreement of the Engineer on certain matters. The Engineer is responsible for the design and must advise which items have an effect on the structural design during construction. It is expected that the CA and the Engineer will meet before construction to establish a working method for dealing with this under the contract. Any changes to these responsibilities resulting from contractual arrangements should be noted in NSCS Part 2.

There may be circumstances where there is more than one Engineer, e.g. Client's Engineer and Design and Build Contracts Engineer. In such instances the responsibilities of each needs to be clarified in writing.

Precast concrete
This is defined carefully so that it includes prefabricated concrete cast on site.

SCC
This is the contractor constructing the structure who may be a main contractor, specialist or a combination of both. The NSCS is written as though the SCC carries out all specialist operations – thus the SCC will cover the prestressing specialist or precasting sub-contractor who may be a sub-contractor to the SCC.

SECTION 1
Materials, workmanship and construction

1.1 GENERAL

1.1.1 **Quality of materials**
The CA has the right to take any materials from the structure for testing to check that they meet the specification. This should boost the Employer's confidence in the quality of the structure. The normal method of payment for such additional tests, where a defect is suspected for example, is that the Employer pays if everything is found to be in accordance with the NSCS, otherwise the SCC bears the cost. This relates to additional testing over and above routine for example testing of concrete cubes, carried out under the contract, payment for which will normally be covered in the main contract.

1.1.2 –

1.1.3 **Modifications**
The intention of this clause is that the SCC may make suggestions to improve or speed up the work. Any suggestions should be considered carefully by the CA. If such suggestions are accepted and agreed it is important that they are put in writing (including drawings or sketches if necessary), so that there is no misunderstanding.

Any modifications instructed by the CA must similarly be documented. NSCS Part 2 P1.5 and P2.3 are the appropriate locations for this purpose.

1.1.4 **Coordinated information**
All aspects of the construction sequence and responsibilities must be understood by all parties before work starts. Work interfaces between trades are potential problem areas, and can result in non-performance of the work. This is particularly important with cladding, finishes and below-ground work such as basement construction where temporary works, shoring and groundwater pumping are critical.

1.1.5 –

1.1.6 **Setting out the structure**
The SCC should be given the required location of the structure. See also NSCS Part 1, Clause 7.1.(i).

1.1.7 **Construction loads**
It is inevitable that construction loads will be added to the structure from, for example, storage of materials and equipment by the SCC or by others working on the project. The effects of backpropping on loading on recently cast slabs will also be a consideration.

1.1.8 **Water-resisting construction**
This clause relates principally to basement construction but is also applicable to other forms of construction (concrete bunds, planters, etc.) requiring resistance to water penetration.

The Engineer is strongly advised to consult with the Client to establish a clear understanding of the expected use, environment and performance of the basement. The distinction between resistance to liquid and vapour penetration is important and should be explained to the Client. Increased performance requirements may mean higher initial costs but lower performance requirements may result in higher long-term maintenance costs. Clause 3.3 of BS 8102: 1990, *Code of practice for protection of structures against water from the ground*, is of particular use here. Understanding when leaks are most likely to occur and responsibility for repairing them is also important. Even if no groundwater is apparent, any below-ground structure is likely to be subjected to some form of water pressure during its life.

If structures are designed to BS 8007 *Code of practice for design of concrete structures for retaining aqueous liquids*, this should be referred to in Part 2.

Water will penetrate even minor defects and it is therefore important that the waterproofing system supplier (where relevant) confirms acceptance of the intended concrete construction and details, movement joints and materials etc.

The specified surface finish and surface deviations need to be suitable for any finishes that are to be applied subsequently.

Before tender, the Engineer should liaise with the waterproofing system supplier to ensure the system is appropriate and compatible with the design of the concrete work.

The waterproofing system supplier should be given the opportunity to agree the construction aspects with the SCC.

In Clause (ii) written confirmation from the waterproofing system supplier is intended to avoid misunderstanding and disagreement.

Reference should be made to BS 8102 and CIRIA Report 139, *Water resisting basement construction – a guide* (CIRIA, 1995) for further information.

1.2 QUALITY ASSURANCE

The SCC must be able to demonstrate how the quality management system enables responsibilities to be executed according to the Contract and the NSCS.

SpeCC, the Registration Scheme for Specialist Concrete Contractors, has now been established and membership is growing. While registration with SpeCC cannot be made a requirement of the Specification, as at this stage this may prove unduly restrictive in terms of potential tenderers, the scheme offers benefits to clients in terms of third party auditing and it is recommended that SpeCC–registered contractors should be appointed where possible.

The SCC may require documentation to be available for a stated period beyond the contract period and this should be stated in NSCS Part 2.

1.3 TESTING

1.3.1 –

1.3.2 **Additional inspections and tests**
The SCC is expected to arrange for all inspections and tests whether or not they are specified in the NSCS or instructed by the CA in addition to routine testing.

1.3.3 **Test nonconformity**
In the event of a test nonconformity the onus is on the SCC to propose a course of action. Several alternative proposals may need to be submitted until one is found which the CA accepts.

1.4 DRAWINGS AND REINFORCEMENT SCHEDULES

1.4.1 **British Standards, numbering and revisions**
This section sets a minimum standard for drawn information.

It is good practice to draw a circle or cloud around revisions to drawings, rather than just relying on the description in the notes box. Such marks should be removed before the next revision is made.

1.4.2 **As-built drawings**
As-built drawings form part of the CDM Health and Safety File and are thus an essential requirement on any building project. All parties should agree the content of these drawings. The drawings should contain enough detailed information to enable structural assessments to be made for future alterations. The responsibility for preparing as-built drawings should be given in NSCS Part 2, Clause P1.3.

1.4.3 –

1.4.4 **Builders work drawings**
Builders work drawings must be provided to the SCC as early as practicable if construction on site is to be right first time. The holes and fixing inserts needed may be shown on a wide range of drawings including the GAs, mechanical and electrical sub-contractor's drawings, and specialists' drawings for windows, cladding, fixings, etc.

Early in the project the CA and SCC need to agree who will produce and coordinate these drawings. NSCS Part 2, Clause P1.3 can identify who produces these coordinated drawings.

1.4.5 **Erection drawings**
Erection drawings need to include the necessary requirements for stability at all times and may form part of a method statement. The Engineer will give consideration during the design stage to the sequence of construction on which the design is based. This information must be included with the pre-tender Health and Safety Plan and may include drawings. The SCC may submit an alternative sequence to the Engineer for agreement. In any event the final sequence of construction must be understood by all parties before work starts.

SECTION 2.
Falsework and formwork

2.1 STANDARDS
Design to the standards referred to in NSCS Part 1 is current best practice in the industry.

The CONSTRUCT *Guide for flat slab falsework and formwork* (Concrete Society, 2003) may be used where applicable in place of CIRIA Report 136, *Formwork striking times – criteria, prediction and method of assessment* (CIRIA, 1995). The Guide offers new techniques for assessing concrete strength and new criteria for early striking of flat slabs. It emphasises the degree of control necessary for site operations if these are to be adopted; there is also a need for close coordination between the Engineer and the SCC and for all involved to clearly understand the processes.

Obviously there are also many safety requirements which will be linked to CDM Regulations and the requirements of the Health and Safety Executive.

2.2 TYPES OF MATERIAL
i) The choice of material in face contact with the concrete has a significant effect on the resulting finish. The main features to be considered are the hardness, permeability and surface texture. The choice of materials will usually depend on the requirements for reuse. High reuse potential is usually the reason for choosing a steel form.

If timber and wood-based materials are used, account must be taken of the permissible stresses.

Wherever practicable, new timber should be from renewable and sustainable sources.

Other materials may also be used for special applications. Detailed guidance on different materials is given in Concrete Society Technical Report 52 *Plain formed concrete finishes* (Concrete Society, 1999).

ii) The nature of the structure to be built may be such that use of permanent formwork is essential. If the decision to use permanent formwork is optional, the final decision should be made at the tender stage after the evaluation of the likely costs and benefits by the SCC. Refer to CIRIA Report C558 *Permanant formwork in construction* (CIRIA, 2001).

2.3 RELEASE AGENTS
If there are special requirements for the release agents to be used they should be specified in NSCS, Part 2, Section P1.5. It is recommended that they are referred to by generic type rather than trade name.

Information on release agents is given in Concrete Society publication *Formwork – A guide to good practice* (Concrete Society, Second Edition 1995). The type of release agent to be used will partly depend on the standard of formed finish required in NSCS Part 1, Clause 4.6.1 and any other finish to be applied subsequently.

2.4 FORMWORK USE
i) The SCC needs to be satisfied that the fresh concrete will not sag or settle unduly due to settlement of the supporting formwork and falsework. It is common practice to set flat slab formwork uniformly high to allow for elastic settlement of the temporary works. The manufacturer of the system to be used should be able to provide relevant information to the SCC.

Proper allowance needs to be made for self-weight deflections when elements are struck.

Theoretically, responsibility for this lies with the Engineer, although in practice both the Engineer and the SCC have a joint obligation to ensure that such deflections are not excessive. Any requirements for pre-cambering or other solutions to limit deflections (e.g. altering reinforcement provision) should be clearly identified at tender stage and stated in the Project specification.

Checklist for erecting and dismantling falsework (Concrete Society, 1999) and *Checklist of assembly, use and striking of formwork* (Concrete Society, 2003) should be refered to.

Flat slab or upstand beams are preferred since they require less complex formwork.

ii) The supporting soil and sub-base to any ground-supported floor slab must not settle significantly under the weight of the fresh concrete. The SCC must be satisfied that the ground is adequately prepared and compacted. Sagging of the concrete slab during early-age setting caused by ground settlement may cause slab weakness and cracking, and affect the level tolerance. Supports for reinforcement and the impact of fresh concrete on supports and reinforcement during placing need consideration before starting work. This also applies in the short term where the ground slab will ultimately rely on piles or other foundations for support rather than the soil/sub-base.

iii) –

iv) Casting against vertical faces of existing construction or excavations may be permitted but will

require the CA's agreement since there may be design implications. In some circumstances (e.g. where the backfill contains sulfides) there are positive advantages to this approach. It is generally acceptable for shallow foundations to be cast against earth faces.

Protection of newly placed concrete against loss of moisture is necessary to ensure durability. 1200-gauge continuous polythene sheet is often placed over hardcore or other absorbent substrates for slab construction. Compliance with Building Regulations Part C, Section 3 is necessary in relation to resistance to ground moisture. The Engineer will need to specify in NSCS Part 2 the appropriate requirements.

The coordination of placement of concrete must be clearly established with other trades through the CA. This will include the timing of excavations as well as the actual placement of concrete.

2.5 BLOCK OUTS AND CAST-IN ITEMS

It is usually impracticable to show all holes, recesses and cast-in items on the General Arrangement drawings particularly since some trades (e.g. building services and cladding contractors), may not be appointed until after GA drawings have been issued for construction. Nevertheless, zones where holes are not permitted should normally be defined at tender stage.

This makes it important for the CA and SCC to get together in the early stages of the contract to obtain a clear understanding of everyone's requirements and to enable a coordinated approach to be taken to the integration of all the cast-in items, holes, recesses etc. required in the structure.

Builders work drawings should incorporate these items, see also NSCS Part 2, Clause P1.3 and Guidance Notes, Clause 1.4.4. These drawings should provide the most comprehensive information, even if they cannot be completed at the outset.

At tender stage it must be made clear to all parties who is to be responsible for supplying information on holes, recesses and cast-in items and for supplying the cast-in items themselves. It is normal for suitable draws and tapers to be used to aid striking of block-out items. Block-out items should be cleared out by the SCC, since other trades are likely to have less experience of such operations, and may damage the structure. It also gives the SCC opportunity to inspect the concrete around the items. However, any void former to a cast-in item (e.g. cardboard or polystyrene) should be removed by the following trade which will fix into that item.

2.6 FORMWORK TIES

Consideration needs to be given to the final surface finish required. If through-ties are not permitted, or there are particular requirements for making good after ties are removed this should be specified in Part 2.

In water-resisting construction it should be recognised that certain types of tie may permit moisture penetration even after careful sealing.

Types of wall ties and sealing methods need to be agreed between the SCC and the CA before work starts. If a waterproofing system to BS 8102 is to be applied, then properly sealed through-ties may be acceptable if the SCC can obtain agreement with the CA and the waterproofing system supplier.

2.7 STRIKING

Detailed guidance on early striking of slab soffits is given in the CONSTRUCT *Guide for flat slab formwork and falsework* (Concrete Society, 2003). This document sets out a new approach to early striking based on serviceability rather than ultimate criteria, as in CIRIA Report 136 *Formwork striking times – criteria, prediction and method of assessment* (CIRIA, 1995). Fundamental to this new approach is the reliable assessment of the concrete strength at early age and strict control over site operations – see comments to Clause 2.1. A Best Practice Guide *Early age strength assessment of concrete on site* (BCA, 2000), gives guidance on strength assessment techniques. Alternatively, or in situations where the above are not relevant, the approaches set out in BS 8110: Part 1: 1997, Clause 6.2.6.3.2 should be followed, unless otherwise agreed with the CA.

In all cases a minimum concrete strength of 5 N/mm^2 is required to minimise the risk of mechanical damage. General considerations governing formwork removal are given in *Formwork – a guide to good practice* (Concrete Society, 1995) and CIRIA Report 136.

In certain construction procedures, items of soffit formwork may be removed without disturbing the supports in contact with the slab.

Further guidance on backpropping is given in the CONSTRUCT *Guide for flat slab formwork and falsework* (Concrete Society, 2003). In most cases the slab immediately beneath that which is being concreted is likely to be the most heavily loaded. In general, backpropping should be installed at the earliest opportunity to ensure maximum distribution of loads through to the supporting slabs and should be re-installed for the construction of each floor in turn to prevent load build-up within it. However, under no circumstances should any backpropping be removed until the most recently cast slab has been struck and is carrying its full self-weight. A spreadsheet for calculating the required level and number of backprops is included in the CONSTRUCT Guide.
Adequate backpropping is crucial in the construction of in situ concrete frame structures and,

accordingly, the SCC must make adequate provision for it when tendering for work, describe clear procedures in the method statement and exercise appropriate control over site operations.

2.8 CONSTRUCTION JOINTS AND POUR SIZES

i) Details and locations of construction joints should be agreed well in advance of any construction.

The SCC should position and form construction joints to suit the structure and to avoid any short-term or long-term distress to the structure, particularly from thermal and shrinkage effects.

The CA should liaise with the Engineer before final agreement with the SCC.

ii) –

iii) Pour sizes should be agreed early in the construction period between the SCC and the CA, as specified in the first edition of the NCFS. However, it has been found that a benchmark is needed and some SCCs have requested guidance. Table 1 has therefore been included.

It should be noted that the pour size is unrelated to the number of restraints imposed upon slabs.

The size and location of restraints define where special measures have to be taken regardless of pour sizes. Pour layouts should be determined taking into account when most shrinkage is likely to occur and the SCC's preferred sequence – particular requirements should be identified in Part 2.

If the maximum size of pour permitted differs significantly from the values suggested by Table 1, the actual size should be specified in the Project specification under Section P1.5, Special requirements. The SCC may also propose variations under Section P2.5.

Controlled large-area pours are frequently carried out where the economic conditions are right and suitable construction methods are available. Ideally, pours should only be restricted to the area that the SCC can place in a working day. Large areas of lightweight concrete in composite slabs can be poured if supplies are available. Pours in post-tensioned slabs may also be significantly larger, particularly where stressing is to be carried out from both ends. Further guidance is given in Reinforced Concrete Council's Reinforcing Links No.3 *Large area pours for suspended slabs – a design guide* (BCA, 1993).

The advice on pour sequencing, joint details etc. is different for ground-supported slabs, particularly industrial and warehouse slabs. Guidance is given in a number of documents such as Concrete Society Technical Report 34, *Concrete industrial ground floors – a guide to their design and construction* (Concrete Society, 2003). The advice on pour sequencing, joint details etc. is different for this form of construction. Particular requirements should be given in Part 2.

2.9 WATER-RESISTING CONSTRUCTION

The intention is that, as a default, water stops will be provided. If waterstops are not to be provided, this should be specified in Part 2, Project specification. In general, an alternative to centre stop water bars is preferred for slab joints. Hydrophilic waterstops may be used where conditions are permanently damp. External water stops, although easier to fix, are not suitable in all locations. The term 'waterstops' covers any type of waterstop, e.g. pvc, hydrophilic.

SECTION 3
Reinforcement

3.1 MATERIALS

3.1.1 **General**

BS 4449: 1997 *Specification for carbon steel bars for the reinforcement of concrete* refers to two ductility classes introduced for Grade 460 steel and their application.

The two classes (A and B) are taken from ENV 10080 and EC2 (ENV 1992-1-1), the latter including design limitations relating to class. Reinforcement bar traditionally supplied in the UK complies with ductility class B and can be used in all situations except seismic design. Care should be taken to avoid inappropriate use of material to ductility class A, because of its lower ductility. Strand and wire are adequately covered by the relevant British Standards.

When specifying using BS 8666 *Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete*, the use of the T designation alone is insufficient to guarantee material of ductility class B in sizes up to and including 16 mm.

Reinforcing bar is available in the UK which has UK CARES approval up to a yield strength of 500 N/mm^2, in addition to meeting all the requirements of BS 4449. This could be considered in cases where BS 8110 allows the use of higher strength reinforcement.

It is implicit in this specification that conventional steel reinforcement will be used. In special circumstances (e.g. in extremely severe exposure conditions) the use of alternative materials might be considered and this would need to be referred to in NSCS Part 2. These include epoxy-coated,

galvanised and stainless steel reinforcement and non-ferrous reinforcement (i.e. fibre reinforced plastics). Where use of these alternative reinforcement materials is considered, specialist advice should be sought.

The following references may be found helpful:

Epoxy coated reinforcement, hot dip galvanising, PVC coating:

Comite Euro-International du Beton (CEB), *Coating protection for reinforcement, State of the art report, (Thomas Telford, 1995).*

BS ISO 14654 *Epoxy coated steel for the reinforcement of concrete.*

Non-ferrous reinforcement:

Interim guidance on the design of reinforced concrete structures using fibre composite reinforcement (Institution of Structural Engineers 1999).

Stainless steel:

BS 6744: 1986 *Specification for austenitic stainless steel bars for the reinforcement of concrete.*

Concrete Society Technical Report 51 *Guidance on the use of stainless steel reinforcement* (Concrete Society, 1998).

3.1.2 **Reinforcement supply and testing**

The introduction of UK CARES Certification or equivalent into the specification results in a more unified reinforcement supply throughout the industry.

Special reinforcements (stainless, galvanised, epoxy-coated), should be dealt with as NSCS Part 2 information.

3.1.3 **Spacers**

Typically spacers will be at 1 m centres, or as otherwise necessary, to support the reinforcing steel as recommended in BS 7973.

Responsibility for fixing reinforcement with the correct cover and for ensuring that spacers and chairs are correctly spaced and have the required performance characteristics rests with the SCC. The requirements set out in BS 7973 should be regarded as a minimum. It is not usually necessary to show spacers on drawings. See also BS 8110: Part 1: 1997, Clause 7.3.

3.1.4 **Couplers**

Reinforcing bars should be adequately prepared to receive couplers. Where threaded couplers are used care should be taken to avoid damaging the threads on the end of the bars and to ensure that an adequate length of thread is contained within the coupler. This is most simply achieved by marking the bar at half the length of the coupler and ensuring that the coupler is screwed firmly on to this length.

3.1.5 –

3.2 WORKMANSHIP

3.2.1 **General**

Generally workmanship should be to BS 8110, but consideration needs to be given to allowing for reinforcement prefabrication as well as the use of such items as shear hoops, shear heads and sliding shear fixings.

Any written instruction to cut reinforcement must come from the Engineer, irrespective of the contractual arrangements on the project.

Achieving the correct cover is vital as it has a fundamental influence on durability and fire resistance. A BRE study has been carried out in conjunction with the University of Birmingham on achieving the correct concrete cover in buildings. The principal outputs from this study are the paper *"How can we get the cover we need?"* (Clark L A et al). and CIRIA report C568 *Specifying durability and achieving cover to reinforcement* (CIRIA, 2000).

3.2.2 **Tying and welding**

There is much evidence of tying wire ends that have been left with insufficient cover corroding and causing concrete to spall. The need for carefully bending ends of tying wire away from the surface cannot be over-emphasised.

Stainless steel tying wire may be necessary in some locations to avoid surface rust staining.

3.2.3 **Projecting reinforcement**

A grout wash consisting of a slurry of cement and water applied to reinforcement is the most commonly used protection for bare reinforcement but this is not always cost effective as it has to be applied quite often, and may cause staining of finishes below when not applied carefully. If other methods are used it is important to ensure that the bond to the next lift of concrete will not be reduced. Further information is given in CIRIA Report 147, *Care and treatment of steel reinforcement and the protection of starter bars* (CIRIA, 1995).

Projecting reinforcement may raise health and safety issues. Problems with projecting reinforcement can be avoided if couplers cast-in flush with the surface of the concrete or other proprietary products are used.

SECTION 4.
Concrete and concreting

4.1 CONCRETE

Under its agreement with CEN, BSI must withdraw conflicting British Standards when European standards are available. Consequently BS 5328 was withdrawn in December 2003 and many parts of BS 1881 have been replaced. In addition, various European Directives require European standards to be used by public bodies and utilities as soon as they become available. For designers there are a number of key changes to be aware of when preparing concrete specifications using the new standard. These are summarised here and discussed in more detail later in these notes.

Language

Consistence is used instead of workability.

The use of the term “mix” has been abandoned and replaced by the term “concrete”.

Specification is now defined as "final compilation of documented technical requirements given to the producer in terms of performance or composition" and the *specifier* as "person or body establishing the specification for the fresh and hardened concrete".

Execution refers to the construction of a structure.

Identity testing and *conformity testing* are stipulated instead of *acceptance* and *compliance testing.*

Concrete families are referred to and are a group of concrete compositions for which a reliable relationship between relevant properties is established and documented. Refer to BS EN 206-1:2000.

Where there is little experience of using the concrete family concept the following is recommended for a family:-

- cement: one type of strength class and source
- demonstrably similar aggregates
- similar additives, if any
- full range of consistence classes
- concretes with limited range of strength classes

Population indicates all concretes within a family.

Technical changes

Concrete now has a dual strength classification e.g. C28/35, to allow for cylinder and cube strengths. The second number is the cube strength; therefore full classification is to be given to avoid misunderstanding.

Generally, consistence for most structural concretes is expected to be a slump in the S3 range.

A consistence class suitable to the application must be specified.

The material specification now covers the selection of concrete to suit design exposure conditions (this was not covered before in the concrete code and the guidance on this is in the UK design code, BS 8110, but is not in the design Eurocode). There are six basic exposure classes:

- No risk of corrosion or attack (XO)
- Corrosion induced by carbonation (XC)
- Corrosion induced by chlorides other than from sea water (XD)
- Corrosion induced by chlorides from sea water (XS)
- Freeze/thaw attack (XF)
- Chemical attack (XA)

In the UK the XA class has been redefined to co-ordinate with the guidance given in BRE Special

Digest 1 (BRE, 2003), and is replaced by using the route of Design Sulfate (DS) class and hence ACEC (Aggressive Chemical Environment for Concrete) class to give a design chemical (DC) class.

BS 8500 – Part 1 covers concrete and cover requirements to suit each exposure class.

This information should therefore no longer be taken from BS 8110, or only taken with care. (Effectively tables 3.3 & 3.4 of BS 8110 are superceded). The change is to align with European design codes, such as EN 1992-1, which do not provide requirements for cover.

The BS 8500 tables refer to minimum cover to which an allowance for tolerance must be added to give the nominal cover to be noted on the drawings. Later Eurocodes will allow the designer to select the tolerance on fixing that relates minimum cover to nominal cover (and therefore will make the designer consider tolerances) but in BS 8110 (Clause 7.3a) the tolerance is defined as 5 mm and so, at present, all nominal cover should be 5 mm more than the minimum given in the BS 8500 tables.

The note to clause 3.1.8 of BS 8500 stating a range of 5 mm to 15 mm is perhaps misleading although it is common practice to increase the cover to reinforcement in foundations to ensure a minimum cover is achieved.

Testing and conformity
In a significant change to previous UK practice all conformity testing is now under the control of the producer with site testing limited to identity testing to indicate that concrete comes from a conforming population. Producers are now required to go through a formal procedure, called 'conformity', to verify that the claims made on the delivery ticket are valid. Any requirement for on-site testing if required for areas of particular concern must therefore be fully defined in the project specification.

4.1.1 **General**

Current Standards
All work is referenced to BS 8500 and BS EN 206-1. These are the current British Standards dealing with specifying concrete as a material.

Unless modified by this specification the procedures to be used in producing, transporting, sampling and testing of the concrete should conform to the relevant parts of these standards.

BSI is preparing a derived document *'Standards for fresh concrete'*. This comprises the whole of BS EN 206-1:2000 and BS 8500-1:2002 and BS 8500-2:2002 giving extended guidance and a commentary. This is the more user-friendly form of the concrete standards.

Extensive guidance on the use of these new standards, including examples of how to specify concretes using them, can be freely downloaded at http://www.bca.org.uk/activities/matstand.

Specification considerations
Specification of the different types of concrete should consider all the following general points:

- The final specification given to the concrete producer will include information from the designer(s) of the structure and the SCC and it is important that all parties are aware of the specified information given to the producer by others
- Selection of the correct concrete for use in any application must consider the exposure conditions, the effect of tolerances on the specified concrete cover, the required finish and the method of placing and the means of compacting the concrete
- Specifications must therefore include requirements other than strength such as maximum water/cement ratio, cement and aggregate type
- The location at which there is a change to concrete specification could in some instances be critical (e.g. monolithic kickers) see the guidance to section 4.2.1 iii)
- The new codes generally expect higher consistence for structural concrete; generally most structural concrete should be consistence class S3 (slump 100 to 150). This should reduce the effort in placing and compacting the concrete and minimise the occasions when water is added on site. These advantages should outweigh the apparent cost benefit, in terms of minimal material cost, of buying concrete with a traditional 50 mm slump. It should also be noted that under the new standards water addition on site will almost certainly result in non-conforming concrete, the need for additional testing and a transfer of responsibility for the concrete quality from the producer to the SCC who asks for the addition of water. (See the guidance to Section 4.2.1)
- Concretes can be subject to chemical attack and the restrictions on mix constituents to avoid problems with chlorides, sulfates and alkali-silica reaction (ASR) are given in BS 8500- 1: 2002, Annex A dealing with durability. Should it need to be referred to, more comprehensive guidance on ASR is given in BRE Digest 330 (BRE, 2003), and Concrete Society Technical Report 30 *Alkali-silica reaction: minimising, the risk of change to concrete* (Concrete Society, 1999)

Guidance on resistance to chemical attack from materials in the ground is given in BRE Special Digest 1 (2001).

When freezing and thawing occurs under wet conditions, enhanced durability can be obtained by the use of suitable air-entrained concrete. The specific recommendations are given in BS 8500-1: 2002, Annex A. Where severe freeze/thaw conditions are identified the specification should include a requirement for freeze/thaw resisting aggregates see BS 8500-1: 2002 Annex A Clause A.10.5.

Concrete Types
The different specific considerations for each type of concrete are given below:

Designated concretes are concretes identified by the application for which the concrete is to be used to satisfy requirements for strength and durability. Use of designated concretes is intended to encourage standardization. Their use should maximize the input to the design of the concrete by the producer and make the task of the specifier easier.

They cannot be used in XD or XS exposure classes and the range of strengths available is limited (to the normal structural range of cube strength 25 to 50 N/mm^2). The concrete is specified by considering the site conditions and then identifying from BS 8500-1: 2002, Annex A Tables A.6 or A.7 the application for which the concrete is to be used, or the application that most closely resembles it, and citing the corresponding designation. Specifiers should note that for many applications more than one exposure class can apply to the concrete. The producer is responsible for producing a concrete that meets the requirements and for ensuring that the constituent materials conform to the requirements of the standards.

Responsibility for testing and assuring conformance rests with the concrete producer via their Quality Assurance (QA) system. Designated concrete can only be produced by producers who have a third party accreditation for their quality assurance scheme. (See guidance in sections 4.1.2 and 4.4).

Designed concretes are specified by their required performance in terms of a strength class, subject to any special requirements for materials, minimum or maximum cement or combination content, maximum free water/cement ratio and any other properties. The producer prepares a concrete design to meet the requirements of the specification based on these requirements. They can be used in all exposure classes.

The specifier or designer is responsible for ensuring that the special requirements for the concrete are in accordance with the standards. Specifying designed concrete therefore requires more input from the specifier than for designated concrete.

In a significant change from BS 5328, the producer is required to test and assess the conformity of these concretes for properties including strength. The specifier may wish to have additional strength testing in some circumstances. This is called "identity testing" and it identifies whether the batches under investigation came from a conforming population. Where the concrete production is not covered by third party certification, routine identity testing is recommended. Where there is a critical element, e.g. very high strength columns, routine identity testing is recommended. Identity testing is carried out by the SCC.

Prescribed concretes are specified by the specifier giving the producer full details of their constituent materials and properties or quantities of those constituents to produce a concrete with the required performance. Specification of a prescribed concrete is unlikely to be an economic way of producing a concrete with the required strength and leaves the specifier alone responsible for ensuring that the concrete conforms to the standards, as the producer has no involvement in the selection of the constituent materials.

The assessment of the mix proportion forms an essential part of the conformity requirements.

Strength testing is not used to assess conformity. A prescribed concrete should only be specified where there is reliable previous evidence or data, established from initial testing, that with the materials and workmanship available the concrete produced will have the required characteristics.

This type of concrete may be required to produce a concrete having particular properties, e.g. to obtain an exposed aggregate finish.

Standardized prescribed concretes are only suitable for use in limited structural applications such as trench fill footings for housing, or similar projects, blinding and other minor work in unreinforced concrete. The producer provides a concrete with the proportions defined by BS 8500-2 Section 8.

Proprietary concretes this method of specification requires the specifier to check the claims made by each different supplier so that at tender stage they may be specified as a particular suppliers product or similar approved. If alternatives are to be offered by the SCC this should be made clear in NSCS Part 2 Section P2 so that the specifier can check that the alternative proposal is acceptable.

Flowcrete, a self compacting concrete, is a fairly common example.

4.1.2 **Plant - Ready-mixed concrete**
The NSCS generally requires the use of ready-mixed concrete suppliers that hold third party certification such as The Quality Scheme for Ready Mixed Concrete (QSRMC) certification and encourages the use of designated concretes. If supplies from other plants are to be used this must be noted in NSCS Part 2.

QSRMC requires certified suppliers to operate a process control system for all the concretes they produce. This includes random sampling and testing of the concrete to monitor conformity with the specification with compressive testing of concrete specimens carried out in a laboratory accredited by UKAS as conforming to BS EN ISO 17025.

BS 8500-2:2002 states that designated concretes can only be supplied by ready-mixed concrete companies holding current product conformity certification based upon product testing and surveillance coupled with approval of the quality system to BS EN ISO 9001 by a certification body accredited by the Secretary of State (or equivalent) for the relevant areas of product and systems conformity certification.

It is recognised that the most effective way of meeting the quality requirements of all appropriate standards and specifications is to specify QSRMC or BSI certification, or an equivalent, for the supply of all concrete.

It should be noted that other forms of certification, which do not meet the QSRMC Quality and Product Conformity Regulations, are also available to specifiers/users of ready-mixed concrete. However not all third party certification schemes are the same with the stringency of the certification process not being what the consumer requires in all cases.

To determine which certification scheme is appropriate the purchaser/specifier should examine the published regulations produced by the certification body and seek confirmation of what industry representation have been involved in their preparation together with confirmation of the assessment team's experience and ability.

For any third party certification body acting on behalf of the specifier/user in assessing a concrete producer's capability appropriate expertise is paramount.

QSRMC is the only scheme dedicated to the concrete industry specialising in ready-mixed concrete. It is controlled by a governing board, on which organisations with an interest in the quality of concrete are represented including the Major Contractors Group, Institutions of Civil and Structural Engineers, and Government bodies such as the Highways Agency and the Government Construction Clients Forum.

BSI also operates a Kitemark scheme, which certificates some ready-mixed concrete suppliers.

4.1.3 **Plant - Other Concrete**
This clause is intended to cover site or precast yard batched concrete, which is not covered by third party certification.

4.1.4 **Supply and transport**
Guidance on supply and transport of concrete is given in *The essential ingredient : Production and transport*, (BCA, 1993).

The addition of water to ready-mixed concrete on site can cause problems of misunderstanding.

BS EN 206 states that it is, in general, forbidden, and the specification of concrete with a higher consistence should reduce the need for addition of water on site, as the usual reason for adding water is to improve the consistence. However it is expected that there are occasions when it would make more sense to add water on site than to send the concrete away. Any water added on site should be noted on the concrete delivery ticket and it should be clear who accepts responsibility for the addition, the producer or the SCC. BS EN 206-1:2000 requires the delivery ticket to be marked as 'non conforming' unless the producer takes responsibility for the addition of water if this results in the total water content of the concrete being within the design limits i.e. if the water/cement ratio of the concrete was 0.55 but the permitted design value was 0.6 then water addition could be conforming if the addition changed the ratio by less than 0.05). However to give confidence to the CA, the NSCS requires identity strength testing for designed AND designated concretes whenever water is added on site.

4.2 CONCRETING

4.2.1 **Placing and compaction**
For certain operations, e.g. where there is congested steel, deep lifts etc, it may be necessary to specify a higher consistence or self-compaction to help achieve full compaction and the required finish. However any concrete used must still be cohesive enough to prevent segregation occurring.

Discussion with the supplier on the requirements of the concrete in advance is paramount.

iii) Kickerless construction should be employed wherever possible. Where kickers are used they should ideally be cast monolithically with the slab. Where the strength class of concrete used for the columns is greater than that for the slab a decision will need to be taken as to whether lower strength class concrete in the kickers is acceptable. Where kickers are used they should be of sufficient height to properly locate and help stabilise the column formwork.

There are issues concerning difference in strength of slab and column whether or not kickers are used. Guidance is given in ACI 318, *Building code requirements for reinforced concrete* (American Concrete Institute, 1995) No problems should be experienced where column strength is not greater than 1.4 times the slab strength.

v) When a pour has been prematurely stopped it is often acceptable to cut back by mechanical means or by jetting until an acceptable, sound vertical face is formed. Any such procedure would need to be agreed in advance with the CA.

4.2.2 **Concreting in extreme conditions**
When it is possible that construction may take place during extreme climatic conditions, suitable precautions should be put in place by the SCC before work starts.

4.3 CURING AND PROTECTION

4.3.1 **Curing**
The whole section on curing in BS 8110: Part 1: 1997 (Clause 6.2.6) is relevant.

4.3.2 **Protection**
ii) Damage caused by any means should be made good by the SCC (obviously to the agreement of the CA). If others have caused the damage it is presumed that compensation will be sought under the terms of Contract.

iv) It is common to ensure that the temperature of the concrete does not exceed 65°C.

The temperature gradient across a section should be controlled to limit the temperature differential to 20°C. Temperatures should be monitored until the hottest part of the section is less than 20°C above the minimum daily ambient temperature. Concrete should be protected from abrupt changes in temperature at the end of the curing period. The temperature of the concrete is affected by the type of mix, additives, protection, type of formwork, stripping times etc. and by the ambient temperature. Temperature variation across a section can be controlled by various methods such as the use of insulation and the timing and method of formwork removal. External restraints need to be taken into account. Further information can be found in CIRIA Report 135, *Concreting lifts and large volume pours* (CIRIA, 1995).

4.4 CONFORMITY AND IDENTITY TESTING DURING CONCRETING OPERATIONS

i) In normal circumstances, when the effects of time and transporting are judged to be of no practical significance, it should be acceptable for representative samples taken at discharge from the ready-mixed concrete lorry to be used for assessment of conformity of concrete delivered into the construction.

BS EN 206-1:2000 requires producers of concrete to undertake conformity testing of all the designated and designed concretes they supply. This may be based on testing individual concretes or concrete families. When a concrete fails any of the conformity criteria, the producer is required to inform the specifier. The NSCS then requires this information to be passed on to the CA and the employer. The non-conformity can be for properties other than strength.

Concrete is therefore now treated as a product (like blocks, bricks or fixing bolts) which is used without the user testing to ensure that, as delivered, it has the properties claimed for it by the supplier. This is a change from the traditional acceptance of concrete by testing of cubes to check for strength but follows on from the development of designated concretes, as products, in the UK.

It is why the NSCS requires third party accreditation for producers so that their claim that the product is acceptable is subject to review. Additional independent testing, called identity testing, can be specified to check that concrete on the site comes from a conforming population and to give confidence to the CA. This needs to be indicated in the project specification so the producer can take this into account. (The statistical risks to the producer of routine identity testing of groups of results are higher than those from application of the continuous production conformity criteria for groups of results.) The identity testing criteria for individual results are the same as the conformity criteria for individual results.

Additional testing may also be carried out to check the concrete strength is acceptable for early striking of formwork – this is not covered by the NSCS.

The following issues should be considered when reviewing the revised philosophy of acceptance for concrete and in selecting the concrete and testing required for a project:

- Is strength a key criterion in the performance of the concrete? Will a concrete with a strength marginally below that specified have any affect on the performance of the completed structure. Why test for a non-critical property?
- Testing for strength will not reveal if the wrong concrete has been placed in an element of structure, yet getting a GEN3 in a heavily loaded beam designed using C28/35 concrete could be a problem
- Site made test cubes may not be properly made or cured, affecting the results of tests
- Has the specifier fully understood the statistics of the design partial safety factors and their relationship to the acceptance criteria for tests on concrete? The identity testing acceptance criteria of annex B of BS EN 206-1:2000 are different from the BS 5328 criteria for compliance.

The NSCS approach to testing in the context of the new standard is to make a clear distinction between designated and designed concretes.

For designated concretes no identity testing is specified (except for cases when water is added on site).

For designed concretes identity testing is identified in Part 2 of the specification (Section 26 of table P1.8.2) and the specifier needs to make a decision on whether this is required. If it is required, the specifier has to identify the lots, e.g. all concrete on one floor slab, and the number of tests per lot. Alternatively testing at a given rate is permitted.

The assessment of early age concrete strength takes on particular significance in the context of early striking. Guidance on such assessment is given in the CONSTRUCT *Guide for Flat Slab Formwork and Falsework* (Concrete Society, 2003).

Guidance on the use of in-situ test methods such as the Lok test as an alternative to conventional cubes for early age strength determination is given in a European Concrete Building Project Best Practice guide.

iii) The addition of water to ready-mixed concrete on site can cause problems of misunderstanding.

BS EN 206 states that it is, in general, forbidden, and the specification of concrete with a higher consistence should reduce the need for addition of water on site, as the usual reason for adding water is to improve the consistence. However it is expected that there are occasions when it would make more sense to add water on site than to send the concrete away. Any water added on site should be noted on the concrete delivery ticket and it should be clear who accepts responsibility for the addition, the producer or the SCC. BS EN 206-1:2000 requires the delivery ticket to be marked as "non conforming" unless the producer takes responsibility for the addition and the addition of water on site results in the total water content of the concrete being within the design limits (i.e. if the water cement ratio of the concrete was 0.55 but the permitted design value was 0.6 water addition could be conforming if the addition changed the ratio by less than 0.05). However to give confidence to the CA, the NSCS requires identity strength testing for designed and designated concretes whenever water is added on site.

v) Conformity testing is the equivalent of compliance testing in accordance with BS 5328. Identity testing as defined in BS EN 206-1:2002 cannot be directly compared with the BS 5328 testing criteria for compliance. The volume of concrete at risk is not necessarily related to the sampling rate and the rate of sampling is left to the specifier to determine as no guidance is given in annex B of BS EN 206-1:2002. However the specification must make clear the "defined volume" to be tested, e.g. all the columns at one level in a building, and the level of testing required for each volume. Each volume identified would then be assessed for conformity. The traditional sampling rates recommended in BS 5328 for compliance testing could be taken as a guide to the maximum rate of identity testing, with the specifier deciding when a lower rate of sampling would be appropriate.

The old rates would be approximately:

Critical elements (very high strength columns, masts, cantilevers etc)	1 sample per 2 trucks
Typical elements (beams, slabs etc)	1 sample per 4 trucks
Low risk elements (rafts etc)	1 sample per 10 trucks

4.5 INSPECTION

4.5.1 **Inspection before placing**

The SCC is responsible for ensuring that proper inspection is made in accordance with the Quality Plan. This will include ensuring that opportunity is also given for the CA to carry out inspections before and after concrete is placed. The CA must be given reasonable warning of work planned that may be subject to such inspections.

It is the SCC's responsibility to inspect the work before placing concrete to ensure that all aspects comply with NSCS and good practice. The SCC must not rely on the CA as the inspector.

Clearly, all parties need to agree such arrangements before work starts on site.

4.5.2 –

4.6 SURFACE FINISHES

4.6.1 **Formed finishes**

It is important not to "over-specify" the quality of finish, particularly where it is covered up by following work, but whatever finish is specified, the concrete must be fully compacted. The 'normal' formed finish assumed for all work is BS 8110 Type A. Finishes of higher quality will usually cost more but the costs may be offset if applied finishes are not then required.

Basic finish is that normally applicable to such items as the sides of foundations and ground beams where no particular requirement is needed other than to ensure compliance with all other clauses of the specification such as concrete compaction and cover to reinforcement.

Type A and *Type B* finishes are generally the most common finishes specified on projects. The wording in Clause 6.2.7.3 of BS 8110: Part 1:1997 on this topic has been a considerable source of conflict in the industry. This was highlighted in a report prepared by the Production Engineering Group of the University of Reading as an area that costs the industry unnecessary expense and creates conflict. As a result, CONSTRUCT formed a committee to produce Reference Panels believed to be representative of Type A and Type B finishes. The Reference Panels are sited at seven regional locations around the UK. They are physical and visual benchmarks of structural concrete finishes enabling all concerned to agree on the acceptable standard both before and after the concrete is poured. The panels are 3 m x 1 m x 0.25 m and provide a true representation of site formed finishes rather than laboratory simulations.

LOCATION OF THE DISPLAY PANELS IN THE UK

London North (external site)
John Doyle Construction Limited
John Doyle House, Little Burrow
Welwyn Garden City
Herts AL7 2SP
Tel: 01707 329481 (Eric Roberts)
Email: ericr@john-doyle.co.uk

London South (external site)
Medway School of Engineering
Medway University Campus
University of Greenwich
Chatham Maritime
Kent ME4 4TB
Tel: 01634 883147 (Terry Graves)
Email: t.graves@gre.ac.uk

South West England (external site)
University of the West of England
Dept of Built Environment,
Coldharbour Lane
Bristol BS16 1QY
Tel: 0117 9656261 (Brian Drury)
ext: 3060 or 3316
Email: brian.drury@uwe.ac.uk

Central England (external site)
Peri Limited
Market Harborough Road,
Clifton upon Dunsmore,
Rugby CV23 0AN
Tel: 01788 861600 (Peter Stenning)
Email: pstenning@peri.ltd.uk

North West England (internal site)
R C Group Ltd
Pendle House
Phoenix Way
Smallshaw Industrial Estate
Burnley
Lancashire BB11 5SX
Tel: 01282 410900 (Phillip Watkins-Smith)
Email: enquiries@rcgroup.co.uk

North East England (internal site)
University of Sheffield,
Sir Frederick Mappin Building,
Mappin Street,
Sheffield S1 3JD
Tel: 0114 2225062 (Shane Smith)
Email: shane.smith@sheffield.ac.uk

Scotland (internal site)
University of Paisley
High Street,
Paisley, PA1 2BE
Tel: 0141 8483267 (Bill Matthews)
or 0141 8483252 (office)
Email: bill.matthews@paisley.ac.uk

Contact CONSTRUCT Tel: 01276 38444 if person listed can not be contacted.

It is intended that the reference panels will avoid the need to repeatedly construct site samples and that a common agreement of the standard of these finishes will develop.

Type C will be a special finish to a particular requirement, so it is not practical to produce reference panels of this finish.

The key issues to be addressed in producing acceptable quality finishes are as follows:

- Early discussion between the Engineer and the SCC, to ensure understanding and good communication. This may include using existing examples as a basis for discussion about what is required. These may be as examples of what the Engineer wants and also, at tender stage, as examples of work that has been done previously by the SCC that can be inspected
- Ensuring satisfactory supervision of the work
- Particular care in the choice of materials, for both formwork and concrete. The use of trial concrete mixes will be helpful
- Construction of sample panels. These should include details of all the expected joints and features, and use the proposed methods for concrete placing, compacting etc.

Checklist of key issues to include when specifying quality finishes:

- required surface regularity
- allowable colour variation of the surface
- extent of acceptable blowholes
- how much making good may be expected
- arrises required
- use of cover spacers
- arrangement of formwork joints and tie holes
- location of a 'sample' or similar finish
- special tolerances
- light reflectance.

Further guidance can be obtained from the following documents:

- Appearance Matters series published by BCA, Crowthorne:
  1 *Visual concrete: design and production,* 1988 (Ref: 47.101)
  2 *External rendering,* 1992 (Ref: 47.102)
  3 *The control of blemishes in concrete,* 1981 (Ref: 47.103)
  4 *Efflorescence on concrete surfaces,* 1982 (Ref: 47.104)
  5 *Removal of stains and growths from concrete,* 1982 (Ref: 47.105)
  6 *The weathering of concrete buildings,* 1986 (Ref: 47.106)
  7 *Textured and profiled concrete finishes,* 1986 (Ref: 47.107)
  8 *Exposed aggregate concrete finishes,* 1985 (Ref: 47.108)
  9 *Tooled concrete finishes,* 1985 (Ref: 47.109)
- Dawson S. *Cast in concrete: Reconstructed stone and precast concrete – a guide for architects.* Architectural Cladding Association, Leicester, 1995.
- The Concrete Society and CONSTRUCT. *Plain formed concrete finishes.* Technical Report 52. The Concrete Society, Crowthorne, 1999.

Where finishes to precast beams and slabs are required to allow in-situ concrete to act compositely, these areas should be clearly identified and described.

Where surface finishes to concrete are required to be smooth and level to provide bearings for precast slabs or beams these areas should also be clearly identified and described.

4.6.2 **Unformed finishes**

Type U1, U2, U3 and U4 finishes are based on similar clauses in the *Manual of Contract Documents for Highway Works,* Vol. 1; *Specification for Highway Works.* However, the clauses have been written in NSCS in a simpler manner to allow flexibility of construction methods in view of the advances made in recent years by specialist concrete flooring contractors in buildings.

U1 finish is a basic finish. The surface will be closed, substantially flat and level in accordance with the profiles but float marks and ridges will occur. If marks or ridges are not acceptable U2 finish should be specified. The 'normal' finish assumed for all work is Type U1 unless otherwise specified in NSCS Part 2.

Consideration of the finish specified should take account of the type of use. Services such as pipes or cables laid on slabs could be damaged if they are pulled over a rough surface. Also a U2 finish may be considered where false floor pedestals require a level surface.

Where the element is to provide a smooth wearing surface or to receive directly applied flooring without the need for a levelling screed, the surface finish and regularity should comply with the requirements of BS 8204-2.

4.6.3 **Surface cracking**
All parties should be aware that concrete will crack and that in most cases this is not harmful. The 0.3 mm surface crack width limit is taken from BS 8110. If this is not acceptable in situations where moisture ingress may cause problems of durability, remedial methods should be agreed.

In locations where the Engineer requires crack widths to be limited to less than 0.3mm, the design should be carried out accordingly. However, extra care will also be needed on site during construction. Cracking may only become visible some time after construction when most shrinkage has taken place and full service loads are applied.

Any restriction or variations on crack widths that the Engineer may require, for example in water-resisting or prestressed structures, should be highlighted in NSCS Part 2.

Guidance on non-structural cracking in concrete can be found in Concrete Society Technical Report 22, *Non-structural cracks in concrete* (The Concrete Society, Third Edition, 1992).

SECTION 5
Precast concrete

5.1 GENERAL
All clauses in the NSCS apply to in-situ and precast concrete where appropriate.

Precast concrete may be incorporated in a composite concrete structure, where precast reinforced or prestressed units act compositely with in-situ concrete, or in a hybrid structure. Design guidance for such construction is given in Clause 5.4 of BS 8110: Part 1: 1997; the requirements for the manufacture and erection of the units (but not for proprietary precast prestressed floor units) are covered in this section of NSCS.

It is recognised that other considerations apply to precast concrete such as size of elements, handling, storage, stability, installation and connections. These need to be considered by the SCC in advance of the start of construction as part of the detailed construction planning.

Precast concrete may be procured in different ways depending on the requirements of the project:

- Proprietary precast products such as floor units or staircases, which are designed by the manufacturer and which are selected by the Engineer to meet the performance criteria (load/span capacity, durability, fire resistance)
- Special precast units designed by the Engineer
- Units designed by the SCC to meet given performance requirements. These will be more extensive than the first category described above.

In each of these approaches, details of lifting inserts, the demoulding process and on-site erection need to be considered.

Further information can be found in the codes of practice available from the British Precast Concrete Federation: *Safe erection of precast concrete frameworks* (1999), *Safe erection of precast concrete cladding* (1998) and *Safe erection of precast concrete flooring* (1997).

5.2 MANUFACTURE AND SUPPLY

5.2.1 **General**
iv) Where precast units are manufactured under factory conditions the permissible deviations for manufacture, which are those in BS 8110: Part 1, should not be difficult to achieve and may easily be tightened up. The BS suggests that they may be halved with due care and monitoring and that even tighter values can be achieved where really necessary. There are costs associated with such accuracy and it should not be specified unnecessarily.

For factory-produced units the precast industry usually works to BS 8297, *Code of practice for design and installation of non-loadbearing precast concrete cladding.*

The Engineer and the SCC should carefully consider the tolerances for the whole building at an early stage. The permissible deviations (PD) for the units should be compatible with those for the frame overall.

The standard of accuracy achieved for units cast on site is likely to be closer to that specified in BS 8110 unless there are particular requirements for more accurate construction.

5.2.2 **Reinforcement**
Well-detailed and constructed reinforcement cages probably provide the best means of achieving the required cover to the steel. A jig is often the best way of constructing the cage.

The requirement for spacer blocks will not apply in all cases. The SCC's previous experience should be taken note of. Special requirements for finishes should be given in Part 2.

If rebending is required mild steel reinforcement will generally be specified although high yield steel may be permitted in certain circumstances with the use of appropriate means of bending.

5.2.3 **Steam curing**
BS 8500 - 1: 2002 Section A9 gives a lower limit on chlorides for prestressed concrete and for concrete which is heat cured.

Rapid heating should not be a problem if conditions b) and c) are met. Rapid cooling can cause surface cracking and should be avoided.

The temperature needs to be monitored close to the units to provide a reasonable guide to the concrete temperature. This should be controlled to avoid the possibility of delayed ettringite formation.

Condensation can cause some discolouration and surface imperfections. Trials may be needed for exposed concrete.

5.2.4 **Demoulding**
The time for demoulding will depend on the conditions in the factory and will be under the control of the SCC. For precasting on site, curing is likely to follow the requirements for in-situ work unless a protected environment is created.

Adequate protection methods should be used for all conditions.

5.3 –

5.4, 5.5 STORAGE, HANDLING AND ERECTION

These aspects are of particular importance in ensuring that the work is carried out safely and that the precast units are not damaged during the various stages before and during final placing.

Reference may be made here to the British Precast *Codes of Practice for Safe Erection* referred to in Section 5.1. Sections 2, 10, 11 and 14 are of particular relevance here. (The Section numbers are identical in each of the three Codes.)

If units are stored on the ground, consideration needs to be given to the ground conditions. Shallow footings may be needed to support the units adequately and prevent distortions.

The SCC's requirements for additional fittings should be coordinated on the general arrangement drawings with those required for the permanent works. Stainless steel is specified as the default material to ensure durability where the inserts will be permanently exposed externally or will be inaccessible in the external cavity. This may not be necessary in all cases.

5.6 –

5.7 MORTAR
A number of proprietary mortar products are now available. Alternatives to the conventional sand:cement mix may be specified in Part 2 or proposed by the SCC in P2.4.

5.8 –

5.9 COMPOSITE CONSTRUCTION
The concrete to be used will be specified in NSCS Parts 1 and 2 as appropriate.

5.10 –

SECTION 6
Prestressed concrete

6.1 GENERAL
At an early stage, responsibility for the design of the prestresssing and preparation of the drawings must be decided. This will be identified in Part 2 (P1.3), in addition to the Contract documents.

6.2 STANDARDS AND DESIGN GUIDES
In view of the many specialised systems used in the industry it is considered appropriate to use BS 8110: Part 1:1997, Section 8 as the basis for the specification. Reference may also be made to Concrete Society Technical Reports 43 *Post-tensioned concrete floors – design handbook* and 47 *Durable post-tensioned concrete bridges* (The Concrete Society, 1994 and 2002).

6.3 TYPE OF SYSTEM AND METHOD STATEMENT

The details required under this clause should be submitted by the SCC before construction and so as to allow time for any discussion needed.

Where bonded tendons are to be used grouting trials will generally need to be carried out; these should be carried out ahead of the permanent structure on representative construction so that there is sufficient time for the results to be considered and any changes to the original method statement made.

6.4 MATERIALS AND EQUIPMENT

6.4.1 **Prestressing tendons**
Seven-wire strand is normally used for post-tensioning concrete floors. This should comply with Type 2 (low relaxation) to BS 5896: 1980, Table 6.

6.4.2 –

6.4.3 **Sheaths**
Ducts may be formed of galvanised steel or may be non-metallic (high density polyethylene or polypropylene) and, for the former, may be of smooth profile or corrugated. Reference should also be made to Section 4.2.2 of Concrete Society Technical Report 43 for unbonded tendons.

6.4.4 –

6.4.5 **Concrete strength at transfer**
In a large concrete pour taking several hours to place, it is better to take the cubes from the later part of the pour so as not to underestimate the strength of the concrete in the element to be prestressed. If the element is stressed before the concrete is strong enough, local failure around the anchorages may occur. It is common for prestressing to be done in several stages, typically at 50% and 100% of the specified transfer strength. Each stage of stressing will require cubes to be crushed to verify that sufficient concrete strength has been achieved. It is often important not to delay the initial stressing operation as this is often the safeguard against cracking. Where timing is important, this should be made clear on the drawings by the Engineer.

6.4.6 **Grout**
The basic requirements for the grout are set out in A.1 of Annex A to BS 8110: Part 1: 1997.

Grout may be site-batched; alternatively, proprietary pre-bagged "special" grout which comes pre-mixed with additives may be used.

The properties of grout in both the fluid and hardened phases are important and it should not shrink when hardening.

Concrete Society Technical Report 47, *Durable post-tensioned concrete bridges* (Concrete Society, 2002) gives information on requirements for fluidity, volume change, bleeding, all of which need to be addressed and may be specified in NSCS Part 2.

Grouting practice and materials have been a cause of concern for bridges in relation to durability of the tendons. This has resulted in the production of Concrete Society Technical Report 47. There is no equivalent publication for buildings and appropriate use of TR 47 should be made.

6.4.7 –

6.4.8 **Transportation, storage and handling**
Methods of storing and handling prestressing steel at all stages must avoid surface contamination and mechanical or heat damage. Visual inspection should look for kinking, pitting, corrosion, and surface contamination. Reference may also be made to Concrete Society Digest 4, *Steel for prestressed concrete* (The Concrete Society, 1984).

6.5 WORKMANSHIP

6.5.1 **General**
i) UK CARES has established a certification scheme for the installation of post-tensioning systems in concrete structures, covering both bonded and unbonded tendons. The scheme is described in Concrete Society Technical Report 47.

Where grouted tendons are used the grouting trial is important and must be carried out long enough before the main works to allow the results to be considered.

The construction used for the trial should be representative of the permanent works in terms of duct length, tendon profile and vent arrangements.

ii) It is important to ensure that the tendon laying sequence works. If the design is particularly sensitive to the precise drape of the tendons the SCC must be made aware of this. The default tolerances given in Clause 7.13 should be amended as required in Part 2 if necessary. Covers may need to be checked at crossover points.

Pour sizes are usually limited by friction losses; the length of tendons differs for single-end and double end stressed tendons, and for bonded and unbonded tendons – refer to Section 7.7.1 of Concrete Society Technical Report 43.

Construction joints should normally be made in the vicinity of quarter and third points of the span.

Shear provision should be made in accordance with good practice – see Section 7.7.2 of TR 43.

Vents are normally required at high points along the ducts where the height between high and low points exceeds 0.5 m – see A.2.1 of BS 8110: Part 1: 1997. Where shallower slabs are used the distance between vents will normally not exceed around 40 m. Grouting trials may be used to verify the adequacy of particular duct and vent arrangements.

6.5.2 **Safety**
There are many safety aspects associated with prestressed concrete construction. A general warning on safety is contained in BS 8110: Part 1: 1997, Clause 8.7.2. The SCC's method statement, referred to under Clause 6.3, should address these issues and set out proposed procedures for controlling the work.

6.5.3 **Soffit marking**
Marking the location of tendons serves two functions:

- It identifies where tendons are located in the zone where post-drilled fixings may be installed
- It records the location of tendons as a record for future alterations to the structure.

Where soffits are to be exposed in the completed structure the method of recording the location must be agreed with the CA.

6.5.4 –

6.5.5 **Tensioning**
When a prestressed slab is stressed it is usual for the tendons to pick up the load in some areas such as mid-span and carry it back to other areas such as the supports. Depending upon the layout of the structure and the stressing sequence adopted there may be occasions when this additional load is imposed on part of the slab that has not been fully stressed and therefore is not capable of taking the load. In such instances the formwork will have the carry the surcharge. Where the design is sensitive to such movement or loading the Engineer should either stipulate stressing sequences to avoid the problem or advise that the surcharges are considered when the formwork system is designed. Reference should be made to Section 7.7.5 of Concrete Society Technical Report 43.

The stressing sequence should in general be planned to avoid overloading the formwork.

6.5.6 –

6.5.7 **Grouting**
Grouting trials should be carried out before construction to ensure that the procedures and vent arrangements are suitable.

6.5.8 **Records**
The CA and the SCC should establish a clear understanding on the extent of records required before work is started.

6.5.9 **Final protection of anchorages and tendons**
Anchorages, including buried dead end anchorages, should be fixed with due regard to cover requirements for corrosion resistance and fire protection.

Reference should be made to Section 7.7.3 of Concrete Society Technical Report 43.

SECTION 7
Construction accuracy

7.1 GENERAL
To arrive at the optimum cost and buildability, a common understanding on tolerances for the structure, cladding and finishes should be shared by all parties.

Discussion is needed at the design stage on any tighter tolerances envisaged, since they will result in higher costs and may not, in any event, be realistic.

Common sense must prevail should any item fail to meet the tolerance specified. It is important to consider whether the work is still acceptable, having regard to the operations that follow and the intended use of the structure. Checking must be carried out as construction proceeds so that any remedial work which is required can be sensibly planned and executed.

Consideration must be given to the type of cladding and finishes and their tolerance in view of those specified in Section 7. It may well be that tolerances in Section 7 will need to be tighter to cater for the cladding and finishes. However it may be more sensible to have tighter tolerances on the cladding and finishes instead and/or provision of greater adjustment in their fixings. The best philosophy is one of loose fit.

Existing guidance on tolerances is available from a number of sources including BS 5606, *Guide to accuracy in building*. Many specifiers who have previously referred to this document in their specifications have found it difficult to follow and not always appropriate. Another relevant document is CEN TC104 pr ENV 13670, *Execution of concrete structures*.

The tolerances specified in Section 7 have taken the foregoing into account and are considered practical tolerances without premium costs for a basic concrete frame building.

The clauses provided are intended to simplify tolerances. For example, plan positions for all elements are covered by Clause 7.5, and position on plan and all linear dimensions are covered for all elements by Clause 7.2, Sizes of elements.

It should be noted that the fit up of abutting elements with different permitted deviations requires careful consideration.

Traditionally, tolerances on stairs are different from and conflict with those specified for other parts of structures. The NSCS method of specifying deviations has the benefit of removing this conflict. The sole requirement is that risers and goings should be even throughout each section of the stair.

The factory-based precast concrete industry is already working to the component tolerances specified in BS 8110 and it is therefore appropriate to highlight this in Section 5.

7.2 SIZE OF ELEMENTS

This clause is intended to cover cross-section, length and height of element, stair risers and goings, holes etc. It is particularly important to control the thickness of thin slabs since this is likely to be critical for strength, fire resistance and deflection. Ground-bearing slabs are normally constructed to different tolerances: see *'Concrete ground floor slabs: thickness tolerances'* (Simpson D, CONCRETE, February 2000, pp22–23).

7.2.1 –

7.2.2 –

7.3 TWIST OF ELEMENTS

This is intended to cover possible warping often attributed to panel construction.

7.4 –

7.5 POSITION ON PLAN

Tolerances stated cover items measured from their location on plan as defined by the reference grid agreed between the CA and the SCC (See Section 7.1).

7.6 LEVEL OF ELEMENTS

This clause indicates levels of all elements in addition to slabs. The tolerances given relate to the pre-struck condition as these are the tolerances over which the SCC has direct control. Consideration must be given to the type and thickness of finishes since the tolerances can lead to finishes that are too thick or too thin resulting in extra costs. The values given are taken to apply to U1 or A finish as appropriate; tighter values may be specified in NSCS Part 2.

Particular attention is drawn to the required tolerances to achieve the correct thickness of grout bed beneath follow-on items such as steel base plates, and also projected lengths of cast-in anchor bolts. The tolerances specified have therefore generally been coordinated with those in the *National structural steelwork specification for building construction*, (BCSA and SCI,1994).

The overall tolerances which need to be considered are a function not only of general construction variability (covered here by the pre-strike tolerance), but also of self-weight deflections which are generally related to the span of the element. Attention is particularly drawn to the use of composite construction (e.g. metal decking) where an overall tolerance may need to be specified in NSCS Part 2. Owing to the deflection of the decking during concrete placement, a level may be specified, in which case the thickness will vary, or vice versa.

When measuring deviations the influence of local surface roughness (e.g. due to a tamped finish) should be averaged out, so that an accurate representation of the overall deviation is obtained.

For ground-supported slabs, particularly for industrial or warehouse use, it may be more appropriate to refer to Concrete Society Technical Report 34, *Concrete industrial ground floors* (Concrete Society, 2003) and to *'Concrete ground floor slabs: thickness tolerances'* (Simpson D, CONCRETE, February 2000, pp22–23).

7.7 –

7.8 VERTICALITY OF ELEMENTS

Tolerances have been increased as height increases for practical reasons.

7.9 –

7.10 ABRUPT CHANGES OF CONTINUOUS SURFACES WHERE FINISH IS NOT SPECIFIED

The clause stated as Δ permitted up to 3 mm is in accordance with Type A reference panels. This value is stated since the NSCS is based on Type A Finish. Naturally if the Engineer specifies Type B Finish then the value of Δ permitted would need to be specified in NSCS Part 2, Project specification as 2 mm.

For other finishes other values would need to be specified.

The values of 3 mm for Type A and 2 mm for Type B finish are consistent with the reference panels described in Clause 4.6.1.

7.11 CAST-IN FOUNDATION BOLTS

The tolerances specified apply to the positions of foundation anchor bolts. As with Section 7.6 the values specified have been chosen to be compatible with those given in the *National structural steelwork specification for building construction*, (BCSA and SCI, 1994).

7.12 –

7.13 PRESTRESSED CONCRETE

Tendons should not be allowed to snake from one side of the tolerance envelope to the other numerous times along their length. In narrow ribs a tighter horizontal tolerance than ± 50 mm may be applicable. In beams and ribs tendons should not be allowed to wander as a group from one side of the tolerance envelope to the other, as this may generate unwelcome lateral effects.

If it is necessary to position a tendon outside the tolerance envelope this should be agreed with the Engineer and recorded on as-built drawings. Such unexpected deviation is sometimes necessary around service openings and where column reinforcement is particularly congested.

Conversely it may be important for future fixings, openings etc. that the position of the tendons is known and these should be marked on the soffit. This information will also be of importance for the Health and Safety File.

Guidance Notes on NSCS Part 2. Project specification

General

NSCS Part 2 is in two sections: Section P1 contains information which is to be supplied to the SCC; Section P2 contains information which is to be supplied by the SCC. It is realised that this information may be supplied at different times, depending on the stage of the project (e.g. at tender, during the contract, or following completion) and thus the information is presented as a list rather than in chronological format.

The SCC is encouraged to make suggestions that may enhance the project.

SECTION P1

Information to be supplied *to* the SCC

This section highlights items of which the SCC should be aware when tendering. Knowledge of this information by the Specialist Concrete Contractor can help to avoid financial difficulties developing and claims arising.

This format has been adopted for simplicity and ease of use. Further requirements should be added and appended as required for the project. If certain clauses are not applicable they should be listed "not applicable" to clearly indicate they have not been overlooked. If information for the SCC is to follow later, the date when it will be available should be given. The Engineer can contribute information to the Employer for inclusion here. This may involve amendments to NSCS clauses in particular cases to suit the requirements of the work, but the Engineer should not make alterations unnecessarily.

P1.1 PROPOSED WORKS

The list identifies individuals or companies which will be involved during the construction of the structure.

Owing to the variable nature of contracts the CA may be from one of various organisations associated with the works. Whoever the CA is, the individual or organisation must obtain agreement from the Engineer on certain matters so as to ensure compliance with the Engineer's design.

A general description of the building (e.g. office, warehouse, industrial, residential, retail) should be stated so as to give basic information only of the type and extent of the works. This information is expected to be read with Clause P1.2. It will include the framing system, the means of achieving stability in the permanent condition and any special temporary requirements for stability during construction. If any precast elements are expected to act as diaphragms or act compositely in the structure then this must be clearly stated.

If more description is required, such as information related to extending existing buildings, then appended information should be referred to.

Details are intended to give information on the location and type of site (e.g. green field, inner city, sloping, confined) and should be read in conjunction with Clause P1.9, Construction planning.

P1.2 DESIGN

Design method describes the design concept and also states if design is to BS 8110 or EN 1992 (EC2).

All loading that the structure will be required to support in addition to its self-weight must be stated. This will include such items as finishes, mechanical and electrical services, lifts and their dynamic effects, and cladding. Abnormal fatigue, thermal and impact effects and other effects from supplied items which may induce stresses or strains in the structure, should also be stated.

Any effects of precast items (e.g. shrinkage and creep) should be considered.

It was not considered practical to cater for all types of loading that may occur on any structure. In view of the numerous types of loading that may occur it is expected that the specifier will append any extra information in Section P1.10 clearly and concisely.

It is important to make clear to all parties the responsibilities for the design of each element and this is the intention of the table in P1.3. This is particularly critical at the interface of elements designed by the Engineer and the SCC. Ideally all parties should meet and clarify in writing the respective responsibilities. In any event the Engineer remains responsible for the overall stability of the structure.

Irrespective of the type of contract or whether the Employer's Engineer or the SCC's Engineer is responsible for the structural design of the structure, the information in this section remains equally important to the SCC.

If the Employer's Engineer is responsible for the structural design, the SCC still needs to know this information for his backpropping, construction loads, temporary stability systems, etc.

If precast elements rely on structural toppings this must be clearly stated. The importance of the effects of prestressed elements on the structure should be identified (e.g. short-term and long-term shortening, cambers and deflections of members).

Variation in pre-camber of precast concrete, particularly prestressed concrete elements, is often unavoidable. This can lead to screed finishes being either too thick or too thin and of variable thickness along the length of the elements. A reasonable variation between maximum and minimum pre-camber needs to be identified at design stage by discussion with precast concrete specialists. This is also important so that the datum level of each floor in relation to the slab surface is clearly understood and identified on the drawings.

Attention is drawn to the strength and stiffness of structural connections between precast units that can be significantly affected by workmanship on site. Attention should therefore be given to BS 8110: Part 1: 1997, Clause 5.3.3.

P1.3 DRAWINGS AND CALCULATIONS

See also Guidance notes section on Definitions and Section 1.4, Drawings and reinforcement schedules.

The table is intended to be used to indicate the flow of information on a project for a variety of procurement routes including but not limited to:

- Full design by the CA with no design input from the SCC
- Design by the CA including detailing of in-situ work but with specialist design by the SCC for precast or prestressed components
- Design by the CA with the SCC detailing the in-situ work and designing the precast or prestressed components
- Full design by the SCC.

It is expected that for any project the number of drawings and timings would be reviewed so the defaults are given as guidance and to ensure that the table cannot be left blank. 'Blacked out' areas on the table are not expected to be needed. It is therefore expected that the CA will adjust the table and blacked out areas to suit the particular project.

General arrangement drawings: It is expected that these will always be issued to the SCC.

Design information drawings: These are needed if the SCC is to detail any of the structure as part of the brief for the SCC.

Erection drawings: It is expected that these will always be issued as necessary and will form part of the Safety Plan under CDM regulations.

Design calculations: For design by the SCC these are needed for acceptance by the CA and for sending to Building Control or other checking authority as required.

Specialist drawings: These are the detailed general arrangement drawings for specialist units such as precast plank layouts or mould drawings for special precast units. If more specialist drawings are needed then this block of information would be repeated.

Reinforcement drawings: It is not expected that these are needed for standard precast units such as planks.

Coordinated builders work drawings: The table should be used at tender stage to make clear who is producing these drawings.

Temporary works drawings: These will form part of the Health and Safety Plan under the CDM Regulations.

As-built drawings: The table should be used at tender stage to make clear who is producing these drawings. It is expected that these will form part of the Health and Safety File under the CDM Regulations.

General Arrangement drawings, sometimes referred to as 'Outline drawings' should set out clearly the locations of concrete grades and finishes if there are various types in the structure and should also detail the loadings (e.g. floor loadings) on elements of the structure. They are not intended to include any precast specialist layout drawings since these would be categorised in the appropriate part of the table.

The NSCS has been produced in a format to allow flexibility for the Engineer, if desired, to recommend to the client that the detailed design and/or Reinforcement Detail drawings and Schedules are prepared by the SCC. This complements the Association of Consulting Engineers *Conditions of Engagement* (1995) and other trends in the industry.

A recommendation in the report by the Reading Production Engineering Group of the University of Reading *Improving construction performance – in-situ concrete frames* (1995) was that reinforcement detailing should be undertaken by the trade contractor in order to maximise construction efficiency, such as by the use of fabric reinforcement and prefabrication.

For many years this way of working has been common practice in North America, the Far East and many other countries. Many UK consultants working on overseas projects are already familiar with this method. There is evidence that reinforcement detailing is being increasingly undertaken by trade contractors in the UK. Careful judgement is obviously needed by the Engineer on how and what information is handed over to the trade contractor to enable clear understanding of the Engineer's requirement.

This is one reason for highlighting 'Design information drawings' where traditionally the Engineer will mark up basic reinforcement requirements for the reinforcement detail drawings to be produced.

Engineers not familiar with SCCs producing the reinforcement detail drawings may be uncertain how much information is required. The *Guide to contractor detailing of reinforcement in concrete* (CONSTRUCT, 1997) encourages the Engineer and SCC to get together at the initial stages of the design of the structure to iron out any uncertainties in information supply and to ensure that the project is clearly understood.

The CONSTRUCT guide includes a model project specification that may be of assistance in looking at the requirements of a particular project. The following issues are important:

- Agreement of a programme between the SCC and the CA for the issue and review of information. Note that the CA (in practice this will generally be the Engineer here) may only be appointed to carry out a limited review of the SCC's details; establish what is required here. Checking of schedules will rarely be done
- The SCC and the CA should agree the level of information to be provided. The CA may provide comprehensive typical details, sometimes in electronic format, and simplified detailing instructions. In such cases the level of checking required should be minimal as the SCC's own QA procedures should provide all that is required, apart from possible spot checks. Non-standard project-specific details will also be needed in some case.
- The CA should ensure that detailing requirements allow the SCC to use the systems preferred by the SCC and should establish what details of proposed proprietary products are required
- Agree the standard of detailing required
- Agree how changes are to be dealt with.

Whether or not the SCC is responsible for the detailing, early liaison and collaboration between the Engineer and the SCC facilitates contractor input, and should be encouraged, though it is recognised that the scope for this will be dependent on the procurement route.

There may be instances on projects when it will be inappropriate for the SCC to carry out all the reinforcement detailing or even prepare the reinforcement schedules.

Where the SCC prepares the reinforcement detail drawings there is opportunity to explore prefabrication methods and the use of fabric reinforcement to suit the preferred method of construction. It also gives a better opportunity for the SCC to choose between precast or in-situ concrete for certain elements such as ground beams. In addition it provides an opportunity to explore the economics of rationalising reinforcement bar sizes and length etc.

The cost of increasing the amount of reinforcement in order to simplify construction may be small compared with the gain in speed of repetition, fabrication and installation. Crane capacity and availability should also be considered.

Drawings supplied to the SCC should not be limited to the Engineer's drawings and should invariably include drawings by the architect and other design-team members and specialists. Such drawings collectively should have sufficient information to enable the SCC to produce the necessary reinforcement detail drawings and dimension outline drawings to illustrate reinforcement positioning. All drawing numbers should be referenced clearly with revisions and where appropriate, referenced to drawing schedules.

The Engineer should review and be satisfied with the reinforcement detail drawings before construction starts to ensure compliance with the structural design. The review requirements will naturally depend on the Engineer's appointment.

‘Reinforcement detail drawings’ will indicate all reinforcement types, bar sizes, quantity, spacing, shape, length, extent, location within the concrete, covers etc. All reinforcement will be given marks for easy identification. Drawings will generally be produced from ‘Design information drawings’ and will have sufficient information when read with all the other information and drawings to enable reinforcement schedules to be produced and reinforcement to be accurately placed on site.

Reinforcement schedules must identify the structural element, and its location, in which the reinforcement is to be placed.

‘Builders work drawings’ should show coordinated information related to holes for services, recesses, cast-in inserts etc. It is common for the Engineers drawings to indicate holes and openings larger than 150 mm square. Holes smaller than this are then coordinated between the SCC and the CA. Naturally this depends on the nature of the project but it must be clearly spelt out to all concerned at the beginning of the project.

It should also be made clear at tender stage who is responsible for producing as-built drawings and noted accordingly in the table provided.

P1.4 MATERIALS

There may be materials that comply with current British or European Standards but which for a particular reason will not be permitted in the structure. This may be due to the Engineer's requirements of the particular design or due to a particular requirement by the Employer.

Best practice guidelines, for example, those in *Good practice in the selection of construction materials* (British Property Federation, British Council for Offices, 1997), should be followed where possible in relation to what have previously been classified as 'excluded' materials.

Items supplied by the Employer are highlighted since this has been an area of some misunderstanding or inadvertent exclusion at tender stage.

Consideration of special materials has been noted to highlight such requirements. This information is also expected to be stated on the drawings (stainless steel reinforcement and fibre reinforcement are examples of special materials). This might also apply to particular requirements such as cement sources, special aggregates, formwork materials, grouts and prestressing materials.

P1.5 PROJECT REQUIREMENTS

This section provides the opportunity for the Employer or Engineer to record, by exception, any amendments to Part 1 considered necessary for the satisfactory construction of the structure.

P1.6 WATER-RESISTING CONSTRUCTION

If water-resisting construction is specified on a performance specification, this may be stated in this section. If more space is required, reference can be made to P1.10, Further Information, where the performance specification can be appended.

Water-resisting systems can be applied sheet, liquid, render, special concrete mixes or any combination of these.

P1.7 –

P1.8 Concretes

For detailed guidance on the different types of concrete see the notes in Section 4.1. The different types are listed in the order in which they are listed in BS 8500-1. The guidance notes produced by the British Cement Association include examples of specification of designed and designated concrete.

Concrete that is to be finally exposed to view should be indicated under 'information from the specifier to the producer' even if it is in an internal environment, as this may have a bearing on the materials and type of mix proportions selected.

P1.9 CONSTRUCTION PLANNING

This section is intended to provide essential information for the tenderer on the site and construction. It is also helpful to the Employer as an *aide memoire* on information to give to the tenderers. Lack of this information can result in misunderstanding and extra costs after tender.

Temporary propping needed for composite construction may be overlooked at tender stage.

P1.10 FURTHER INFORMATION

The clauses to which any additional information relates to should be clearly stated. It is important that the CA edits the Table P2.9, Precast concrete, before issue so that it reflects the project requirements.

SECTION P2

Information to be supplied *by* the SCC

The CA needs to review this section to ensure that only information relevant to the project is requested.

Information required from the SCC is necessary to enable the Employer to complete the detailed programme and for quality control of the entire project.

The programme for the issuing of any drawings by the SCC is required early in the project since the Engineer may need to comment and requires adequate review time.

P2.9 PRECAST CONCRETE

The table should be used to make clear the detailed information that the CA needs from the SCC at different stages.

Sources of information

British Cement Association (BCA)
Riverside House,
4 Meadows Business Park,
Station Approach, Blackwater,
Camberley, Surrey, GU17 9AB, UK
Telephone: 01276 608700
Fax: 01276 608701
www.concrete.org.uk

British Precast (BP)
60 Charles Street
Leicester LE1 1FB
Tel: 0116 253 6161, Fax: 0116 251 4568
www.britishprecast.org.uk

British Standards Institution (BSI)
389 Chiswick High Road
London W4 4AL
Tel: 020 8996 9001, Fax: 020 8996 7001
www.bsi.org.uk

Building Research Establishment (BRE)
Garston
Watford, Herts WD25 9XX
Tel: 01923 664000, Fax: 01923 664010
www.bre.co.uk

CIRIA
174–180 Old Street, London
EC1V 9BP
Tel: 020 7549 3300, Fax: 020 7253 0523

CONSTRUCT
Riverside House,
4 Meadows Business Park,
Station Approach, Blackwater,
Camberley, Surrey, GU17 9AB, UK
Telephone: 01276 38444
Fax: 01276 38899
www.construct.org.uk

Quality Scheme for Ready Mixed Concrete (QSRMC)
3 High Street
Hampton, Middlesex TW12 2SQ
Tel: 020 8941 0273, Fax: 020 8979 4558

The Concrete Society
Riverside House,
4 Meadows Business Park,
Station Approach, Blackwater,
Camberley, Surrey, GU17 9AB, UK
Telephone: 01276 607140
Fax: 01276 607141
www.concrete.org.uk

UK CARES
Pembroke House, 21 Pembroke Road Sevenoaks,
Kent TN13 1XR
Tel: 01732 450000, Fax: 01732 455917
www.ukcares.com

United Kingdom Accreditation Service (UKAS)
21–47 High Street
Feltham, Middlesex TW13 4UN
Tel: 020 8917 8556, Fax: 020 8917 8499
www.ukas.com

The Concrete Centre
Riverside House,
4 Meadows Business Park,
Station Approach, Blackwater,
Camberley, Surrey, GU17 9AB, UK
Telephone: 0700 4 822 822
Fax: 01276 606801
www.concretecentre.com

CONSTRUCT – The Concrete Structures Group

CONSTRUCT is an association of member companies dedicated to the improvement of the construction efficiency of building in-situ concrete frames and associated structures.
The membership centres on specialist concrete contractors, supported by other associated market leaders in the supply chain, notably from the reinforcement, formwork and concrete industries.

4 Meadows Business Park, Station Approach, Blackwater,
Camberley, Surrey, GU17 9AB, UK
Telephone: 01276 38444 Fax: 01276 38899
www.construct.org.uk

REFERENCES

Standards

BS 4449:	Specification for carbon steel bars for the reinforcement of concrete
BS 5328:	Concrete (withdrawn)
BS 5606:	Guide to building accuracy
BS 5896:	Specification for high tensile steel wire and strand for the prestressing of concrete
BS 6399:	Loading for buildings
BS 6744:	Stainless steel bars for the reinforcement of and use in concrete. Requirement sand test methods
BS 7973:	Spacers and chairs for steel reinforcement and their specification, Part 1: Product performance and specification, Part 2: Fixing and application of spacers and chairs and tying of reinforcement
BS 8007:	Code of practice for the design of concrete structures for retaining aqueous liquids
BS 8102:	Code of practice for protection of structures against water from the ground
BS 8110:	Structural use of concrete, Part 1:Code of practice for design and construction, Part 2: Code of practice for special circumstances
BS 8204:	Screeds bases and insitu floorings. Part 2 - Concrete wearing surfaces. Code of practice
BS 8297:	Code of practice for the design and installation of non-loadbearing precast concrete cladding
BS 8500:	Concrete – Complementary British Standard to BS EN 206-1, Part 1: Method of specifying and guidance for the specifier, Part 2: Specification for constituent materials and concrete
BS 8666:	Specification for scheduling, dimensioning, bending and cutting of steel reinforcement
BS EN 206:	Concrete, Part 1: Specification, performance, production and conformity
BS EN 1991:	Actions on structures
BS EN ISO 9001:	Quality systems. Requirements
BS EN ISO 17025:	General requirements for the competence of testing and calibration laboratories
BS ISO 14654:	Epoxy coated steel for reinforcement of concrete
DD ENV 10080:	Steel for reinforcement of concrete. Weldable ribbed reinforcing steel B500. Technical delivery conditions for bars, coils and weldable fabric
DD ENV 13670:	Execution of concrete structures
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for Building Construction

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UDC 693.95				

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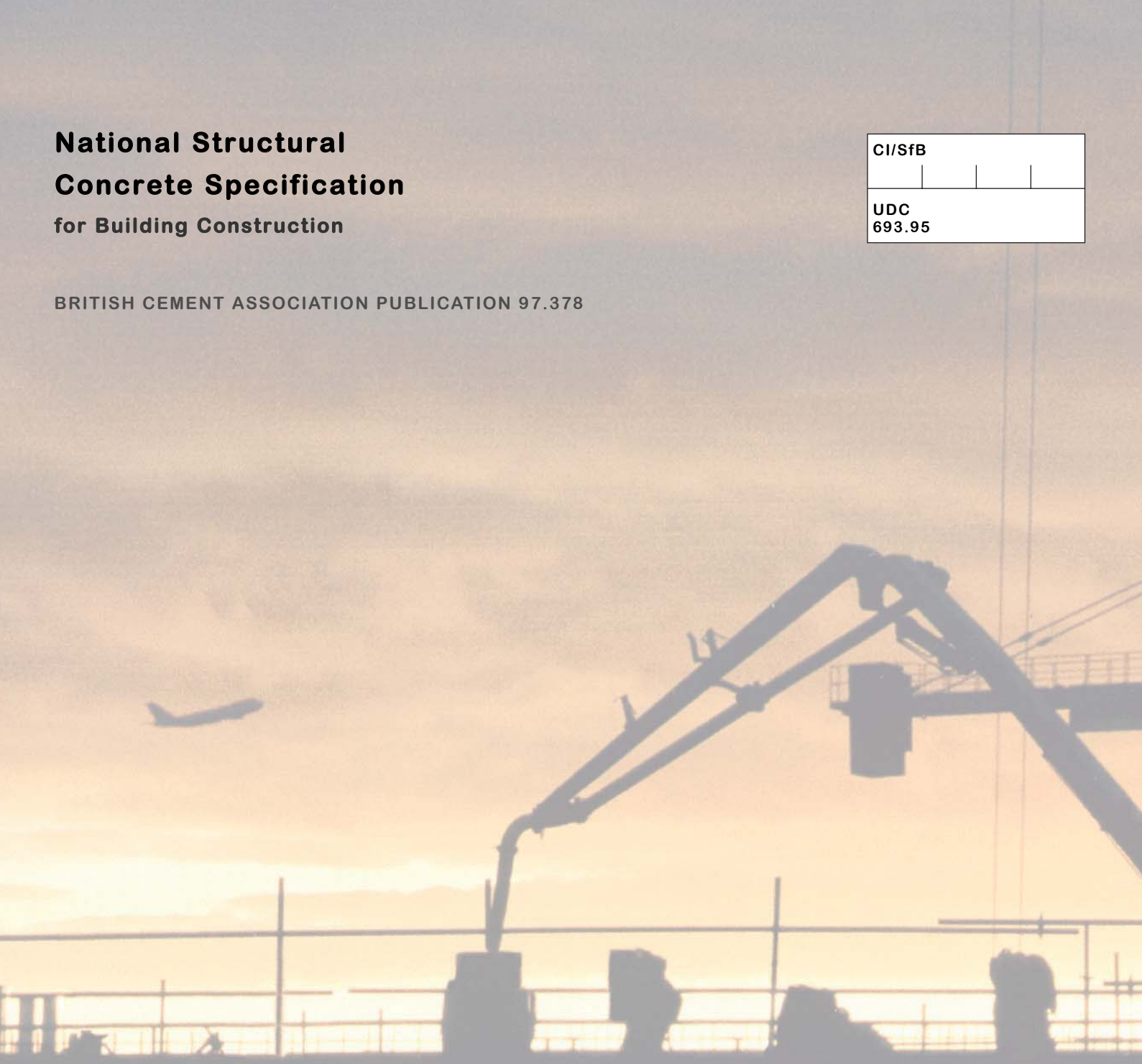

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