

The new concrete standards – getting started

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*An introductory guide to the new standards
for concrete BS EN 206-1 and BS 8500*

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Introduction

In-situ concrete structures are robust and inherently fire-resistant. They are durable and require little maintenance compared with some competing structural materials. With in-situ concrete construction, work can start on site almost immediately and construction can be rapid when required.

Constructing in concrete is the sustainable option. About 90% of fresh concrete is made from widely available local materials (aggregates and water). By-products from other industries, e.g. ground granulated blastfurnace slag and fly ash, are widely used and, at the end of its life, the concrete in a structure can be crushed and recycled. Nearly all reinforcing steel used in concrete construction is made from recycled steel.

The total environmental impact of a building over its lifetime is dominated by the impacts associated with its use. One of the key environmental impacts is the energy used by the occupants for heating, cooling, lighting, power, etc. In this respect, a concrete structure can excel. By using the concrete's thermal mass, the energy demands of the building are significantly reduced, which in turn leads to a reduction in the carbon dioxide emissions.

BS 5328⁽¹⁾ has been superseded by the European standard BS EN 206-1⁽²⁾ and its complementary British Standard BS 8500⁽³⁾. The British Standards Institution will withdraw BS 5328 on 1 December 2003. The new standards are comprehensive and include options that are for specialist use. This publication guides specifiers through the process of determining the recommended concrete quality and specifying the concrete to the producer.

Durable concrete structures

Design, detailing, specification, execution and maintenance all influence the durability of a structure regardless of the materials used for its construction.

This publication explains how to select the appropriate concrete quality in relation to the cover to reinforcement to provide a structure that is required to be durable in the identified exposure classes for the intended working life. To achieve a durable structure, other aspects of the process of design, specification and construction are equally important and should not be overlooked – in particular, achieving the minimum cover, attention to detailing and care during the execution of the works.

By following the recommendations in BS 8500-1⁽³⁾, structures made from properly compacted, 'just conforming' concrete, even if the achieved cover to reinforcement is the minimum specified, should still be durable for at least their intended working (design) life. While concrete structures are very robust, it is not practical to set concrete qualities and covers to reinforcement to compensate for gross errors in selecting the exposure classes or in executing the works.



Canon UK offices, Reigate – Daylight is reflected by the concrete soffits, and the thermal mass of the concrete results in significant energy savings throughout the life of a building.

The new standards

BS EN 206-1 Concrete – Part 1: Specification, performance, production and conformity

This is a first generation CEN standard and it makes a substantial step towards common standards for concrete in Europe. However, it is confusing to use as it tries to cover different interfaces and is a mixture of requirements, recommendations and guidance.

While this standard contains a clause on specification (clause 6), the designer will find it simpler to use BS 8500-1.

BS EN 206-1 contains some of the requirements for concrete and most of the conformity and identity test criteria.

BS 8500-1 Concrete – Complementary British Standard to BS EN 206-1

Part 1: 2002 Method of specifying and guidance for the specifier

This is written for the specifier. Anyone wishing to specify concrete to BS EN 206-1 as applied in the UK should use BS 8500-1. Once the method of specifying has been selected, clause 4 gives the requirements that *have* to be specified and those that *may* be specified. Most requirements have notes showing where guidance on what to specify may be found.

BS 8500-2 Concrete – Complementary British Standard to BS EN 206-1

Part 2: 2002 Specification for constituent materials and concrete

The producer needs this together with BS EN 206-1. It contains specifications for materials and procedures that are outside of European standardisation but within national experience. This standard supplements the requirements in BS EN 206-1.

Standards for fresh concrete

Published by BSI, this derived document is a composite of BS EN 206-1 and BS 8500 woven together as a user-friendly version of the standards. It contains additional guidance and a commentary.

While this is not a standard, it is not necessary to hold the separate standards as all the requirements and information in the standards is contained in this document.



Reinforced concrete footbridge, Newark, 1915. Concrete – the material for extreme weather conditions.

What documents do I need to select and specify concrete?

You need to have BS 8500-1 or the derived document *Standards for fresh concrete*⁽⁴⁾. If you have aggressive ground conditions, you should also have *Concrete in aggressive ground* (Second edition)⁽⁵⁾.

To help with the selection and specification of concrete, it is useful to have the ‘ConSpec’ software package⁽⁶⁾. Using standard forms for specifying designated and designed concrete will ensure that the full details are passed to the concrete producer. Suitable forms are given in Appendix A and electronic versions are available.

The new concrete standards cite a large number of European and residual British standards for constituent materials and test methods. Guidance on these may be found in *European replacements for British Standards – Concrete and its constituent materials*⁽⁷⁾.

Jargon busting

One of the main difficulties with the new standards is getting familiar with the new terms. The following explanations should help. More guidance is given in *Guidance on the use of terms relating to cement and concrete*⁽⁸⁾.

Additions	This is the term for constituent materials, such as fly ash, ground granulated blastfurnace slag, silica fume, etc., that are added at the concrete mixer.	Execution	Workmanship.
Chloride class	The way of expressing the maximum chloride content of a concrete. For example, a chloride class of Cl 0,40 means a maximum chloride ion content of 0.40% by mass of cement.	Fly ash	Pulverized-fuel ash.
Combinations	Cements made in the concrete mixer by combining Portland cement with an addition in proportions that satisfy the criteria given in BS 8500-2, Annex A.	Identity testing	Acceptance testing in all but name. It 'identifies' whether a particular batch or batches of concrete come from a conforming population.
Comma	BS EN 206-1 uses a 'comma' where we in the UK would expect to see a decimal point. Where a 'comma' has been used in a class notation, e.g. Cl 0,40, the comma has been retained in BS 8500.	Intended working life	Period of time that a properly maintained structure is required to be serviceable and durable.
Compressive strength class	A more complex way of expressing the 'grade' of concrete using letters ('C' for normal-weight and heavyweight concrete and 'LC' for lightweight concrete) followed by the minimum characteristic strength of a 150mm diameter by 300mm cylinder, a slash, and the minimum characteristic cube strength, e.g. C40/50.	Minimum cover to reinforcement	Cover to reinforcement assumed to be achieved when determining the concrete quality.
Concrete	A specifier species a 'concrete' and a producer designs a 'mix' that satisfies all the specified requirements for the concrete.	Mix	A composition that satisfies all the requirements specified for the concrete. Different producers may have different mixes, all of which satisfy the concrete specification.
Conformity	Tests and procedures undertaken by the producer to verify the claims made on the delivery ticket. This replaces the compliance testing procedures in BS 5328.	Nominal cover to reinforcement	Cover to reinforcement shown on the drawings equal to the minimum cover plus a tolerance (margin) for fixing precision.
Consistence	Workability.	Prescribed concrete	Called 'Prescribed mix' in BS 5328 (see 'Concrete' and 'Mix').
Consistence class	A recommended alternative to specifying consistence by a target value.	Proprietary concrete	Concrete for which the producer assures the performance, subject to good practice in placing, compacting and curing, and for which the producer is not required to declare the composition.
Designated concrete	Called 'Designated mix' in BS 5328 (see 'Concrete' and 'Mix').	Recycled aggregates	Aggregate resulting from the reprocessing of inorganic material previously used in construction. A sub-set of this is 'recycled concrete aggregate', which is mostly crushed concrete.
Designed concrete	Called 'Designed mix' in BS 5328 (see 'Concrete' and 'Mix').	Specification	Final compilation of documented technical requirements, in terms of performance or composition, given to the producer by the specifier.
Established suitability	The concept of established suitability allows materials and procedures to be used on a national basis that are not currently covered by European standards, but have a satisfactory history of local use.	Specifier	Term reserved for the person or body who passes the specification to the producer.
		Standardized prescribed concrete	Called 'Standard mix' in BS 5328 (see 'Concrete' and 'Mix'). The new term correctly identifies the type of concrete and avoids the misunderstanding caused when 'standard' is taken to mean 'normal'.
		User	Person or body using fresh concrete.

The process for selecting and specifying concrete quality and cover

The new standards do not change the normal process of design. However, a number of aspects that were implicit in previous standards, e.g. the intended working life and the type of aggressive actions on the concrete and reinforcement, are addressed explicitly in the new standards. The process comprises:

- Gathering information relating to the structural and fire design
- Determining the intended working life
- Identifying relevant exposure classes
- Identifying other requirements for the concrete
- Selecting the method of specifying
- Selecting the concrete quality and cover to reinforcement
- Preparing the specification
- Exchange of information.

Gathering information relating to the structural and fire design

BS 8500⁽³⁾ will be operational before the European structural and fire design codes are in place. Consequently, in the short term, the output of the design process will come from the application of British Standards such as BS 8110⁽⁹⁾ and be in the form of the required ‘grade’ of concrete, which is the minimum characteristic cube strength required. This needs to be converted to the new notation of a compressive strength class using Tables 1 or 2 as appropriate.

The first number in each notation in the compressive strength class is the minimum required characteristic strength of 150mm diameter by 300mm cylinders. This is the design strength used in the European structural design codes. Consequently it is important that the new classification is always used in full, as the concrete producer will not know if a single value is the minimum required characteristic cylinder or cube strength.

In addition to the minimum required characteristic strength of concrete (expressed as a compressive strength class), the other key output from designing to British Standards is the nominal cover to reinforcement. The margin (the difference between the nominal cover and the minimum cover) needs to be established. Clause 7.3 of BS 8110: Part 1: 1997⁽⁹⁾ implies that the margin is 5mm. While this is a suitable margin in some conditions, e.g. internal concrete, this is the lower limit of the recommended range (5mm to 15mm). In an aggressive

Table 1: Compressive strength classes for normal-weight and heavyweight concrete.

Required grade, i.e. required minimum characteristic cube strength, N/mm ²	Specify compressive strength class
10	C8/10
15	C12/15
20	C16/20
25	C20/25
30	C25/30
35	C28/35
37	C30/37
40	C32/40
45	C35/45
50	C40/50
55	C45/55
60	C50/60
67	C55/67
75	C60/75
85	C70/85
95	C80/95
105	C90/105
115	C100/115

Table 2: Compressive strength classes for lightweight concrete.

Required grade, i.e. required minimum characteristic cube strength, N/mm ²	Specify compressive strength class
9	LC8/9
13	LC12/13
18	LC16/18
22	LC20/22
28	LC25/28
33	LC30/33
38	LC35/38
44	LC40/44
50	LC45/50
55	LC50/55
60	LC55/60
66	LC60/66
77	LC70/77
88	LC80/88

environment, careful consideration should be given to what is practical and an appropriate margin selected. This does not mean that you have to change the section size or nominal cover, just the concrete quality, see example below.

Example. Exposed column of a building (exposure class XC4) with 40mm nominal cover.

Nominal cover mm	Selected margin mm	Resulting minimum cover mm	Recommended designated concrete from BS 8500-2, Table A.6
40	5	35	RC30
40	10	30	RC35
40	15	25	RC40



High-quality, in-situ concrete finishes at the European Institute of Health and Medical Sciences, Guildford.

Determining the intended working life

BS EN 1990: 2002 *Eurocode – Basis of structural design*⁽¹⁰⁾, gives recommended intended working lives for different types of structure. These are shown in Table 3. Where BS 8500-1 gives recommended concrete qualities, it uses the phrase ‘for an intended working life of at least xx years’ to indicate that most structures will continue to perform adequately well beyond the intended working life.

Identifying relevant exposure classes

The main exposure classes are given in Table 4.

BS 8500-1 covers all these exposure classes except abrasion. For guidance on abrasion you need to consult other standards, such as BS EN 13813 *Screed materials and floor screeds – Properties and requirements*⁽¹¹⁾, which contains wear classes for floors. With the exception of X0, all these exposure classes are split into a series of sub-classes. These exposure classes, sub-classes and informative examples are all given in BS 8500-1, Table A.1. Moisture conditions given in the class description are those in the concrete cover to reinforcement, but, in many cases, conditions in the concrete cover can be taken as being the same as those in the surrounding environment.

Table 3: Intended working lives recommended in BS EN 1990.

Temporary structures	10 years
Replaceable structural parts	10 to 25 years
Agricultural and similar structures	15 to 30 years
Building structures and other common structures	50 years
Monumental building structures, bridges and other civil engineering structures	100 years

Table 4: Main exposure classes.

Designation	Description
X0	No risk of corrosion or attack
XC	Corrosion induced by carbonation
XD	Corrosion induced by chlorides other than from seawater
XS	Corrosion induced by chlorides from seawater
XF	Freeze/thaw attack with or without de-icing agents
ACEC class	Chemical attack
	Abrasion

There will always be one, and often more than one, relevant exposure class. Different element faces may have different exposures and all should be identified. Table 5 gives guidance on the exposure classes that have to be identified.

BSI has not adopted the chemical attack exposure classes given in BS EN 206-1 as they cover only natural ground with static water, which represents a very limited proportion of the aggressive ground conditions found in the UK. The provisions in BS 8500 are taken from BRE Special Digest 1 *Concrete in aggressive ground*⁽⁵⁾, with its comprehensive ‘aggressive chemical environment for concrete’ (ACEC) classification and recommendations.

BRE SD1 makes important recommendations about the way in which site investigations should be undertaken. In particular, experience has shown that the aggressiveness of a site can be underestimated because of a failure to recognise potential sulfate from materials such as pyrite and incorrect classification of the groundwater as being static.

The four steps for determining the ACEC class are set out in BS 8500-1, Table A.2, and are fully described in BRE Special Digest 1:

Step 1: Determination of the design sulfate class

The measured sulfate content is increased to take account of materials that may oxidise into sulfate, e.g. iron pyrite, and other aggressive species such as hydrochloric or nitric acid. The magnesium ion content is also used in the classification.

Step 2: Soil classification

The soil is classified as natural or brownfield. A ‘brownfield site’ is one that may contain chemical residues from previous industrial use or from imported wastes.

Step 3: Groundwater mobility and pH

Determine whether the groundwater is static or mobile. If there is any doubt, it should be classed as mobile. The pH of the groundwater needs to be measured.

Table 5: Relevant exposure classes

Main exposure	Relevant exposure class						
	X0	XC	XD	XS	XF	ACEC class	Abrasion
No risk of corrosion or attack	Yes	No	No	No	No	No	No
Corrosion induced by carbonation only	No	Yes	No	No	Possible	Possible	Possible
Corrosion induced by chlorides from sources other than seawater	No	Yes	Yes	No	Possible	Possible	Possible
Corrosion induced by chlorides from seawater	No	Yes	No	Yes	Possible	Possible*	Possible
Unreinforced concrete where there is some risk of attack	No	No	No	No	Possible	Yes	Possible

* The chemical attack from the seawater has already been taken into account within the recommendations for resisting the XS exposure.

Step 4: Determination of the ACEC class

Using BS 8500-1, Table A.2 and the information determined in Steps 1 to 3, the ACEC class is determined. In a few cases it will also be necessary to record the design sulfate class (DS class), as this influences the cement types that may be used.

Identifying other requirements for the concrete

There are a number of requirements for the structure that affect the choice of concrete. These include:

- **aesthetic considerations**
 - high-quality as-struck surface finish
 - white or coloured concrete
 - exposed aggregate, tooled or other surface finishes that remove the surface
- **minimising cracking due to**
 - restrained early-age thermal effects
 - long-term drying shrinkage
 - delayed ettringite formation
- **construction requirements**
 - method of placement
 - accelerated or retarded setting
 - plastic settlement cracking
 - high early strength
 - low early strength
 - overcoming problems caused by congested reinforcement
 - overcoming difficult placing conditions
 - self-compacting concrete
 - coping with high/low ambient temperatures.

Further guidance is given in three modules in the series *Specifying concrete to BS EN 206-1/BS 8500*⁽¹²⁾:

- *Guidance on the additional requirements for designed concrete*
- *Visual concrete*
- *Coloured concrete*

and in the derived document *Standards for fresh concrete*⁽⁴⁾.



South Quay Plaza, London Docklands – Flat slab construction for freedom to route services.

Selecting the method of specifying

Where corrosion due to chlorides is not an identified exposure class, the structural concrete may be specified using the designated concrete or designed concrete methods of specifying. For structural concrete where there are exposure classes that include corrosion due to chlorides, only the designed concrete method of specifying is appropriate.

An exception to this general recommendation is where an exposed aggregate finish, tooled finish or other method of finishing that removes the concrete surface is required. To get an appealing finish, a special mix design is needed. In these cases it is recommended that initial testing is undertaken including a trial panel and, from the results of these tests, a prescribed concrete is specified. The nominal cover to

reinforcement at casting should also make allowance for the material to be removed from the surface.

For housing applications, the specifier should give as alternatives a designated concrete and a standardised prescribed concrete. This will allow the ready-mixed concrete producer with accredited certification to quote for supplying a designated concrete, and the contractor and ready-mixed concrete producers without certification to quote for supplying a standardised prescribed concrete.

Selecting the concrete quality & cover to reinforcement

Guidance on the selection of concrete quality and cover to reinforcement is given in BS 8500-1, Annex A and in the derived document *Standards for fresh concrete*⁽⁴⁾. An alternative approach is to use the ConSpec software package⁽⁶⁾. This is strongly recommended where there is a complex set of exposure classes.

The recommendations in BS 8500-1 are based on the use of normal steel reinforcement. Guidance on the use of stainless steel reinforcement is given in Concrete Society Technical Report 51: *Guidance on the use of stainless steel reinforcement*. For guidance on non-ferrous reinforcement, see state-of-the-art literature. The International Standards Organisation (ISO TC 71: SC6) is in the process of developing standards and guidance on the use of non-ferrous reinforcement.

In principle, the selection process is simple. For the intended working life and for each of the identified exposure classes, the recommended concrete quality is noted for the nominal cover to reinforcement used in the structural design and the most onerous values are selected. If this results in an excessively high concrete quality, the designer should look at the option of increasing the cover to reinforcement and reducing the concrete quality.

In practice the process is also simple where there are only one or two identified exposure classes. See example on the right.

Example

External column (exposure classes XC4 and XF1) for an intended working life of at least 50 years. The structural and fire designs lead to a nominal cover of 40mm and the designer selects a margin (Δc) of 10mm. The minimum cover is $(40 - 10) = 30\text{mm}$ and the nominal cover, as expressed in BS 8500-1, is $(30 + \Delta c)$ mm.

For designated concrete, BS 8500-1, Table A.6 recommends, for a cover of $(30 + \Delta c)$ mm, an RC35 designated concrete.

If the margin was selected as 15 mm (nominal cover $(25 + \Delta c)$ mm), BS 8500-1, Table A.6 recommends an RC40 designated concrete.

For designed concrete with 20mm maximum aggregate size, BS 8500-1, Table A.10 gives, for exposure class XC4 and a nominal cover of $(30 + \Delta c)$ mm:

Compressive strength class C28/35, maximum water/cement ratio 0.60, minimum cement/combination content 280kg/m^3 .

For exposure class XF1, Table A.14 gives a minimum concrete quality of C28/35, 0.60, 280. The specifier should compare each of the requirements and select the most onerous value for the specification, but in this case the requirements are the same.

If the margin was selected as 5mm (nominal cover $(35 + \Delta c)$ mm), BS 8500-1, Table A.10 gives for XC4: C25/30, 0.65, 260. The recommendations for resisting exposure XF1 are unchanged and as these are the most onerous requirements, the concrete quality to specify is C28/35, 0.60, 280.



Waterloo International Terminal – Concrete track and platform structure: fast, on time and on budget. (Photo: Lilley Construction)



BRITPAVE slipformed concrete crash barrier – for safest motorway travel.

Where exposure classes include aggressive chemicals and chloride-induced corrosion, identifying the options is more complex. This is where ConSpec software program is extremely helpful. ConSpec automatically identifies all the options and the designer simply selects from these. During this selection, the designer should take account of the other requirements for the concrete.

Further examples of the selection of concrete quality and cover to reinforcement are given in two modules in the series *Specifying concrete to BS EN 206-1/BS 8500*⁽¹²⁾:

- *Examples of specification of designated concrete*
- *Examples of specification of designed concrete.*

Preparing the specification and exchange of information

Appendix A contains forms to help with the specification of designated concrete and designed concrete. Electronic versions of these forms are also available from the Quarry Products Association.

The main problem with these forms is understanding the new designations for cements/combinations and consistence. To help bridge this gap, Table 6 gives the likely target values for a range of slump and flow classes and Table 7 provides guidance on the cement/combination type designations.

BS 8500 treats cement and combinations as being equivalent and so, when specifying, do not add 'C' or 'CEM' before the II, III or IV. This makes it clear that both are acceptable. The producer will add 'C' or 'CEM' to the delivery ticket to indicate which one has been used.

Table 6: Likely target values for a range of slump and flow classes.

Slump class	Likely target slump, mm	Flow class	Likely target flow, mm
S1	20	F2	380
S2	70	F3	450
S3	120	F4	520
S4	180	F5	590

For more information about cements and additions, see the two modules *Specifying constituent materials for concrete to BS EN 206-1/BS 8500*⁽¹⁴⁾:

- *Cements*
- *Additions.*

Conformity

In a significant improvement to BS 5328, the producer is required to verify that the claims made on the delivery ticket are valid. Routine testing of the concrete and applying conformity criteria that are defined in BS EN 206-1 achieve this. If the concrete is found to be non-conforming and the non-conformity was not obvious at delivery, the producer has to inform the specifier and user. Non-conformities that will be regarded by producers as being obvious at delivery include consistence, air content, colour and maximum aggregate size. Non-conformities that are not obvious at delivery include strength, maximum w/c ratio and minimum cement content. When the producer measures the consistence or air content, the results should be conveyed to the user. If the tolerances exceed the limits for an individual batch, the user decides whether to accept or reject the batch. The batch is accepted or rejected and this is the end of the matter.



Self-compacting concrete – for difficult placing conditions or where high-quality surface finishes are required.

Table 7: Guide to cement/combination type designations.

Designation	Guidance on meaning
CEM 1	Portland cement
SRPC	Sulfate-resisting Portland cement
IIA	Portland cement with 6 to 20% of fly ash (pfa), ground granulated blastfurnace slag or limestone*
IIB	Portland cement with 21 to 35% of fly ash (pfa) or ground granulated blastfurnace slag*
IIIA	Portland cement with 36 to 65% ground granulated blastfurnace slag
IIIB	Portland cement with 66 to 80% ground granulated blastfurnace slag
IVB	Portland cement with 36 to 55% of fly ash (pfa)
+SR	This is applied to cement or combination types IIB, IIIB and IVB where the proportions and properties for a sulfate-resisting cement or combination is required.

* There are a number of other second main constituents, but these are unlikely to be used in the UK.



Four examples of exposed aggregate finishes – a special mix design is needed. Talk to your concrete producer. (Photo: CIL)

To ensure that the number of tests is manageable, but still adequate for effective control, related concretes may be grouped into families. A concrete family is a group of concrete compositions for which a reliable relationship between relevant properties is established and documented. Concrete producers in the UK have used the family system of control for over a decade and it has been proved to be extremely effective. Its main benefit is that changes in quality can be detected rapidly and effective action taken to ensure that the production remains in a state of statistical control.

However, many specifiers have no knowledge of the concrete family system and treat it with suspicion. The logic for using these systems can be easily understood by turning the argument around and asking, for example, which concretes would be affected if a constituent material were to change in its performance? It should be clear that all concretes made with this constituent material would be affected and, where concrete families have been established, in a predictable way. The use of concrete families will also reduce the assessment period, i.e. the period the producer uses to verify that all the concrete produced conforms to BS 8500-2.



Pile of recycled concrete aggregate (RCA) – BS 8500 makes provision for the use of RCA.

The complexities of concrete families and the conformity criteria is a very good reason why specifiers should include a requirement for UKAS or equivalent third-party product conformity certification. The concrete certification bodies in the UK (BSI Kitemark and QSRMC) are familiar with concrete families and will audit the producer's records to ensure that conformity was correctly undertaken and, in the case of non-conformity, the required action was taken.

For more guidance on concrete families, see CEN Report 13901: *The use of the concept of concrete families for the production and conformity control of concrete*⁽¹⁵⁾.

For guidance on the application of the conformity criteria, see *Guidance on the application of the EN 206-1 conformity rules*⁽¹⁶⁾.

The concrete producer will declare that the concrete conforms to BS 8500-2: *Concrete. Complementary British standard to BS EN 206-1. Part 2: Specification for constituent materials and concrete*. As BS 8500-2 requires conformity to BS EN 206-1: *Concrete. Part 1: Specification, performance, production and conformity*, a declaration of conformity to BS 8500-2 includes conformity to BS EN 206-1.

Identity testing

Identity tests are acceptance tests in all but name, and are carried out by the specifier or user. The main function of these tests is to verify that an individual batch of concrete is as specified. The identity test criterion for an individual batch is the same as the conformity criterion for an individual batch.

The specifier or user may also use identity tests for strength to assess if the concrete in a structural element or series of elements came from a conforming population, i.e. is acceptable. Where such testing is to be routinely undertaken, the specifier needs to inform the concrete producer of the type and number of tests on each element or series of elements cast with the same concrete and whether a non-accredited laboratory will be used for these tests. The specifier should accept elements in which the concrete satisfies the identity criteria. Where they fail the identity criteria, further investigations might be required.

Conformity testing replaces the compliance testing of BS 5328. If there is any doubt about a particular batch, an identity or conformity test on that batch is strongly recommended. Regular identity testing in addition to conformity testing should be limited to special cases.

Concrete test methods

There are three series of concrete test methods:

- BS EN 12350: *Testing fresh concrete*⁽¹⁷⁾ (seven published parts)
- BS EN 12390: *Testing hardened concrete*⁽¹⁸⁾ (eight published parts)
- BS EN 12504: *Testing concrete in structures*⁽¹⁹⁾ (four parts, of which two are published).

In most cases the tests are very similar to the BS 1881⁽²⁰⁾ tests they replace. Appendix B gives the European equivalents to the BS 1881 100 series of test methods.

Transition period

Concrete producers are gearing up for a clean changeover from BS 5328 to BS EN 206-1 and BS 8500 on 1 December 2003 to avoid confusion and the costs of operating a dual system. Specifications for concrete to be supplied after 1 December 2003 should be prepared in accordance with BS 8500-1 with the requirement that the concrete conforms to BS 8500-2.

In practice, the transition has already started. Even though BS 5328 cites British Standards for constituent materials, concretes are currently being supplied with cement



Milton Keynes Gallery – your imagination is the limit.



Coloured concrete – what colour would you like?

conforming to BS EN 197-1⁽²¹⁾ and admixtures conforming to BS EN 934-2⁽²²⁾.

The main difficulty is with contracts that span the transition date. In the vast majority of cases, adopting the new standards will not change the actual quality of the concrete you receive. Specifiers will be concerned about the implications of changing the technical basis of the contract for the supply of concrete and this should be discussed with the concrete producer. There is a range of options and it should be possible to reach a mutually satisfactory agreement.



Modern ready-mixed concrete plant – rmc is made in factories under closely controlled conditions.

Appendix A: Forms for specifying or scheduling designated and designed concrete in accordance with BS 8500-1

(Available for downloading from www.qpa.org/pro_rea.)

DESIGNATED CONCRETES

Schedule for the specification requirements of designated concretes for use on contract					
.....					
Contract period					
BS 8500-1 reference	Requirement	Schedule			
4.2.2a)	The concretes below shall be supplied as designated concretes in accordance with this specification and the relevant clauses of BS 8500-2*				
4.2.2b)	Concrete designation				
4.2.2c)	Maximum aggregate size when other than 20mm				
4.2.2d)	Consistence (Ring the class required when other than the default classes of S3 for the GEN, FND and RC series and S2 for the PAV series. Use a separate column for different consistence with the same designated concrete) Other (specify)	S1, S2, S3, S4 F2, F3, F4, F5	S1, S2, S3, S4 F2, F3, F4, F5	S1, S2, S3, S4 F2, F3, F4, F5	S1, S2, S3, S4 F2, F3, F4, F5
4.2.3	Additional requirements				
Exchange of information					
BS EN 206-1, 7.1	Total volume required Anticipated peak delivery rate Any access limitations				
5.1a)	Intended method of placing, e.g. pumping, and finishing, e.g. power floating, the concrete				
5.1b)	Where identity testing is routine: Type of test Volume of concrete in assessment Number of tests on this volume Whether a non-accredited laboratory will be used				
5.1 and BS EN 206-1, 7.1	Other information from the specifier to producer				
5.2 and BS EN 206-1, 7.2	Information required from the producer				
* There is no need to cite BS EN 206-1 as BS 8500-2 has a clause that requires conformity to BS EN 206-1.					

DESIGNED CONCRETES

Schedule for the specification requirements of designed concretes for use on contract					
.....					
Contract period					
BS 8500-1 reference	Requirement	Schedule			
4.2.2a)	The concretes below shall be supplied as designed concretes in accordance with this specification and the relevant clauses of BS 8500-2*				
	Concrete reference, if any				
4.3.2b)	Compressive strength class				
4.3.2c)	For sulfate resisting concrete, design chemical class	DC-	DC-	DC-	DC-
	For other concretes, limiting values of composition: Maximum w/c ratio Minimum cement/combination content, kg/m ³				
4.3.2d) and 4.3.3a)	Cement or combination types† (delete those not permitted) Other or special property, e.g. white, low heat, +SR (specify)	CEM I, SRPC IIA, IIB IIIA, IIIB, IVB	CEM I, SRPC IIA, IIB IIIA, IIIB, IVB	CEM I, SRPC IIA, IIB IIIA, IIIB, IVB	CEM I, SRPC IIA, IIB IIIA, IIIB, IVB
4.3.2e)	Maximum aggregate size, mm				
4.3.2f)	Chloride class (ring the one required)				
	Prestressed or heat cured reinforced concrete	Cl 0,10	Cl 0,10	Cl 0,10	Cl 0,10
	Reinforced‡ Unreinforced with no embedded metal	RC Cl 1,0	RC Cl 1,0	RC Cl 1,0	RC Cl 1,0
4.3.2g) and h)	For lightweight and heavyweight concrete, target density				
4.3.2i)	Consistence (Ring the class required. Use separate columns for the same basic concrete with different consistence) Other (specify)	S1, S2, S3, S4 F2, F3, F4, F5	S1, S2, S3, S4 F2, F3, F4, F5	S1, S2, S3, S4 F2, F3, F4, F5	S1, S2, S3, S4 F2, F3, F4, F5
4.3.2 Note 2	UKAS or equivalent accredited third party product conformity certification (delete if not required)	Yes	Yes	Yes	Yes
4.3.3b) to n)	Additional requirements				
Exchange of information					
BS EN 206-1, 7.1	Total volume required Anticipated peak delivery rate Any access limitations				
5.1a)	Intended method of placing, e.g. pumping, and finishing, e.g. power floating, the concrete				
5.1b)	Where identity testing is routine:				
	Type of test				
	Volume of concrete in assessment				
	Number of tests on this volume Whether a non-accredited laboratory will be used				
5.1 and BS EN 206-1, 7.1	Other information from the specifier to producer				
5.2 and BS EN 206-1, 7.2	Information required from the producer				
* There is no need to cite BS EN 206-1 as BS 8500-2 has a clause that requires conformity to BS EN 206-1. † If a DC- class has been specified, the cement/combination types need not be specified. ‡ Where RC is ringed, the chloride class shall be Cl 0,40 except where SRPC is used. In this case the chloride class shall be Cl 0,20.					

Appendix B: Equivalent European tests to the BS 1881 100 series

Where the Part number of BS 1881 *Testing concrete* is in **bold**, this indicates that the standard will continue after 1 December 2003, the date on which many parts of BS 1881 will be withdrawn.

BS EN 12350-1: 2000. Testing fresh concrete

BS 1881 Testing concrete	BS EN 12350-1: 2000. Testing fresh concrete	Comment
Part 101. Method of sampling fresh concrete on site	Part 1. Sampling	
Part 102. Method for determination of slump	Part 2. Slump test	
Part 103. Method for determination of compacting factor		These tests are different, but as they are used on the same types of concrete, BS 1881 Part 103 will be withdrawn.
	Part 4. Degree of compactability	
Part 104. Method for determination of Vebe time	Part 3. Vebe test	
Part 105. Method for determination of flow	Part 5. Flow table test	
Part 106. Methods for determination of air content of fresh concrete	Part 7. Air content of fresh concrete – Pressure methods	
Part 107. Method for determination of density of compacted fresh concrete	Part 6. Density	
Part 125. Methods for mixing and sampling fresh concrete in the laboratory		No European equivalent
Part 128. Methods for analysis of fresh concrete		See also CEN Report 13902: 2000: <i>Test methods for determining water/cement ratio of fresh concrete</i>
Part 129. Method for determination of density of partially compacted semi-dry fresh concrete		No European equivalent

BS EN 12504-1: 2000. Testing concrete in structures

BS 1881 Testing concrete	BS EN 12504-1: 2000. Testing concrete in structures	Comment
Part 120. Method for determination of the compressive strength of concrete cores	Part 1: Cored specimens – Taking, examining and testing in compression	

BS EN 12390-1: 2000. Testing hardened concrete

BS 1881 Testing concrete	BS EN 12390-1: 2000. Testing hardened concrete	Comment
	Part 1. Shape, dimensions and other requirements for test specimens and moulds	Replaces equivalent text in BS 1881: Parts 108, 109 and 110.
Part 108. Method for making test cubes from fresh concrete	Part 2. Making and curing specimens for strength tests	BS EN 12390-1 covers part of BS 1881: Part 108.
Part 109. Method for making test beams from fresh concrete	Part 2. Making and curing specimens for strength tests	BS EN 12390-1 covers part of BS 1881: Part 109.
Part 110. Methods for making test cylinders from fresh concrete	Part 2. Making and curing specimens for strength tests	BS EN 12390-1 covers part of BS 1881: Part 110.
Part 111. Method of normal curing of test specimens (20°C method)	Part 2. Making and curing specimens for strength tests	
Part 112. Methods of accelerated curing of test cubes		No European equivalent
Part 113. Method for making and curing no-fines test cubes		No European equivalent
Part 114. Methods for determination of density of hardened concrete	Part 7. Density of hardened concrete	
Part 115. Specification for compression testing machines for concrete	Part 4. Compressive strength – Specification of compression testing machines	
Part 116. Method for determination of compressive strength of concrete cubes	Part 3. Compressive strength of test specimens	
Part 117. Method for determination of tensile splitting strength	Part 6. Tensile splitting strength of test specimens	
Part 118. Method for determination of flexural strength	Part 5. Flexural strength of test specimens	
Part 119. Method for determination of compressive strength using portions of beams broken in flexure (equivalent cube method)		No European equivalent
Part 121. Method for determination of static modulus of elasticity in compression		European standard under preparation
Part 122. Method for determination of water absorption		No European equivalent
	Part 8. Depth of penetration of water under pressure	This is a completely different test to the BS 1881: Part 122 test.
Part 124. Methods for analysis of hardened concrete		No European equivalent
Part 127. Method of verifying the performance of a concrete cube compression machine using the comparative cube test		No European equivalent
Part 130. Method for temperature-matched curing of concrete specimens		No European equivalent
Part 131. Methods for testing cement in a reference concrete		No European equivalent

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The new concrete standards – getting started

Tom Harrison

New British standards for concrete, BS 8500 and BS EN 206-1, are being introduced, and supersede the current standard BS 5328, which will be withdrawn on 1 December 2003.

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This publication guides the reader through the procedure of selecting and specifying structural concrete. By following this procedure, the reader will become familiar with the key parts of the new concrete standards. For many specifiers, these are the only parts of the standard they will ever need.

Professor Tom Harrison BSc PhD CEng MICE FICT

Tom Harrison is chairman of the British Standards Institution concrete committee. He is the technical consultant to the QPA-BRMCA and a Visiting Industrial Professor at the University of Dundee.

Tom was involved with the evolution of ENV 206 into BS EN 206-1 and heavily involved in the drafting of BS 8500. He also compiled the derived document Standards for fresh concrete and has drafted many of the guidance modules on the new standards.

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