BS 8500-2:2015

BSI Standards Publication

Concrete – Complementary British Standard to BS EN 206

Part 2: Specification for constituent materials and concrete

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 40, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 8500 is published by BSI Standards Limited, under licence by the British Standards Institution, and came into effect on 30 June 2015. It was prepared by Working Group B/517/1/WG20, *Specification drafting*, under the authority of Subcommittee B/517/1, *Concrete production and testing*, and Technical Committee B/517, *Concrete and related products*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

BS 8500-2:2015 supersedes BS 8500-2:2006+A1:2012, which will be withdrawn on 30 June 2015.

Relationship with other publications

BS 8500 contains additional United Kingdom provisions to be used in conjunction with BS EN 206. Together they form a complete package for the specification, production and conformity of fresh concrete.

BS 8500 is published in two parts:

- Part 1, *Method of specifying and guidance for the specifier*;
- Part 2, *Specification for constituent materials and concrete*.

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- changes necessary to align with the publication of BS EN 206:2013;
- changes resulting from new or revised European Standards published since 2006;
- alignment with conformity assessment and accreditation policy in the United Kingdom;
- introduction of designated cement-bound concrete;
- modification of requirements for concrete to resist freezing and thawing;
- corrections and minor clarifications;
- a new Annex (Annex D) has been added which sets out where to find the BS 8500 provisions that cover BS EN 206 requirements that defer to provisions in the place of use; and
- all references have been updated.

Hazard warnings

WARNING. Where skin is in contact with fresh concrete, skin irritations are likely to occur owing to the alkaline nature of cement. The abrasive effects of sand and aggregate in the concrete can aggravate the condition. Potential effects range from dry skin, irritant contact dermatitis, to – in cases of prolonged exposure – severe burns. Take precautions to avoid dry cement entering the eyes, mouth and nose when mixing mortar or concrete by wearing suitable protective clothing. Take care to prevent fresh concrete from entering boots and use working methods that do not require personnel to kneel in fresh concrete. Unlike heat burns, cement burns might not be felt until some time after contact with fresh concrete, so there might be no warning of damage occurring. If cement or concrete enters the eye, immediately wash it out thoroughly with clean water and seek medical treatment without delay. Wash wet concrete off the skin immediately. Barrier creams may be used to supplement protective clothing but are not an alternative means of protection.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

The requirement for third-party certification has been approved by the Standards Policy and Strategy Committee.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

The requirements in this part of BS 8500 are given for defined materials with an established or accepted adequate performance in the conditions found in the United Kingdom. These requirements might not be appropriate for use in exposure conditions different from the United Kingdom, particularly in hot climates. The use of constituents not listed in this standard should be by agreement between the producer and specifier on a case-by-case basis.

BS 8500 and BS EN 206 take account of the distinct and different technical responsibilities of the specifier, producer and user. Where a body is responsible for more than one of these roles, internal procedures within that body should allocate responsibilities for the various actions.

1 Scope

This part of BS 8500 specifies constituent materials and concrete. This part of BS 8500 complements BS EN 206. It provides United Kingdom national provisions where required or permitted by BS EN 206. It also covers materials, methods of testing and procedures that are outside the scope of BS EN 206, but within national experience.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 812-104, *Testing aggregates – Part 104: Method for qualitative and quantitative petrographic examination of aggregates*

BS 812-123, *Testing aggregates – Part 123: Method for determination of alkali-silica reactivity – Concrete prism method*

BS 1704, *Specification for solid-stem general purpose thermometers*

BS 1881-124, *Testing concrete – Part 124: Method for analysis of hardened concrete*

BS 1881-129, *Testing concrete – Part 129: Method for determination of density of partially compacted semi-dry fresh concrete*

BS 6068-2.37, *Water quality – Part 2: Physical, chemical and biochemical methods – Section 2.37: Method for the determination of chloride via a silver nitrate titration with chromate indicator (Mohr's method)*

BS 6068-2.42, *Water quality – Part 2: Physical, chemical and biochemical methods – Section 2.42: Determination of sodium and potassium: determination of sodium by atomic absorption spectrometry*

BS 6068-2.43, *Water quality – Part 2: Physical, chemical and biochemical methods – Section 2.43: Determination of sodium and potassium: determination of potassium by atomic absorption spectrometry*

BS 6068-2.44, *Water quality – Part 2: Physical, chemical and biochemical methods – Section 2.44: Determination of sodium and potassium: determination of sodium and potassium by flame emission spectrometry*

BS 7943, *Guide to the interpretation of petrographical examinations for alkali-silica reactivity*

BS 7979, *Specification for limestone fines for use with Portland cement*

BS 8000-2.1, *Workmanship on building sites – Part 2: Code of practice for concrete work – Section 2.1: Mixing and transporting concrete*

BS 8500-1:2015, *Concrete – Complementary British Standard to BS EN 206 – Part 1: Method of specifying and guidance for the specifier*

BS EN 196-1, *Methods of testing cement – Part 1: Determination of strength*

BS EN 196-2, *Methods of testing cement – Part 2: Chemical analysis of cement*

BS EN 197-1:2011, *Cement – Part 1: Composition, specifications and conformity criteria for common cements*

BS EN 206:2013, *Concrete – Specification, performance, production and conformity*

BS EN 450-1:2012, *Fly ash for concrete – Part 1: Definitions, specifications and conformity criteria*

BS EN 480-1, *Admixtures for concrete, mortar and grout – Test methods – Part 1: Reference concrete and reference mortar for testing*

BS EN 480-10, *Admixtures for concrete, mortar and grout – Test methods – Part 10: Determination of water soluble chloride content*

BS EN 480-11, *Admixtures for concrete, mortar and grout – Test methods – Part 11: Determination of air void characteristics in hardened concrete*

BS EN 480-12, *Admixtures for concrete, mortar and grout – Test methods – Part 12: Determination of the alkali content of admixtures*

BS EN 933-11, *Tests for geometrical properties of aggregates – Part 11: Classification test for the constituents of coarse recycled aggregates*

BS EN 934-2, *Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – Definitions, requirements, conformity, marking and labelling*

BS EN 1008, *Mixing water for concrete – Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in concrete industry, as mixing water for concrete*

BS EN 1097-3, *Tests for mechanical and physical properties of aggregates – Part 3: Determination of loose bulk density and voids*

BS EN 1744-1:2009+A1:2012, *Tests for chemical properties of aggregates – Part 1: Chemical analysis*

BS EN 12350-6, *Testing fresh concrete – Part 6: Density*

BS EN 12390-2, *Testing hardened concrete – Part 2: Making and curing specimens for strength testing*

BS EN 12390-3, *Testing hardened concrete – Part 3: Compressive strength of test specimens*

BS EN 12390-7, *Testing hardened concrete – Part 7: Density of hardened concrete*

BS EN 12620, *Aggregates for concrete*

BS EN 12878:2014, *Pigments for the colouring of building materials based on cement and/or lime – Specifications and methods of test*

BS EN 13055-1, *Lightweight aggregates – Part 1: Lightweight aggregates for concrete, mortar and grout*

BS EN 13263-1, *Silica fume for concrete – Part 1: Definitions, requirements and conformity criteria*

BS EN 13286-51, *Unbound and hydraulically bound mixtures – Part 51: Method for the manufacture of test specimens of hydraulically bound mixtures using vibrating hammer compaction*

BS EN 14216, *Cement – Composition, specifications and conformity criteria for very low heat special cements*

BS EN 15167-1, *Ground granulated blastfurnace slag for use in concrete, mortar and grout – Part 1: Definitions, specifications and conformity criteria*

BS EN 45011, *General requirements for bodies operating product certification systems*

BS EN ISO 9001, *Quality management systems – Requirements*

BS EN ISO/IEC 17021, *Conformity assessment – Requirements for bodies providing audit and certification of management systems (ISO/IEC 17021:2011)*

Other publications

[N1] BRITISH CEMENT ASSOCIATION (BCA). *Alkali–silica reaction – Testing protocol for greywacke aggregates – Protocol of the BSI B/517/1/20 ad hoc group on ASR.* BCA: Crowthorne, Berkshire, 1999.

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this part of BS 8500, the terms and definitions given in BS EN 206 and BS 8500-1 and the following apply.

*NOTE The definition of the term "site (construction site)" given in BS EN 206:2013, **3.1.1.16** may be taken to include any land immediately adjacent to the contract specifically used for the purpose of setting up a batching plant.*

3.1.1 cement-bound concrete

concrete suitable for vibrating plate compaction or roller compaction to a target density

NOTE Cement-bound concrete that conforms to this British Standard is concrete comprised of any cements or combination listed in Table 7, which have a maximum size of aggregate of 20 mm or 40 mm, and where the aggregate conforms to the grading shown in Table 8.

3.1.2 certified average alkali content

average of 25 consecutive determinations of alkali content carried out on spot samples and expressed as the sodium oxide equivalent (Na_2O eq.)

3.1.3 declared mean alkali content

alkali content expressed as the sodium oxide equivalent, which is not exceeded without prior notice from the manufacturer

NOTE It is a certified average alkali content plus a margin that reflects the manufacturer's variability of production.

3.1.4 density of fresh concrete

mass of a quantity of compacted fresh concrete divided by its volume, expressed in kilograms per cubic metre (kg/m^3)

NOTE For the method of determining the density of fresh concrete, see BS EN 12350-6. Compaction by the method described in BS EN 12350-6 is not appropriate for semi-dry concretes. The method for determining the density of partially compacted semi-dry concrete is described in BS 1881-129.

3.1.5 general suitability
suitability of each constituent for its use in concrete

NOTE 1 This term is used in BS EN 206.

NOTE 2 Where general suitability is established for a constituent, this does not indicate suitability in every intended use of the concrete and for every concrete composition.

3.1.6 guaranteed alkali limit
alkali limit, expressed as the sodium oxide equivalent (Na_2O eq.), which the constituent material supplier guarantees is not exceeded by any test result on any spot sample

3.1.7 lot
quantity of a material produced under conditions presumed uniform

NOTE After specified tests this quantity, as a whole, is regarded as conforming or not conforming to the specified requirements.

3.1.8 production day

3.1.8.1 production day (for strength testing)
day on which 20 m^3 or more of concrete from a family or a designed or designated concrete outside of a family has been produced or day on which a cumulative 20 m^3 has been produced since the last production day or since commencing production

3.1.8.2 production day (for air content testing)
day on which 50 m^3 or more of concrete with a specified air content has been produced or day on which a cumulative 50 m^3 has been produced since the last production day or since commencing production

3.1.9 production week
period of seven consecutive days comprising at least five production days or the period taken to complete five production days, whichever is longer

3.1.10 time of loading
time of first contact between cement and aggregates or, where the aggregates are surface dry, between cement and added water

3.1.11 product conformity certification
certification, based on product testing and surveillance, and approved by an accredited third-party certification body in accordance with a documented quality system

NOTE 1 Users of this part of BS 8500 are advised to consider the desirability of quality system assessment and registration against BS EN ISO 9001 by an accredited third-party certification body. Many certification bodies have this as a requirement of their product conformity certification. Further information on the provisions for assessment, surveillance and certification of production control can be found in BS EN 206:2013, Annex C.

NOTE 2 Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

NOTE 3 Attention is drawn to the Department for Business, Innovation and Skills policy document, Conformity assessment and accreditation policy *[1].*

3.2 Symbols and abbreviations
For the purposes of this part of BS 8500, the symbols and abbreviations given in BS EN 206 and BS 8500-1 apply.

4 Complementary requirements for constituent materials

4.1 General

Constituent materials that conform to the relevant European Standards cited in BS EN 206 or the relevant British Standards cited in this part of BS 8500 shall be deemed to meet the requirement that they do not contain harmful ingredients in such quantities as might be detrimental to the durability of the concrete or cause corrosion of the reinforcement, provided that the concrete conforms to any specified limits placed on it, e.g. chloride class.

Where types and classes of constituent materials are not detailed in the specification, the producer shall select constituent materials for the specified requirements.

4.2 Cement and combinations

Where cements and combinations have been specified using a broad designation, the producer shall select one of the cements or combinations from Table 1 for the specified designation. Where neither a DC-class nor a specific cement or combination type is specified, the producer shall use one of the cements or combinations from Table 1.

Other cements and combinations, e.g. Portland-composite cements (CEM II-M), composite cements (CEM V), combinations of blended cements with an addition or Portland cement with two or more additions, shall be used only when specified or agreed with the specifier.

4.3 Aggregates

4.3.1 General suitability

General suitability is established for the following:

a) normal-weight and heavyweight aggregates conforming to BS EN 12620 and the requirements specified in **4.3.2**;

b) coarse crushed concrete aggregate (CCA) conforming to BS EN 12620 and the requirements specified in **4.3.2** and **4.3.3**;

NOTE 1 In previous editions of this standard and other guidance documents, CCA was called recycled concrete aggregate (RCA).

c) granulated, including pelletized, blastfurnace slag and air-cooled blastfurnace slag conforming to BS EN 12620 and the requirements specified in **4.3.2** and **4.3.4**;

d) lightweight aggregates conforming to BS EN 13055-1 and the requirements specified in **4.3.2** and **4.3.5**; and

e) reclaimed aggregate conforming to BS EN 206.

*NOTE 2 Suitabililty is not established for coarse recycled aggregate (RA), fine RA or fine CCA. There are some requirements for coarse RA set out in **4.3.6** but these are not sufficient to form an adequate specification.*

NOTE 3 When using the European Standards, the use of normal-weight and heavyweight aggregates should follow the recommendations given in PD 6682-1.

Table 1 **General purpose cements and combinations** (1 of 2)

Type	Notation	Standard	Broad designation	Grouping used in BRE SD1:2005 [2]
Portland cement	CEM I	BS EN 197-1	CEM I	A
Portland silica fume cement [A)]	CEM II/A-D	BS EN 197-1	IIA	A
Portland limestone cement	CEM II/A-L	BS EN 197-1	IIA	B [B)] or C [B)]
	CEM II/A-LL	BS EN 197-1	IIA	B [B)] or C [B)]
Portland slag cements	CEM II/A-S	BS EN 197-1	IIA	A
	CEM II/B-S	BS EN 197-1	IIB-S	A
Portland fly ash cements	CEM II/A-V	BS EN 197-1	IIA	A
	CEM II/B-V	BS EN 197-1	IIB-V	A
	CEM II/B-V+SR [C)]	BS EN 197-1	IIB+SR	D
Blastfurnace cements	CEM III/A	BS EN 197-1	IIIA	A
	CEM III/A+SR [D)]		IIIA+SR	D
	CEM III/B	BS EN 197-1	IIIB	A
	CEM III/B+SR [D)]		IIIB+SR	F
Pozzolanic cement [E)]	CEM IV/B(V)	BS EN 197-1 or BS EN 14216	IVB-V	E
Sulfate-resisting Portland cement	CEM I–SR 0 CEM I-SR 3	BS EN 197-1	CEM I-SR 0 CEM I-SR 3	G
Combinations conforming to Annex A manufactured in the concrete mixer from Portland cement and fly ash, ggbs or limestone fines:				
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of fly ash conforming to BS EN 450-1	CIIA-V	BS 8500-2, Annex A	IIA	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 21% to 35% of combination of fly ash conforming to BS EN 450-1	CIIB-V CIIB-V+SR [C)]	BS 8500-2, Annex A	IIB-V IIB+SR	A D
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36% to 55% of combination of fly ash conforming to BS EN 450-1	CIVB-V	BS 8500-2, Annex A	IVB-V	E
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of ggbs conforming to BS EN 15167-1	CIIA-S	BS 8500-2, Annex A	IIA	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 21% to 35% of combination of ggbs conforming to BS EN 15167-1	CIIB-S	BS 8500-2, Annex A	IIB-S	A
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36% to 65% of combination of ggbs conforming to BS EN 15167-1	CIIIA CIIIA+SR [D)]	BS 8500-2, Annex A	IIIA IIIA+SR	A D
CEM I cement conforming to BS EN 197-1 with a mass fraction of 66% to 80% of combination of ggbs conforming to BS EN 15167-1	CIIIB CIIIB+SR [D)]	BS 8500-2, Annex A	IIIB IIIB+SR	A F

Table 1 **General purpose cements and combinations** (2 of 2)

Type	Notation	Standard	Broad designation	Grouping used in BRE SD1:2005 [2]
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6% to 20% of combination of limestone fines conforming to BS 7979	CIIA-L CIIA-LL	BS 8500-2, Annex A	IIA IIA	B [B)] or C [B)] B[B)] or C [B)]

[A)] When IIA or IIA-D is specified, CEM I and silica fume may be combined in the concrete mixer using the k-value concept; see BS EN 206-1:2013, **5.2.5.2.3**.

[B)] The classification is B if the cement or combination strength is class 42,5 or higher and C if it is class 32,5.

[C)] With a minimum proportion of fly ash of 25%.

[D)] Where the alumina content of the slag exceeds 14%, the tricalcium aluminate content of the Portland cement fraction shall not exceed 10%.

[E)] CEM IV/A cement with siliceous fly ash should be classified as either CEM II/A-V (6%–20% siliceous fly ash) or CEM II/B-V (21%–35% siliceous fly ash).

4.3.2 Requirements for aggregates

Where D_{upper} is specified, the producer shall supply concrete with a D_{max} not greater than D_{upper}.

NOTE 1 Where D_{max} *is specified, either in error or in accordance with previous editions of this standard, then the producer is likely to assume* D_{max} *equals* D_{upper} *and that a* D_{lower} *has not been specified. In practical terms this means that specifying* D_{max} *in accordance with a previous version of this standard is the same as specifying* D_{max} *to this edition of the standard.*

Where D_{lower} is specified, the producer shall supply concrete with a D_{max} not less than D_{lower}.

The aggregate drying shrinkage shall be not more than 0.075% when determined in accordance with BS EN 12620, unless otherwise specified.

The Los Angeles coefficient category, as classified in BS EN 12620, of the combined coarse aggregate, excluding lightweight aggregates, shall be the category specified in the project specification; or where a category has not been specified, it shall meet the requirements for LA_{40}.

NOTE 2 Aggregates having Los Angeles coefficient values above 40 might also perform satisfactorily in normal concrete, but their compressive strength performance and, if the concrete is reinforced, shear strength performance should be established in concrete trials before use.

Where freeze-thaw resisting normal-weight or heavyweight aggregates are specified, the aggregate shall meet the requirements in BS EN 12620 for magnesium sulfate soundness category MS_{25} for use in XF3 exposures and magnesium sulfate soundness category MS_{18} for use in XF4 exposures, except for porous flint aggregates. Porous flint aggregates shall be deemed to be suitable for use if they have been used successfully in concrete that has been exposed to freeze-thaw conditions for at least 10 years.

4.3.3 Coarse crushed concrete aggregate

Coarse crushed concrete aggregates (CCA) shall meet the requirements set out in Table 2. These provisions shall apply to mixtures of crushed concrete and natural coarse aggregates.

NOTE 1 In previous editions of this standard and other guidance documents, CCA was called recycled concrete aggregate (RCA).

Table 2 **Requirements for coarse crushed concrete aggregate**[A)]

Properties	BS EN 12620 size or category	Description of category
Aggregate size	$d \geq 4$, $D \geq 10$[B)]	–
Maximum fines	f_4	≤4% by mass of particles passing the 0.063 mm sieve
Maximum acid-soluble sulphate (SO_3)	$AS_{0,8}$	≤0.08% by mass acid soluble sulfate
Content of: concrete, concrete products, mortar, concrete masonry units	Rc_{90}	≥90% by mass
Content of: concrete, concrete products, mortar, concrete masonry units, unbound aggregate, natural stone, hydraulically bound aggregate	Rcu_{90}	≥90% by mass
Content of: clay masonry units (i.e. bricks and tiles), calcium silicate masonry units, aerated non-floating concrete	Rb_{10-}	≤10% by mass
Content of bituminous materials	Ra_{5-}	≤10% by mass
Content of other materials:	XRg_{1-}	≤1% by mass
Cohesive (i.e. clay and soil)		
Miscellaneous metals, ferrous and non-ferrous		
Non floating wood, plastic and rubber		
Gypsum plaster and glass		
Floating material by volume	FL_{2-}	≤2 cm^3/kg

A) Where the material to be used is obtained by crushing hardened concrete of known composition that has not been in use, e.g. surplus precast units or returned fresh concrete, and not contaminated by storage or processing, the only requirements are for aggregate size, fines content, drying shrinkage and resistance to fragmentation.

B) The designation accepts the presence of some particles which are retained on the upper sieve (oversize) and some which pass the lower sieve (undersize). For single size coarse aggregate with a specified maximum aggregate size of 40 mm, 20 mm, 14 mm and 10 mm the BS EN 12620 aggregate sizes are 20/40, 10/20, 6.3/14 and 4/10 respectively.

When determining that the maximum chloride content of concrete containing CCA, the chloride content of coarse CCA and its variability shall be established and taken into account.

Except where permitted by the footnotes, coarse CCA shall not be used in concrete with a strength class greater than the maximum specified in Table 3 and shall be used only in the exposure classes specified in Table 3.

NOTE 2 The WRAP/EA Quality Protocol – Aggregates from inert waste *[3] sets out criteria for the production and use of aggregates from inert waste for various applications including concrete.*

Table 3 **Limitations on the use of coarse CCA**

Type of aggregate	Limitations on use	
	Maximum strength class[A)]	Exposure class [B)]
CCA	C40/50	X0, XC1, XC2, XC3, XC4, XF1, DC-1

[A)] Material obtained by crushing hardened concrete of known composition that has not been in use and not contaminated during storage and processing may be used in any strength class.

[B)] These aggregates may be used in other exposure classes provided it has been demonstrated that the resulting concrete is suitable for the intended environment, e.g. freeze-thaw resisting, sulfate-resisting.

4.3.4 Blastfurnace slag

Air-cooled blastfurnace slag aggregate shall meet the requirements specified in BS EN 12620 for acid-soluble sulfate category $AS_{1,0}$.

4.3.5 Lightweight aggregates, furnace bottom ash and fly ash

For lightweight aggregates specified in accordance with BS EN 13055-1, the producer shall specify to the aggregate supplier the requirements for lightweight aggregates given in this Clause, together with the following:

a) maximum aggregate size;

b) grading including tolerances; and

c) target loose bulk density.

Lightweight aggregates shall conform to the following requirements:

1) the acid-soluble sulfate content shall meet the requirements specified in BS EN 12620 for acid-soluble sulfate category $AS_{0,8}$; and

2) for furnace bottom ash or clinker, the loss-on-ignition shall be not more than 10% when measured in accordance with BS EN 1744-1.

Where freeze-thaw resisting lightweight aggregates are specified, the producer shall hold data demonstrating that the chosen lightweight aggregates produce concrete with adequate freeze-thaw resistance.

NOTE 1 Freeze-thaw resistance is deemed to be adequate if the aggregates have a successful track record of use for at least 10 years in similar or worse environments with concrete of the quality specified or lower than the quality specified.

Where fine lightweight aggregate is to be used, the method of determination of the water absorption shall be selected by the producer and documented. The producer shall supply details of the test method to the specifier, if requested.

NOTE 2 There is no standard test method; the most appropriate technique depends on the type of lightweight aggregate used. The specifier may require a different method to be used.

NOTE 3 The method given in BS EN 1097-6 is not applicable to aggregates with particle sizes less than 4 mm unless it is possible to surface-dry the aggregates without losing particles.

NOTE 4 Fly ash and furnace bottom ash (FBA) produced from coal-fired power generation are covered by the WRAP/EA Quality Protocol: Pulverised Fuel Ash (PFA) *[4], which describes bound and grout applications in construction and manufacturing.*

4.3.6 Coarse recycled aggregate (RA)

Where coarse RA is specified, its use in concrete shall be assessed on a case-by-case basis taking into account its specific composition. The minimum requirements of coarse RA in accordance with BS EN 12620 shall be as given in Table 4.

When determining the maximum chloride and alkali content of concrete containing RA, the chloride and alkali content of coarse RA and its variability shall be established and taken into account.

NOTE 1 Clean fine CCA is suitable for use in concrete. However, it is known that some concrete elements have been coated with gypsum plaster, and on crushing most of this gypsum plaster finishes in the fine CCA. This gypsum plaster is known to increase the sulfate content, which in turn can increase the risk of delayed ettringite formation (see BRE Information Paper IP11/01 [5]) and there are great difficulties in detecting localized high volumes of sulfate. In addition there is no information on possible stockpile segregation. For these reasons, the use of fine CCA is left to the project specification, which can take account of the particular source of CCA.

NOTE 2 Some fine RA might also be suitable for use in concrete, but because of the wide range of composition and lack of detailed information, generic requirements cannot be given at present. The comment in Note 1 on gypsum in fine CCA also applies to some sources of fine RA.

4.4 Additions

4.4.1 General

General suitability as a Type II addition is established for the following:

a) fly ash conforming to BS EN 450-1;

b) silica fume conforming to BS EN 13263-1;

c) ggbs conforming to BS EN 15167-1; and

d) metakaolin with an appropriate Agrément Certificate. [1)]

General suitability as a Type I addition is established for the following:

1) filler aggregate conforming to BS EN 12620 or BS EN 13055-1; and

2) pigments conforming to BS EN 12878:2014, Category B.

General suitability of limestone fines conforming to BS 7979 is established for use in combinations conforming to Annex A.

NOTE Pigments conforming to BS EN 12878 and containing chloride may be used for unreinforced concrete.

Additions may be used as a constituent of concrete, but to be considered part of the cement or combination content they shall be used in accordance with either **4.4.2**, **4.4.3** or **4.4.4**.

[1)] Available from the British Board of Agrément <http://www.bbacerts.co.uk> [last viewed 20 April 2015].

Table 4 **Requirements for coarse recycled aggregate**

Properties	BS EN 12620 size or category	Description of category
Aggregate size	$d \geq 4$ mm, $D \geq 10$ mm [A)]	–
Maximum fines	f_4	≤4% by mass of particles passing the 0.063 mm sieve
Maximum sulfate	– [B)]	Limit%, by mass
Content of: concrete, concrete products, mortar, concrete masonry units	Rc_{NR}	No requirement
Content of: concrete, concrete products, mortar, concrete masonry units, unbound aggregate, natural stone, hydraulically bound aggregate	Rcu_{NR}	No requirement
Content of: clay masonry units (i.e. bricks and tiles), calcium silicate masonry units, aerated non-floating concrete	Rb_{NR}	No requirement
Content of bituminous materials	Ra_{5-}	≤10% by mass
Content of other materials:	XRg_{1-}	≤1% by mass
Cohesive (i.e. clay and soil)		
Miscellaneous metals, ferrous and non-ferrous		
Non floating wood, plastic and rubber		
Gypsum plaster, and Glass		
Floating material by volume	FL_{2-}	≤2 cm^3/kg

A) The designation accepts the presence of some particles which are retained on the upper sieve (oversize) and some which pass the lower sieve (undersize). For single size coarse aggregate with a specified maximum aggregate size of 40 mm, 20 mm, 14 mm and 10 mm the BS EN 12620 aggregate sizes are 20/40, 10/20, 6.3/14 and 4/10 respectively.

B) The appropriate limit and test method need to be determined on a case-by-case basis.

4.4.2 Equivalent performance of combinations concept (EPCC)

Provided the additions are within the limits established in accordance with Annex A, the following additions shall be taken fully into account in the concrete composition in respect of the cement content and the w/c ratio:

a) Category A or B fly ash conforming to BS EN 450-1;

b) ggbs conforming to BS EN 15167-1; and

c) limestone fines conforming to BS 7979.

*NOTE The conformity procedure for combinations set out in Annex A meets all the requirements of BS EN 206:2013, **5.2.5.4** for the equivalent performance of combinations concept (EPCC).*

4.4.3 Equivalent concrete performance concept (ECPC)

The equivalent concrete performance concept (ECPC) shall not be used unless the producer's proposals for demonstrating equivalence and ensuring conformity have been approved by the specifier. The ECPC shall be in accordance with the principles given in BS EN 206:2013, **5.2.5.3**.

4.4.4 k-value concept

*COMMENTARY ON **4.4.4***

k-value is a prescriptive concept based on the comparison of a reference concrete with a cement "A" against a test concrete in which part of the cement "A" is replaced by an addition as a function of the water/cement ratio and the addition content.

Where the k-value concept is used, it shall be as given in BS EN 206:2013, **5.2.5.2**, where the water/cement ratio calculated as "water/(cement + k × addition)" ratio and the amount of cement calculated as (cement content) + (k × addition content) shall be as specified for the reference concrete.

NOTE This standard does not contain any provisions for the use of the k-value concept with ggbs.

4.5 Admixtures

*COMMENTARY ON **4.5***

There is no requirement to use the concrete producer's constituent materials, other than the admixtures, as any adverse interactions between admixtures are shown by the test in BS EN 480-11 using standard materials.

Where the concrete contains one or more admixtures in addition to an air-entraining agent for freeze-thaw resistance, the air void characteristics of the combination of admixtures shall be tested in accordance with BS EN 480-11 using the admixture supplier's standard materials. The air void spacing factor, measured on specimens of hardened concrete made with reference concrete III in accordance with BS EN 480-1 and an air content within ±1% of the target, shall be not greater than 0.20 mm.

Initial testing shall confirm that the entrained air content is within the permitted tolerance at the limits of the specified consistence class.

*NOTE Initial tests as required by BS EN 206:2013, **5.2.6** for air-entrained concretes containing more than one admixture need only determine the air content to assess the performance of the air void system.*

4.6 Fibres

General suitability for use in concrete conforming to BS EN 206 and this part of BS 8500 is established for:

a) steel fibres conforming to BS EN 14889-1;

b) polymer fibres conforming to BS EN 14889-2; and

c) fibres for concrete conforming to a European Technical Approval.

5 Complementary basic requirements for concrete

5.1 General

If the specification is not understood by the producer or is ambiguous, the ambiguities shall be identified to the specifier and clarification sought.

NOTE The producer may assume that the specification is suitable for the intended use.

Concrete shall conform to **5.2**, **5.3**, **5.4**, **5.5** and **5.6** and the relevant requirements of BS EN 206.

5.2 Resistance to alkali–silica reactions

The risk of damaging alkali–silica reaction shall be minimized in accordance with the requirements set out in Annex B, except:

a) for prescribed concrete; and/or

b) where the specifier has specified provisions for resisting alkali–silica reaction.

*NOTE For the exceptions, the specifier is responsible for ensuring that the concrete is not subject to damaging alkali–silica reaction, but they may, by specification, place this requirement on the producer (see BS 8500-1:2015, **A.8.1**).*

5.3 Chloride content

When determining conformity of chloride content in accordance with BS EN 206:2013, **9.9**, the method for determining the chloride content of constituent materials shall be as specified in Table 5.

Table 5 **Method for determining the chloride content of constituent materials**

Constituent	Method specified in
Cement, fly ash, ggbs, limestone fines, metakaolin	BS EN 196-2
Aggregate excluding CCA and filler aggregate made from fly ash	BS EN 1744-1
Coarse CCA	BS 1881-124
Admixture	BS EN 480-10
Water [A)]	BS EN 196-2 [B)] or BS 6068-2.37 [B)] (ISO 9297)

[A)] Testing is not required if the water is from a potable supply.

[B)] BS EN 1008 cites "the relevant clauses of BS EN 196-21" for the determination of chloride ion content. This standard has been incorporated into BS EN 196-2. The chemical procedure is the same as that given in BS 6068-2.37 and in this case the starting point is a sample of water. When the chloride ion content is outside the recommended range for the test procedure, dilution and factoring is necessary.

5.4 Concrete temperature

When measured in accordance with the procedure specified as follows, the temperature of the fresh concrete at the time of delivery shall not exceed:

a) where specified, the specified value; or

b) 35 °C in all other cases.

The procedure used to measure the temperature of the fresh concrete shall be one of the following.

1) Within 2 min of taking the sample at delivery, insert a type A 100 mm immersion thermometer having a range of -5 °C to +110 °C, graduated in intervals of 1 °C and conforming to BS 1704, in the sample to a depth of not less than 100 mm. When steady conditions have been maintained for 1 min, record the temperature to the nearest 1 °C.

2) Use an alternative form of temperature measurement device with a precision at least that of a thermometer conforming to BS 1704, to record the steady-state temperature to the nearest 1 °C.

5.5 Requirements for hardened lightweight concrete

When determining the conformity of lightweight concrete to the specified density class in accordance with BS EN 206, the density determination of hardened lightweight concrete shall be in accordance with BS EN 12390-7 and for the oven-dry condition.

When determining the conformity of lightweight concrete to the target density in accordance with BS EN 206, the density determination of hardened lightweight concrete shall be in accordance with BS EN 12390-7 and for either:

a) the oven-dry condition; or

b) the condition specified.

5.6 Quantity of concrete

The unit of measurement shall be the cubic metre (m^3) of fresh, fully compacted concrete. Where the volume of concrete is required to be determined, the volume of a given batch shall be calculated from the total mass of the batch in kilograms (kg) divided by the density of fresh concrete, determined in accordance with BS EN 12350-6 for concrete of normal consistence and BS 1881-129 for semi-dry concrete.

The total mass of the batch shall be either:

a) the sum of the masses of all materials used including water; or

b) determined from the gross and tare weights of the vehicle carrying the concrete on a weigh-bridge.

6 Designated concrete

6.1 General

Where designated concrete is specified, the producer shall have product conformity certification and control conforming to **6.2** and shall use the constituent materials specified in **6.3** to make concrete conforming to **6.4** and to the appropriate options given in the specification.

6.2 Product conformity certification and control

The producer shall have product conformity certification with the following minimum requirements:

a) approval of a concrete producer's quality management system to BS EN ISO 9001;

b) product testing by or calibrated against a laboratory accredited for the tests undertaken;

c) surveillance that includes checking the validity of the producer's declarations of conformity, by a certification body accredited to BS EN ISO/IEC 17021 and BS EN 45011 by UKAS or an equivalent accreditation body. A UKAS equivalent accreditation body is recognized by UKAS through the European cooperation for Accreditation (EA) for the relevant areas of product conformity certification.

NOTE 1 These requirements for product conformity certification are essential for the production of designated concretes to ensure the highest probability that the designated performance is achieved.

Conformity control of designated concretes shall be in accordance with the conformity control requirements for designed concretes specified in BS EN 206:2013, Clause **8**.

NOTE 2 Provisions for assessment, surveillance and certification of production control by an accredited body are as given in BS EN 206:2013, Annex C.

When requested, the producer shall inform the specifier of the status of the concrete production plant at the time of tender and immediately if any change in status occurs during the period between the time of tender and completion of supply.

*NOTE 3 Producers who do not have product conformity certification in accordance with **6.2** are not permitted to supply designated concrete.*

6.3 Constituent materials

6.3.1 Cements and combinations

The cement or combination shall be selected from those given in Table 6 for the specified designated concretes for general applications and Table 7 for designated cement-bound concretes, except where the specification places additional restrictions or relaxations on the cement or combination types. In this case, the cement or combination shall be selected from the specified range.

Table 6 **Requirements for designated concretes for general applications**

Concrete designation	Min. strength class	Slump class [A]	Max. w/c ratio	Min. cement or combination content (kg/m^3) for max. aggregate size (mm)				Cement and combination types
				≥40	20	14	10	
GEN0	C6/8	S3	—	120	120	120	120	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
GEN1	C8/10	S3	—	180	180	180	180	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
GEN2	C12/15	S3	—	200	200	200	200	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
GEN3	C16/20	S3	—	220	220	220	220	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
RC20/25	C20/25	S3	0.70	240	240	260	280	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
RC25/30	C25/30	S3	0.65	240	260	280	300	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V [B]
RC28/35	C28/35	S3	0.60	260	280	300	320	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V [B]
RC30/37	C30/37	S3	0.55	280	300	320	340	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V [B]
RC32/40	C32/40	S3	0.55	280	300	320	340	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V [B]
RC35/45	C35/45	S3	0.50	300	320	340	360	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V [B]
RC40/50	C40/50	S3	0.45	320	340	360	360	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V [B]
RC40/50XF	C40/50	S3	0.45 [C]	320	340	360	360	CEM I, IIA, IIB-S, IIB-V, IIIA [D]
PAV1	C28/35 [E]	S2	0.55 [C]	280	300	320	340	CEM I, IIA, IIB-S, IIB-V, IIIA [D]
PAV2	C32/40 [E]	S3	0.45 [C]	320	340	360	380	CEM I, IIA, IIB-S, IIB-V, IIIA [D]
FND2	C25/30	S3	0.55	300	320	340	360	IIB-V+SR, IIIA+SR, IIIB+SR, IVB-V
			0.50	320	340	360	380	CEM I, CEM I-SR 0, CEM-SR 3, II-S, II-V, IIIA, IIIB
			0.45	340	360	380	380	IIA-L or LL class 42,5
			0.40	360	380	380	380	IIA-L or LL class 32,5
FND2Z	C25/30	S3	0.55	300	320	340	360	All in Table 1
FND3	C25/30	S3	0.50	320	340	360	380	IIIB+SR
			0.45	340	360	380	380	IVB-V
			0.40	360	380	380	380	IIB-V+SR, IIIA+SR, CEM I-SR 0, CEM I-SR 3
FND3Z	C25/30	S3	0.50	320	340	360	380	All in Table 1
FND4	C25/30	S3	0.45	340	360	380	380	IIIB+SR
			0.40	360	380	380	380	IVB-V
			0.35	380	380	380	380	IIB-V+SR, IIIA+SR, CEM I-SR 0, CEM I-SR 3
FND4Z	C25/30	S3	0.45	340	360	380	380	All in Table 1
FND4M	C25/30	S3	0.45	340	360	380	380	IIIB+SR

[A] Except where a different consistence class has been specified. In this case, the concrete conforms to the specified consistence class or target value.

[B] Only if specifically permitted under BS 8500-1:2015, **4.2.3**a).

[C] See **6.3.2** for requirements for aggregates.

[D] With a maximum proportion of ggbs 55% unless a higher proportion is specifically permitted under BS 8500-1:2015, **4.2.3**a).

[E] The concrete contains an air-entraining admixture to give minimum air content by volume at delivery of 4.0%, 4.5%, 5.5% or 6.5% with aggregate of 40 mm, 20 mm, 14 mm and 10 mm aggregate size respectively at delivery.

Table 7 **Requirements for designated cement-bound concretes**

Concrete designation	Min. strength class [A]	Min. cement or combination content [B] for D_{max} of 20 mm or 40 mm,%	Cement and combination type
CB6/8	C6/8	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB8/10	C8/10	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB12/15	C12/15	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB16/20	C16/20	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB20/25	C20/25	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB25/30	C25/30	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB28/35 [C]	C28/35	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB30/37 [C]	C30/37	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB32/40 [C]	C32/40	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB35/45 [C]	C35/45	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V
CB40/50 [C]	C40/50	3	CEM I, IIA, IIB-S, IIB-V, IIIA, IVB-V

[A] The characteristic compressive strength at 28 days of cylinders or cubes made in accordance with BS EN 13286-51 and tested in accordance with BS EN 12390-3.
[B] Aggregate grading for cement bound concrete as given in Table 8.
[C] The requirements for aggregate grading in Table 8 may be relaxed to account for the extra cement content required to achieve the required strength class.

6.3.2 Aggregates

Aggregates shall be normal-weight and shall conform to **4.3** and to any specified requirements for special properties. For designated concretes RC40/50XF, PAV1 and PAV2, the aggregates shall be freeze-thaw resisting as specified in **4.3** for XF4 exposures. The aggregate grading for the aggregate in cement bound concrete CB shall be in accordance with Table 8.

NOTE 1 Where the aggregates are required by the specifier to have special properties in addition to those given in this Clause, these requirements are included in the specification.

Table 8 **Range of aggregate grading for cement-bound concrete**

Sieve size mm	Percentage by mass passing nominal maximum size [A] 40 mm	20 mm
63	98 to 100	–
40	90 to 99	100
20	50 to 90	90 to 99
4	20 to 60	30 to 55
0.5	8 to 30	10 to 35
0.125	0 to 8B)	0 to 8B)

[A] Aggregate may be all-in or a combined grading where the aggregate is made up of single sizes.
[B] 0 to 10 for crushed rock fines.

Where coarse CCA or RA is to be used:

a) it shall conform to **4.3**;

b) in designated concretes RC20/25 to RC40/50, its proportion shall be not more than a mass fraction of 20% of coarse aggregate, except where the specification permits higher proportions to be used; and

c) where RA is used, the issues identified in BS 8500-1:2015, **A.7.10** shall be addressed, documented and approved by the certification body.

NOTE 2 Coarse CCA or coarse RA may comprise any mass fraction of the coarse aggregate in designated concretes GEN0 to GEN3.

CCA or RA shall not be used in any of the FND or PAV designated concretes nor in designated concrete RC40/50XF.

Unless otherwise specified, the maximum aggregate size shall be 20 mm.

6.3.3 Admixtures

Admixtures shall conform to BS EN 934-2.

Calcium chloride or admixtures based on chlorides shall not be used in designated concretes.

Accelerating and retarding admixtures shall be used only where an accelerated or retarded set has been specified.

6.3.4 Other materials

Mixing water shall conform to BS EN 1008.

Where a specified coloured concrete requires a pigment, the pigment shall conform to BS EN 12878. For reinforced concrete, the pigment shall conform to BS EN 12878:2014, Category B.

Where the k-value concept is to be used (see BS EN 206:2013, **5.2.5.2**), the fly ash shall conform to BS EN 450-1:2012, Category A or B.

Fibres shall be used only where specified.

6.4 Concrete requirements

Designated concretes shall conform to the requirements specified in Table 6 and Table 7, and to all the requirements specified in Clause **4**, Clause **5** and BS EN 206:2013, Clause **5** that are applicable to designed concrete.

The cement or combination content of concrete shall not exceed 550 kg/m^3.

The chloride content class shall be:

a) the specified class, where a class has been specified; or

b) where a class has not been specified, Cl 1,0 for the GEN and CB series of designated concretes or Cl 0,40 for other designations for all cements except CEM I+SR0 or SR3, in which case it shall be Cl 0,20.

7 Designed concrete

7.1 General

Where designed concrete is specified, the constituent materials and basic requirements shall be in accordance with Clause **4** and Clause **5** respectively.

Unless specified otherwise, the maximum aggregate size shall be 20 mm and the chloride class shall be Cl 0,40.

When requested, the producer shall provide the items of information selected from the list in BS 8500-1:2015, **5.2**.

Where information on the strength development of concrete has been requested, it shall be provided either:

a) in terms of the cement or combination type and strength class to be used; or

b) by a strength development curve at 20 °C between 2 days and 28 days or more; or

c) by a strength development class (see BS EN 206:2013, **7.2**).

The strength development of concrete or strength development class shall be obtained from test data where:

1) constituent materials are stored at (20 ±5) °C for 2 days prior to their use to make concrete; and

2) after casting, cubes are stored at (20 ±5) °C until stripped and the cubes placed in a temperature-controlled tank in accordance with BS EN 12390-2.

7.2 DC-class designed concrete

Where a DC-class designed concrete is specified, the concrete shall conform to the requirements specified in Table 9.

Table 9 **Limiting values of composition and properties for concrete where a DC-class is specified**

DC-class	Max. w/c ratio	Min. cement or combination content in kg/m³ for max. aggregate sizes (mm) of:				Cement and combination types [A]	Grouping used to BRE SD1:2005 [2]
		≥ 40	20	14	10		
DC-1 [B]	—	—	—	—	—	All in Table 1	A to G
DC-2	0.55	300	320	340	360	IIB-V+SR, IIIA+SR, IIIB+SR, IVB-V	D, E, F
	0.50	320	340	360	380	CEM I, CEM I-SR 0, CEM I-SR 3, IIA-D, IIA-S, IIA-V, IIB-S, IIB-V, IIIA, IIIB	A, G
	0.45	340	360	380	380	IIA-L or LL ≥ class 42,5	B
	0.40	360	380	380	380	IIA-L or LL class 32,5	C
DC-2z	0.55	300	320	340	360	All in Table 1	A to G
DC-3	0.50	320	340	360	380	IIIB+SR	F
	0.45	340	360	380	380	IVB-V	E
	0.40	360	380	380	380	IIB-V+SR, IIIA+SR, CEM I-SR 0, CEM I-SR 3	D, G
DC-3z	0.50	320	340	360	380	All in Table 1	A to G
DC-4	0.45	340	360	380	380	IIIB+SR	F
	0.40	360	380	380	380	IVB-V	E
	0.35	380	380	380	380	IIB-V+SR, IIIA+SR, CEM I-SR 0, CEM I-SR 3	D, G
DC-4z	0.45	340	360	380	380	All in Table 1	A to G
DC-4m	0.45	340	360	380	380	IIIB+SR	F

[A] For the sulfate-resisting characteristics of other cements and combinations, see *BRE Special Digest 1* [2] and IP 17/05 [6].

[B] If the concrete is reinforced or contains embedded metal, the minimum concrete quality for 20 mm maximum aggregate size is C25/30, 0.65, 260 or designated concrete RC25/30.

8 Prescribed concrete

Where prescribed concrete is specified, the constituent materials and basic requirements shall be in accordance with Clause **4** and Clause **5** respectively.

9 Standardized prescribed concrete

9.1 General

Where standardized prescribed concrete is specified, the producer shall use the materials specified in **9.2** to make concrete conforming to **9.3** and to any further restriction given in the specification.

9.2 Constituent materials

The cements, combinations and aggregates for standardized prescribed concrete shall be selected from those listed below, except where they have been further restricted in the specification, in which case the constituent materials shall be selected from the specified restricted range:

a) cement and combination types CEM I, CEM I-SR 0, CEM I-SR 3, IIA-L or LL, IIA-S, IIA-V, IIB-S, IIB-V, IIIA;

b) normal-weight aggregate conforming to **4.3**, including filler aggregate but excluding RA;

c) for ST1, ST2 or ST3 only, all-in aggregate conforming to **4.3**;

d) admixtures conforming to BS EN 934-2, excluding air-entraining admixtures; and

e) mixing water conforming to BS EN 1008.

Where the concrete is ST1 or ST2, the chloride class shall be Cl 1,0. In all other cases, the chloride class shall be Cl 0,40 for all cements and combinations, except CEM I-SR 0 and CEM I-SR 3 in which case it shall be Cl 0,20.

9.3 Concrete requirements

The appropriate concrete proportions for the specified standardized prescribed concrete and the specified slump class shall be selected from Table 10. The risk of damaging alkali–silica reaction shall be minimized by either:

a) conforming to **5.2**; or

b) a low alkali cement (guaranteed alkali limit not more than 0.60%).

The mass of cement or combination given in Table 10 shall be reduced by 10% where cement or a combination of standard strength class 42,5 or higher is used. A 10% reduction shall also be applied to a cement or combination of standard strength class 32,5, with or without an admixture, provided there are test data for the reduced cement/combination content with any admixture dosage used showing that the target mean strength is not less than the assumed characteristic strength in BS 8500-1:2015, Table A.17 plus 12 N/mm^2, i.e. it satisfies the criterion in BS EN 206:2013, **A.5**.

NOTE 1 The mix proportions for standardized prescribed concretes given in Table 10 are based on the use of cements and combinations of standard strength class 32,5 and normally provide concrete having the characteristic strengths given in BS 8500-1:2015, Table A.17.

Table 10 **Mix proportions for standardized prescribed concretes using class 32,5 cements and combinations**

Standardized prescribed concrete	Constituent	Quantity or proportion of constituent					
		Maximum aggregate size 40 mm or 45 mm			Maximum aggregate size 20 mm or 22.4 mm		
		Slump class S1 or S2	Slump class S3	Slump class S4	Slump class S1 or S2	Slump class S3	Slump class S4
ST1 [A)]	Cement or combination	200 kg	220 kg	230 kg	230 kg	255 kg	265 kg
	Total aggregate	1 990 kg	1 930 kg	1 895 kg	1 925 kg	1 860 kg	1 825 kg
ST2 [A)]	Cement or combination	230 kg	255 kg	270 kg	265 kg	285 kg	300 kg
	Total aggregate	1 960 kg	1 905 kg	1 870 kg	1 895 kg	1 840 kg	1 805 kg
ST3 [A)]	Cement or combination	265 kg	285 kg	300 kg	295 kg	330 kg	345 kg
	Total aggregate	1 930 kg	1 875 kg	1 850 kg	1 865 kg	1 800 kg	1 765 kg
ST4	Cement or combination	310 kg	330 kg	340 kg	330 kg	365 kg	380 kg
	Total aggregate	1 900 kg	1 840 kg	1 815 kg	1 835 kg	1 775 kg	1 740 kg
ST5	Cement or combination	350 kg	375 kg	390 kg	375 kg	395 kg	415 kg
	Total aggregate	1 870 kg	1 805 kg	1 780 kg	1 800 kg	1 740 kg	1 705 kg
ST1 ST2 ST3	Fine aggregate [B)] as a mass fraction of total aggregate	30% to 45%	30% to 45%	35% to 50%	35% to 50%	35% to 50%	40% to 55%
ST4 ST5	Fine aggregate[B) C)] as a mass fraction of total aggregate						
	Grading limits 0/4 (CP)	30% to 40%			35% to 45%		
	Grading limits 0/4 (MP) or 0/2 (MP)	25% to 35%			30% to 40%		
	Grading limits 0/2 (FP) or 0/1 (FP)	25% to 30%			25% to 35%		

[A)] The aggregates may be batched by volume (see Table 11).

[B)] Lower proportions are generally applicable to finer gradings, smoother textures or rounded shapes. Higher proportions are generally applicable to coarser gradings, rougher textures or angular shapes. For all grades, small adjustments in the percentages of fine aggregates might be required depending on the properties of the particular aggregates used.

[C)] The overlapping ranges reflect the overlapping grading limits CP, MP and FP in BS EN 12620. The higher proportions are applicable to the coarser end of each grading limit and to concretes of higher consistence. Where the grading of the fine aggregate approaches the coarser end of grading limits CP or the finer end of grading limits FP, the proportion of fine aggregate shall be checked to verify that it produces satisfactory concrete.

Adjustments shall be made to the mass of aggregate selected from Table 10 for the appropriate standardized prescribed concrete, so that the yield is one cubic metre.

NOTE 2 Table 10 is based on typical values of the relative densities of cement and aggregates. The aggregate quantities in Table 10 are based on them being in a saturated surface-dry condition.

Where several sizes of single-sized coarse aggregates are used, they shall be combined in such proportions that the combined grading falls within the limits given in BS EN 12620 for graded coarse aggregate of the appropriate nominal size, with a tolerance of not more than ±5%. This tolerance shall be divided between the sieves within the total of 5%. The percentage of fine aggregates in the mix shall be adjusted according to the characteristics of the particular aggregates used.

The actual batch quantities shall be calculated from the values given in Table 10 to suit the size of the batch required. Allowance shall be made for a moisture content typical of the aggregates being used.

Where standardized prescribed concretes ST1, ST2 or ST3 are batched by volume, the volumes of constituent materials shall be in accordance with Table 11.

Table 11 **Mix proportions for volume batching of ST1, ST2 and ST3**

Standard strength class of cement	Standardized prescribed concrete	Slump class	Number of (25 kg) bags of cement	Fine aggregate litres	Coarse aggregate litres
	ST1	S1, S2	1	60	90
	ST2	S1, S2	1	50	75
	ST2	S3	1	50	65 [A)]
42,5 or higher	ST2	S4	1	45	60 [A)]
	ST3	S1, S2	1	45	65
	ST3	S3	1	40	55 [A)]
	ST3	S4	1	40	50 [A)]
	ST1	S1, S2	1	50	80
	ST2	S1, S2	1	45	65
	ST2	S3	1	45	55 [A)]
32,5	ST2	S4	1	45	50 [A)]
	ST3	S1, S2	1	40	55
	ST3	S3	1	35	50 [A)]
	ST3	S4	1	35	45 [A)]

[A)] Fine aggregates MP and CP only.

9.4 Production control

Production control shall be carried out in accordance with BS EN 206 and Clause **13** of this British Standard as appropriate, except for the case of small quantities of volume-batched production using bagged cements where it shall be carried out in accordance with either BS EN 206 and Clause **13** or BS 8000-2.1.

10 Proprietary concrete

Where proprietary concrete is specified, the constituent materials and basic requirements shall be in accordance with Clause **4** and Clause **5** respectively. The producer shall provide on request information selected by the specifier from the lists in BS 8500-1:2015, **4.6.3** and **5.2**.

11 Delivery of fresh concrete

In addition to the requirements specified in BS EN 206:2013, **7.3**, the delivery ticket for each load of concrete shall contain a declaration of conformity to BS 8500-2:2015. [2)]

*NOTE 1 As Clause **12** requires conformity to and compliance with the relevant clauses of BS EN 206, a declaration of conformity to BS 8500-2 is sufficient.*

In addition to the requirements specified in BS EN 206:2013, **7.3**, the delivery ticket for each load of designated concrete and standardized prescribed concrete shall contain:

a) the designation of the specified designated concrete or standardized prescribed concrete;

b) the consistence class or, where specified, target consistence;

c) the chloride class, if specified;

d) the maximum aggregate size; and

e) any additional specified requirements.

NOTE 2 Space should be provided for any additional items.

In the case of proprietary concrete, the delivery ticket shall contain the name of the proprietary concrete and any other specified requirements.

Additional information required by BS EN 206:2013, **7.3**a) and **7.3**b) for designed and prescribed concrete shall be given on each delivery ticket or on a product data sheet. Where it is given on a product data sheet, the delivery ticket shall clearly identify the concrete reference code used on the product data sheet.

NOTE 3 BS 8500-1 requires designed concrete specifications to contain the limiting values or DC-class and not the exposure class. Consequently, the delivery ticket for designed concrete need not contain the exposure class.

NOTE 4 Concrete conforming to BS EN 206 and BS 8500-2 is not covered by a harmonized European Standard or a European Technical Approval Assessment under the Construction Products Regulation [7]. Therefore, Declarations of Conformity, Declarations of Performance and CE Marking as required by the CPR are not applicable to concrete and this information is not referenced from or included on the delivery ticket.

NOTE 5 If admixtures, pigments, fibres or water are added to the concrete in a truck mixer on site without approval/supervision of the producer's quality management personnel or are more than is permitted by the specification of concrete, the concrete batch or load is deemed to be "non-conforming" and the customer is responsible for the consequences.

[2)] Marking BS 8500-2:2015 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity, which might also be desirable.

12 Conformity testing and conformity criteria

12.1 General

Conformity testing and conformity criteria shall be in accordance with **12.2** and **12.3** and the relevant requirements of BS EN 206.

Where the producer has failed to comply with any requirement for production process and production control, the producer shall investigate the consequences of the non-compliance and, when this results in a non-conformity with respect to this Clause, BS EN 206:2013, Clause **8** or the requirements placed on the concrete, the producer shall declare the concrete as non-conforming. In all cases the cause of the non-conformity with the requirements on the production process and production control shall be investigated and corrected without delay.

Where the concrete is not under third-party product certification, the producer shall confirm whether the concrete was in conformity for the period of supply and, on request, supply the test data on which this confirmation was based.

12.2 Conformity control for compressive strength

Conformity testing of ready-mixed concrete shall be based on samples taken at or before delivery (see BS EN 206:2013, **8.1** and **8.2.1.2**). If conformity to the specified compressive strength class is determined using 100 mm cubes, the minimum characteristic 100 mm cube strength shall be that specified for 150 mm cubes in BS EN 206:2013, Table 12 and Table 13.

NOTE 1 The minimum characteristic strength for the additional compressive strength classes used in BS 8500 is given in Table 12.

Where BS EN 206:2013, **8.2.1.3.2**, Method C is used to assess conformity of compressive strength, there shall be no requirements in addition to BS EN 206:2013, **8.2.1.3.2** (10).

*NOTE 2 It should be recognized that even for well-controlled concrete in continuous production with normal or enhanced design margins, statistical analysis of strength data gives a small probability of non-conformity with the mean strength criteria in BS EN 206:2013. Actions to be taken in the case of non-conformity are specified in BS EN 206:2013, **8.4**.*

Table 12 **Additional compressive strength classes to those given in BS EN 206**

Compressive strength class	Minimum characteristic cylinder strength	Minimum characteristic 100 mm or 150 mm cube strength
	$f_{ck,\,cyl}$ N/mm^2	$f_{ck,\,cube}$ N/mm^2
C6/8	6	8
C28/35	28	35
C32/40	32	40
LC28/31	28	31 [A)]
LC32/35	32	35 [A)]

[A)] Other values may be used if the relationship between these and the reference cylinder strength is established with sufficient accuracy and is documented.

12.3 Conformity criteria for properties other than strength

12.3.1 Fresh concrete temperature

The temperature of the fresh concrete, when measured in accordance with **5.4**, shall not exceed any specified maximum value or fall below any specified minimum value at the point of delivery.

12.3.2 Minimizing the risk of damaging alkali-silica reaction

The risk of damaging alkali–silica reaction shall be deemed to be minimized if the concrete conforms to **5.2**.

12.3.3 Fibre content

Where fibres are added at the concrete batching plant, the fibre content of the fresh concrete shall be determined in accordance with BS EN 206:2013, **5.4.4**.

NOTE The UK does not have a standard test method to measure the content of class 1a and class 1b polymer fibres in samples of fresh concrete.

Where fibres are added on site under the supervision of the producer then the producer shall maintain records to confirm that the quantity added is as specified within the tolerance as specified in BS EN 206:2013, **9.7**.

Where fibres are added on site under the supervision of the customer then the customer shall be responsible for any records to confirm that the quantity added is as specified and within the tolerance as specified in BS EN 206:2013, **9.7**.

12.3.4 Target values of flow diameter

The tolerance on the flow diameter test in accordance with BS EN 12350-5 shall be ±50 mm.

NOTE The tolerance given in BS EN 206:2013, Table 23 is not compatible with the precision of the test.

12.4 Action in the event of non-conformity

Where there is a specified requirement for certification, the producer shall make available at the next routine inspection records of any non-conformity and the actions taken.

*NOTE 1 Extraordinary inspections (see BS EN 206:2013, **C.3.2**) are applicable only where the producer has failed to detect non-conformity or to take appropriate action.*

*NOTE 2 The certification body is expected to audit that the actions taken by the producer were appropriate (see BS EN 206:2013, **C.3.2**).*

13 Production control

13.1 General

Where production control procedures differ from those specified in BS EN 206:2013, Clause **9**, the procedures shall be documented.

*NOTE 1 BS EN 206:2013, **9.1** states that production control comprises all measures necessary to maintain the properties of concrete in conformity to specified requirements. It then sets out a non-exhaustive list of general requirements for the production control. BS EN 206:2013, **9.2** to **9.9** give procedures that amplify some aspects of the general requirements. BS EN 206:2013, **9.1** allows for any of these procedures to be varied to take account of:*

a) the kind and size of the production;

b) the works;

c) the particular equipment being used;

d) procedures and rules in use at the place of production; and

e) the use of the concrete.

In summary:

1) the producer is required to have a documented production control system;

2) there is flexibility in the procedures that can be used, provided they achieve effective control of each aspect of production and the procedure is documented; and

3) the producer is required to follow this production control system.

*NOTE 2 The term "batching equipment" used in BS EN 206:2013, **9.6.2.2** is deemed to include volumetric measuring equipment.*

13.2 Storage of materials

Silos shall be constructed from such materials and in such a manner as are known to produce a weatherproof container, and shall permit free flow and efficient discharge of their contents. Each silo shall be fitted with an independent filter, cleaned at regular intervals as defined in the producer's production control manual, or other method of dust control sufficient to allow the delivery to be maintained at the correct pressure.

NOTE It is important to ensure that the silo remains weatherproof throughout its working life.

The producer shall take precautions to ensure that bagged cement does not become damp either from the weather or from the ground. The store shall be managed so that the cement is used in the same order as it is delivered.

Where cement has been treated to limit the water-soluble chromium VI content, it shall be used within the period of validity of the treatment.

Cement that has been adversely affected by damp or other causes shall not be used.

13.3 Production control procedures

Production control procedures shall be carried out to ensure that CCA and RA continues to conform to the requirements specified in **4.3**. The procedures for CCA shall include the tests specified in Table 13.

The mix design and production procedures shall take account of the variability of CCA and RA in such a way as to ensure conformity to limits placed on the concrete.

Table 13 **Materials control for CCA**[A)]

Property	Test method	Requirement specified in
Loose bulk density [B)]	BS EN 1097-3	Production control manual
Composition	BS EN 933-11	Table 2
Acid-soluble sulfate content	BS EN 1744-1	Table 2
Acid-soluble chloride content	BS 1881-124	**4.3** [C)]

[A)] CCA shall be sampled and tested at a frequency sufficient to give enough data to demonstrate a conforming product. The testing rates shall be varied to ensure a controlled process.

[B)] To assess consistency in terms of yield.

[C)] There is no specific requirement for chloride content in **4.3**, but a method is specified for determining the chloride content to be used in the calculations for verifying conformity of concrete to the specified chloride class.

14 Transport of concrete

14.1 Transport to the point of delivery

Concrete shall be transported in:

a) a truck mixer or agitator; or

b) a non-agitating vehicle where permitted by the specifier.

Where non-agitating vehicles are used, procedures shall be followed that have been proven to minimize:

- segregation;
- any change in entrained air content, except for the case where the loss of air has been taken into account (see BS 8500-1:2015, **B.1**);
- loss of any constituent; and
- ingress of foreign matter or water.

14.2 Time of transport

Concrete shall be delivered within 2 h after the time of loading where transported in truck mixers or agitators or within 1 h after the time of loading where non-agitating equipment is used, unless a shorter time is specified or a longer time permitted by the specifier.

Annex A (normative) Conformity procedure for combinations

COMMENTARY ON Annex A

This Annex sets out a procedure for establishing the suitability of combinations to count fully towards the cement content and w/c ratio in concrete. The procedure is applicable to a specific source of addition combined with a specific source of Portland cement, and determines permitted proportions for the addition relative to the cement.

The specification might place further restrictions on the proportion of fly ash, ggbs or limestone fines, depending on the use of the concrete.

*This Annex meets all the requirements in BS EN 206:2013, **5.2.5.4** for the Equivalent Performance of Combinations Concept.*

A.1 Procedure

NOTE 1 An example of the procedure is given in Annex C.

The procedure shall be used only for combinations of a CEM I cement of standard strength class 42,5 or greater conforming to BS EN 197-1 with one of the following additions:

a) fly ash conforming to BS EN 450-1:2012, Category A or B;

b) ggbs conforming to BS EN 15167-1; or

c) limestone fines conforming to BS 7979.

Each month, samples shall be obtained that are representative of each lot of the addition and each lot of CEM I cement that are to be evaluated for use in combination. Combinations of these addition and cement samples, in appropriate proportions, shall be tested for compressive strength in accordance with the method for testing cement specified in BS EN 196-1, with all references to "cement" therein being construed as referring to "combination".

NOTE 2 Where third-party certification is required, the certification body might require the proportions selected to be justified.

The strength test results shall be evaluated against the requirements for one of the strength classes in Table A.1.

Table A.1 **Requirements for the compressive strength of combinations**

Strength class of combination	Early strength		Standard strength	
	2 day N/mm²	7 day N/mm²	28 day N/mm²	
22,5	—	≥12.0	≥22.5	≤42.5
32,5L	—	≥12.0		
32,5N	—	≥16.0	≥32.5	≤52.5
32,5R	≥10.0	—		
42,5L	—	≥20.0		
42,5N	≥10.0	—	≥42.5	≤62.5
42,5R	≥20.0	—		
52,5L	≥10.0	—	≥52.5	—
52,5N	≥20.0	—		

The running means of the early and standard strengths shall be calculated as the averages of the most recent test results, taken over a period of not less than 6 months and not more than 12 months, except in the case of a new combination. In this case, the running means shall be based on all the available data.

NOTE 3 Where the relationship between compressive strength and combination proportions is re-established at least once every 2 years it may be used to extrapolate the running means of strength for proportions other than that tested.

The only proportions of the combination which shall be deemed to conform to this Annex ("permitted proportions") are those proportions for which the measured or extrapolated running means of the early and standard strengths:

1) exceed the relevant lower limits in Table A.1 by a statistical margin; and

2) do not exceed the relevant upper limit.

The statistical margin added to the lower limits shall be:

i) +5 N/mm^2 on the lower limits for standard strength and +3 N/mm^2 on early strength limits; or

ii) calculated statistically from the testing of spot samples, such that an estimate of the overall percentage of results that are less than the required lower limit does not exceed 5% for the lot from which the samples are taken.

NOTE 4 The statistical margin allows for variability in the cement and addition. No statistical margin is required on the upper limit because the possibility of a combination occasionally exceeding an upper limit is unlikely to substantially reduce the suitability of the combination for its intended use.

Irrespective of the results obtained by testing, no proportion shall exceed 85% of the combination for ggbs, 20% of the combination for limestone fines and 55% of the combination for fly ash unless higher proportions have been specified.

NOTE 5 It is permissible to specify higher proportions (see BS 8500-1:2015, Table A.6, footnote A), but BS 8500-1 contains no recommendations on how such high proportions should count towards the minimum cement or combination content and w/c ratio in concrete.

A.2 Issue of certificates

Where a certificate of conformity to this Annex is issued, [3)] it shall relate to fly ash, ggbs or limestone fines from a specific source combined with CEM I cement from a specific source. It shall contain:

a) identification of the source of the addition and of the CEM I cement;

b) the means by which composite samples of the addition and CEM I cement were obtained;

c) the month represented by the latest composite samples;

d) the period used for evaluating conformity where this is less than 6 months;

e) the strength test results for the latest combination of composite samples, stating the proportions tested;

f) details of the permitted proportions which conform to the requirements of this Annex, stating the combination strength class or classes which apply; and

g) the signature of the person responsible for the testing.

[3)] Marking BS 8500-2:2015, Annex A on or in relation to a product represents a declaration of conformity, i.e. a claim that the product meets the requirements of the annex. The accuracy of the claim is solely the responsibility of issuer of the certificate. Such a declaration is not to be confused with third-party certification of conformity, which might also be desirable.

Annex B (normative) Minimizing the risk of damaging alkali-silica reaction in concrete

COMMENTARY ON Annex B

*Where the alkali content of concrete is determined in accordance with **B.2** and the aggregate combination is classified in accordance with **B.4**, conformity to one of **B.5** to **B.12** of this Annex satisfies the requirement in **5.2** to minimize the risk of damaging alkali-silica reaction.*

The requirements of this Annex are intentionally conservative. There is no evidence in the UK of damaging alkali-silica reaction in concrete made with normal reactivity aggregates at alkali contents below 4.8 kg Na_2O equivalent/m^3 (see Livesey, 2009 [8]). The requirements given are equally applicable to sand cement grouts with no coarse aggregate.

B.1 General

The relevant declared mean alkali content shall be obtained from the manufacturer/producer of the cement and any addition used. This shall be based on the certified average alkali content, calculated as the average of the manufacturer's latest 25 consecutive determinations of the sodium oxide equivalent on spot samples, taken in accordance with a statistically based sampling plan, e.g. auto control. It shall include a margin that takes into account the manufacturer's variability of production, such that the certified average alkali content plus the margin shall not exceed the declared mean alkali content, without prior notice. The alkali content of the cement or addition shall be measured as the "sodium oxide equivalent" in percent, determined as: $\%Na_2O$ eq $= \%Na_2O + 0.658\%K_2O$.

NOTE The guaranteed alkali limit may be used in place of the declared mean alkali content.

B.2 Determination of the alkali content

B.2.1 Cement

The alkali content of cement shall be determined as the declared mean in accordance with BS EN 197-1:2011, Annex NA.

NOTE The provisions in BS EN 197-1:2011, Annex NA also apply to cements conforming to BS EN 14216.

B.2.2 Additions

Where limestone fines are used as a filler aggregate and the determined alkali content is less than or equal to 0.1% Na_2O equivalent, no account shall be taken of the additions contribution to the alkali content of the concrete.

The alkali contents of ggbs, fly ash, silica fume limestone fines and metakaolin shall be determined in accordance with BS EN 196-2 or by a secondary X-ray fluorescence method calibrated against that method, and shall be expressed as the declared mean or the guaranteed alkali limit.

B.2.3 Other constituents

The alkali content of siliceous fly ash used as a filler aggregate shall be determined by the appropriate method given in BS EN 196-2 or by a secondary X-ray fluorescence method calibrated against that method.

The proportion of the alkali content of siliceous fly ash, where used as a filler aggregate, to be taken into account in the calculation of the alkali content of the concrete shall be determined in the same way as for fly ash used in cement or a combination.

NOTE 1 Example calculations are given in UKQAA Technical Datasheet 1.7 [9].

The alkali content of aggregates other than fly ash, CCA or RA shall be determined from the chloride ion content, where the chloride content of the aggregates measured by the method given in BS EN 1744-1:2009+A1:2012, Clause **7** or Clause **9** shall be converted to a sodium oxide equivalent by multiplying the mass fraction (%) of chloride ions by 0.76.

NOTE 2 Natural aggregates extracted from the UK may be assumed to contribute no alkalis except from those associated with their chloride content.

NOTE 3 Sintered fly ash or expanded clay lightweight aggregates may be assumed to contribute no alkalis except from those associated with their chloride content.

The chloride content of aggregates containing a mass fraction of not less than 0.01% chloride ions shall be determined at least once per production week by the method given in BS EN 1744-1:2009+A1:2012, Clause **7** or Clause **9**.

The alkali content of CCA shall be 0.2 kg Na_2O equivalent per 100 kg of CCA; or, where the composition of CCA that has not been previously used in construction is known, the alkali content may be determined as that of the original concrete.

The alkali content of other constituents, e.g. admixtures, shall be determined by the method given in BS EN 480-12 or be declared as the specified maximum value given in the constituent material standard or the manufacturer's declared value.

The alkali content of non-potable water shall be determined by the methods given in BS 6068-2.42 for sodium and BS 6068-2.43 for potassium or by the method given in BS 6068-2.44 for both sodium and potassium.

Where limestone fines are used as a filler aggregate and the determined alkali content is less than or equal to 0.1% Na_2O equivalent, no account shall be taken of its contribution to the alkali content of the concrete

B.3 Calculation of the alkali content of concrete

The alkali content of concrete shall be calculated from the mix proportions and the determined alkali contents of each of the constituents, except in the case of ggbs and fly ash constituents (see **B.2.3** for cases where siliceous fly ash is used as a filler aggregate), where Table B.1 shall apply.

Table B.1 **Proportion of declared mean alkali content of ggbs or fly ash to be taken into account in the calculation of alkali content of concrete**

Proportion of addition in a combination	Percentage of the declared mean alkali content of addition to be taken into account when calculating the alkali content of concrete
not less than 40% ggbs	0%
25% to 39% ggbs	50%
<25% ggbs	100%
not less than 25% fly ash	0%
20% to 25% fly ash	20%
<20% fly ash	100%

NOTE 1 Where high reactivity aggregate is used and the cement or combination contains either ggbs or fly ash then proportions less than 50% by mass for ggbs and 40% by mass for fly ash are not recommended.

*NOTE 2 Where siliceous fly ash is used as a filler aggregate see **B.2.3**.*

B.4 Aggregate reactivity

The reactivity of the aggregate combination shall only be taken as being low reactivity where low reactivity is proven for both the coarse and fine fractions by:

a) the classification of the aggregate when assessed using BS 812-104 and BS 7943 comprising mineral constituents listed in Table B.2 as low reactivity. For aggregate reactivity classification purposes, a single examination is adequate, i.e. the duplicate examinations required by BS 812-104 are not necessary for this purpose;

b) the service life record, as described in **B.10**; or

c) testing in accordance with BS 812-123.

CCA may be classified as normal reactivity provided it does not contain high or extreme reactivity aggregate. Classification shall be based on the knowledge that the source of CCA was concrete made with low or normal reactivity aggregates. Where such knowledge does not exist, the CCA shall be classified as high reactivity.

NOTE Many common coarse aggregates are classified as low reactivity but when combined with siliceous sand can create the pessimum proportions and expansions that place the aggregate combination in the normal reactivity class. Hence, as a precautionary measure, aggregate combinations in which both aggregate fractions have a high proportion of flint and where the total flint content is greater than 60% by mass are considered to be normally reactive unless other (non-petrographic) evidence indicates that the aggregates are of low reactivity. Recycled aggregates are classified as high reactivity unless it is made from CCA which only contains normal or low reactivity aggregate.

Table B.2 **Reactivity of constituents of aggregates used in concrete in the UK**

Low reactivity [A]		**Normal reactivity**	**High reactivity**	**Extreme reactivity**
Andesite	Limestone [B]	Constituents not listed in the other columns	Crushed greywacke [C]	Borosilicate glass
Basalt	Marble			
Diorite	Microgranite		Crushed greywacke-type sandstones, siltstones or mudstones [C]	Opal [D]
Dolerite	Schist			Opaline silica [D]
Dolomite	Slate			Calcined flint
Gabbro	Syenite		CCA containing any of the constituents listed in **B.4**	
Gneiss	Trachyte			
Granite [A]	Tuff		Bottle and plate glass	
Air cooled blastfurnace slag			RA [E]	
Expanded clay/shale/slate				
Sintered fly ash				

[A] Excluding constituents with partially altered feldspars, e.g. some granite.

[B] One UK silicified limestone deposit gave abnormal expansion but this is related to its particular and localized geology.

[C] This requirement does not apply to materials of these types that are found in some sand and gravel deposits provided the sand or gravel is not crushed.

[D] Rarely found in UK aggregates but where encountered they are often dispersed within aggregate particles and require a gel-pat test to confirm their presence (see BS 7943).

[E] Excluding RA made from CCA known to contain low or normal reactivity aggregates.

Recovered aggregates shall be classified the same as the original aggregate type or combination.

Aggregates or aggregate combinations containing in total more than 10% by mass crushed greywacke, crushed greywacke-type sandstones, siltstones or mudstones or CCA containing any of these constituents shall be classified as high reactivity.

B.5 Low reactivity aggregate

Where both the coarse and fine fractions of the aggregate are classified in accordance with **B.4** as low reactivity the alkali content of the concrete when determined and calculated in accordance with **B.2** and **B.3** shall not exceed 5.0 kg Na_2O equivalent/m^3.

B.6 Normal reactivity aggregates

Where the aggregate is classified in accordance with **B.4** as normal reactivity, the alkali content of the concrete when determined and calculated in accordance with **B.2** and **B.3** shall not exceed 3.5 kg Na_2O equivalent/m^3.

B.7 High reactivity aggregates (option 1)

Where the aggregate is classified in accordance with **B.4** as high reactivity, the alkali content of the concrete when determined and calculated in accordance with **B.2** and **B.3** shall not exceed 2.5 kg Na_2O equivalent/m^3.

NOTE Recycled aggregates are classified as high reactivity unless it is made from CCA that only contains normal or low reactivity aggregate.

B.8 High reactivity aggregates (option 2)

Where the aggregate is classified in accordance with **B.4** as high reactivity based on the concrete containing more than 10% by mass of aggregate of crushed greywacke or crushed greywacke type materials and the aggregate comes from a source that has been tested and assessed in accordance with *Alkali-silica reaction – Testing protocol for greywacke aggregates* [N1], and the test data obtained in accordance with this testing protocol give not more than 0.08% expansion at 2 years at either:

- 3.5 kg Na_2O equivalent/m^3 of concrete, the alkali content of the concrete shall not be greater than 2.0 kg;
- 4.0 kg Na_2O equivalent/m^3 of concrete, the alkali content of the concrete shall not be greater than 2.5 kg;
- 4.5 kg Na_2O equivalent/m^3 of concrete, the alkali content of the concrete shall not be greater than 3.0 kg; or
- 5.0 kg Na_2O equivalent/m^3 of concrete, the alkali content of the concrete shall not be greater than 3.5 kg.

B.9 Extreme reactivity aggregates

*COMMENTARY ON **B.9***

The provisions in this Annex do not cover extreme reactivity aggregates such as some types of glass or opal, which can cause damaging ASR expansion when present in only small proportions but these are not common constituents of UK aggregates.

B.10 Service life record

The risk of damaging alkali–silica reaction shall be deemed to be minimal if both of the following conditions are met.

a) The service record of the combination of cement-aggregate does not include any instances of cracking due to alkali–silica reaction.

b) The combination of coarse and fine aggregate has had no cases of cracking due to alkali–silica reaction for at least 10 years in a wet environment and with the selected or a higher cement content with cements of similar or higher alkali levels than the chosen cement.

NOTE The amount of evidence needed to support this rule is agreed between producer and the producer's third-party certification body or, where there is none, the specifier.

B.11 Use of silica fume

Concrete that contains at least 8% of silica fume, conforming to BS EN 13263-1, by mass of cement or combination shall have an alkali content, when determined and calculated in accordance with **B.2** and **B.3**, of less than 4.0 kg Na_2O equivalent/m^3 where the aggregate is classified as normal reactivity.

Where the aggregate combination is classified as high reactivity, the alkali content of the concrete, when determined and calculated in accordance with **B.2** and **B.3**, shall not exceed 3.0 kg Na_2O equivalent/m^3.

B.12 Use of metakaolin

Where the aggregate is classified as normal or high reactivity, the alkali content of the concrete when determined and calculated in accordance with **B.2** and **B.3** shall not exceed 5.0 kg Na_2O equivalent/m^3 in the following cases:

a) in exposure classes XD2, XD3, XS2 or XS3 or in other conditions where there is a significant external source of alkalis, concrete containing at least 15% of metakaolin with at least 45% by mass of SiO_2, conforming to an appropriate Agrément Certificate [4)], by mass of cement or combination;

b) in exposure classes other than described in a), concrete containing at least 10% of metakaolin with at least 45% by mass of SiO_2, conforming to an appropriate Agrément Certificate[4)], by mass of cement or combination.

Annex C (informative) Example of the conformity procedure given in Annex A

C.1 General

As an example, this Annex contains a convenient plan for the declaration of conformity to combination strength class 42,5 N. It is suitable for one source of addition to be used in combination with several sources of CEM I cement. This plan establishes limits on the proportions of addition with each specific CEM I cement source to ensure that the conformity criteria for strength are met. Four stages are involved.

a) The relationships between compressive strength and proportion of addition are established for each CEM I cement (see **C.2**).

[4)] Available from the British Board of Agrément <http://www.bbacerts.co.uk> [last viewed 20 April 2015].

b) The monthly composite samples of the addition and each CEM I cement are tested in combination, and running means of the early and standard strengths are calculated over not less than 6 months and not more than 12 months (see **C.3**).

c) The statistical margins are established (see **C.4**).

d) The relationships, the running means and the statistical margins, together with the requirements for strength class 42,5 N in Table A.1, are then used to determine the permitted proportions (see **C.5**).

C.2 Establishment of the relationship between compressive strength and proportions

A composite sample of the addition is obtained by blending not less than eight spot samples of similar mass obtained at regular intervals over at least one calendar month. A composite sample of each CEM I cement is similarly obtained.

Strength tests are carried out at 2 days and at 28 days, in accordance with BS EN 196-1, on the combinations of the composite samples given in Table C.1.

NOTE This example is for a combination of strength class 42,5 N. With some other strength classes, testing at 7 days is required in place of the 2-day testing.

Table C.1 **Mass fraction of addition[A)] in combinations for strength testing**

ggbs [B)]	**Fly ash** [B)]	**Limestone fines** [B)]
%	%	%
0	0	0
30	20	10
50	35	15
70	60	20
90	—	—

[A)] The remaining percentage comprises CEM I cement.

[B)] Expressed as a percentage of the mass of combination.

C.3 Monthly tests on individual Portland cement with addition

Monthly bulk average samples of the addition and each CEM I cement source are obtained either from the material suppliers or by blending not less than eight spot samples of similar mass, taken regularly throughout the month. These composite samples are combined in the ratios:

a) 50:50 for ggbs to CEM I cement;

b) 15:85 for limestone fines to CEM I cement; or

c) 30:70 for fly ash to CEM I cement.

Tests for strength are carried out in accordance with BS EN 196-1 at 2 days and at 28 days. The mean strength, M, of each combination of addition and a specific CEM I cement is the average of the most recent monthly strength tests taken over a period of not less than 6 months and not more than 12 months.

C.4 Estimation of statistical margin

The statistical margin, m, is either taken as +5 N/mm^2 on the lower limits for standard strength and +3 N/mm^2 on early strength limits (see **A.1**), or calculated by:

$$m = k_A s$$

where k_A is the acceptability constant which depends on the number of samples, n.

Values of k_A corresponding to 5% of results outside of a required value can be found in BS EN 197-1:2011, Table 6, in the 5% P_k column. In determining the statistical margin, *n* is the number of spot sample test results used to calculate the standard deviation.

The standard deviation, *s*, is determined from data based on the anticipated most variable combination of CEM I cement and addition. The choice of the nominated CEM I cement for the most variable combination is reviewed at least every 2 years. The basis of the review is the variability of the monthly tests of the various combinations given in **C.3** or, where no historical data exist for combinations, the variability of the autocontrol data for the various CEM I cements where such information is available.

At least once a week, a spot sample of the addition and a spot sample of the nominated CEM I cement are taken in accordance with BS EN 196-7 and combined in the ratios shown in **C.3**. The combination is tested in accordance with BS EN 196-1 for strength at 2 days and at 28 days. The standard deviation, *s*, is calculated from the results of the tests carried out in the test period corresponding to that used in **C.3**.

C.5 Establishment of limits on proportions

To determine the limits on proportions for the conformity of combinations to strength class 42,5 N, construct a diagram showing the relationship obtained in accordance with **C.2** between 28-day strength and proportions for the addition with a specific CEM I cement (see Figure C.1). On this diagram, mark a lower limit of 42.5 N/mm^2 + *m* corresponding to the lower limiting value from Table A.1 plus the margin. Mark an upper limit of 62.5 N/mm^2 corresponding to the upper limiting value.

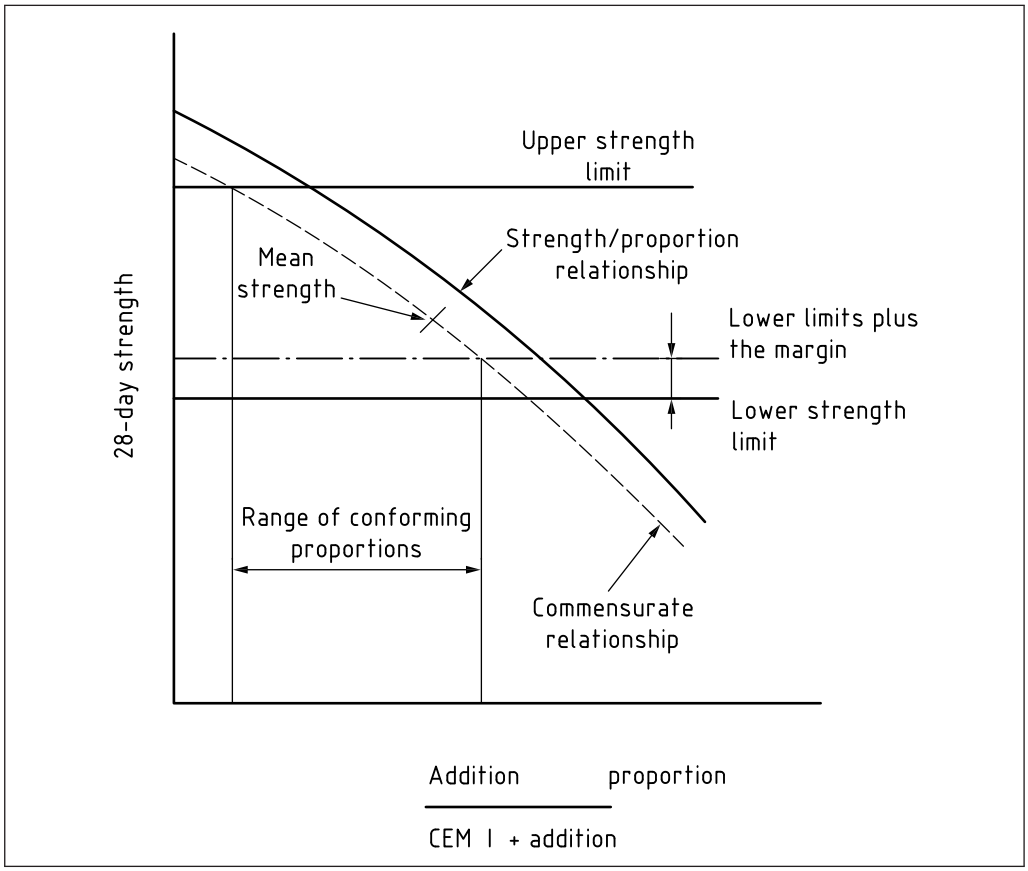
Then mark the point corresponding to the mean strength, *M*, determined in accordance with **C.3**. Draw a line through this point, commensurate with the relationship between 28-day strength and proportion.

Conformity with strength class 42,5 N is achieved for proportions where this line is between the upper and lower limits.

Carry out a similar exercise for the 2-day strength results (in this case no upper limit is applicable).

The proportions that conform to combination strength class 42,5 N are those for which both early and 28-day strength requirements are met, subject also to their not exceeding 85% for ggbs, 20% for limestone fines or 55% for fly ash.

Figure C.1 **Determination of conformity limits for combinations**



Annex D (informative) BS 8500 provisions linked to BS EN 206 requirements

BS EN 206:2013, Annex M (Informative) lists those provisions which may be augmented or replaced by provisions valid in the place of use. Table D.1 shows where the BS 8500 provisions augment those of BS EN 206.

Table D.1 **Guidance on where to find BS 8500 provisions that cover BS EN 206 requirements that defer to provisions in the place of use** (1 of 2)

BS EN 206		BS 8500		Subject
Clause	**Para**	**Part**	**Clause/ Table**	
1	5	–	–	Additional or different requirements in other European Standards
1	6	Part 2	Annex D	Supplementary requirements: Designated concretes, including cement-bound concrete
4.1	1	Part 1, Annex A	A.2.1, Table A.1	Exposure classes. UK Example includes
4.1	2	Part 1, Annex A	A.2.1, Table A.2	Exposure to chemical attack, classification of ground conditions
5.1.1	2	Part 2	4	Constituent materials
5.1.2	2	Part 2	4.2, Table 1	Cements and combinations
5.1.3	1, 2, 3	Part 2	4.3.1–4.3.6	Aggregates, general suitability
				Aggregates, recycled and manufactured
				Aggregates needing additional requirements
5.1.5	2	Part 2	4.5	Admixtures
5.2.1	2, 5	Part 2	5, 9	Basic requirements
				Standardized prescribed concrete
5.2.3.5	1	Part 2	5.2 and Annex B	Minimizing the risk of damaging alkali-silica reactions in concrete
5.2.5.1	2, 4, 5	Part 2	4.4.2–4.4.4	Additions
				k-value concept
				EPCC and ECPC
5.2.5.2.3	4	Part 2	4.4.4	k-value silica fume
5.2.5.2.4	1	Part 2	4.4.4	k-value ggbs
5.2.5.3	3	Part 2	4.4.3	Equivalent Concrete Performance Concept
5.2.8	Table 15	Part 1	A.4.2	Chloride classes
5.3.2	1, 3	Part 1	A.4	Limiting values for concrete composition
				50 year requirements
5.3.3	1	–	–	Performance related methods. No additional provisions.
5.4.2	2	–	–	BS EN 1097-6 Water absorption of fines. No additional provisions.
6.1	2	Part 1	4	Specification of concrete
6.4	2	Part 1	4.5	Standardized Prescribed Concrete
7.2	4	Part 1	5.2	Information from the producer of the concrete to the specifier or user
7.3	3	Part 2	11	Delivery of fresh concrete
8.2.1.2	Table 17	Part 2	3.1.8	Production day
8.2.1.3.2	11	Part 2	12.2	Use of control charts
8.2.3.3	Table 21	Part 2	12.3	Conformity criteria for properties other than strength at the point of delivery
8.2.3.3	Table 23	Part 2	12.3	Conformity criteria for target values of consistence and viscosity
9.4	2	Part 2	9.4, 13	Production control testing at each place of production

Table D.1 **Guidance on where to find BS 8500 provisions that cover BS EN 206 requirements that defer to provisions in the place of use** (2 of 2)

9.7	2	Part 2	13	Tolerance for the batching process of constituents. No additional provisions
9.9	Table 28	Part 2	13.1	Calibration of weigh batch equipment
10.2	1	Part 2	12.1	Assessment, surveillance and certification of production control
A.4	5	Part 2	Table 7	Composition of standardized prescribed concrete
D.2.1	1, 3	Part 2	4.2	Cement and combinations
D.3.3	1	Part 1	A.4	Water/cement ratio requirements
D.3.4	2	Part 1	A.11	Concrete for geotechnical works
Annex F	3	Part 1	A.4	Limiting values for concrete composition
Annex F	Table F.1	Part 1	A.4	Limiting values for concrete composition, sulfate resistance

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 196-7, *Methods of testing cement – Part 7: Methods of taking and preparing samples of cement*

BS EN 196-21, *Methods of testing cement – Part 21: Determination of the chloride, carbon dioxide and alkali content of cement*

BS EN 1097-6, *Tests for mechanical and physical properties of aggregates – Determination of particle density and water absorption*

BS EN 12350-5, *Testing fresh concrete – Part 5: Flow table test*

BS EN 14889-1, *Fibres for concrete – Part 1: Steel fibres – Definitions, specifications and conformity*

BS EN 14889-2, *Fibres for concrete – Part 2: Polymer fibres – Definitions, specifications and conformity*

PD 6682-1, *Aggregates – Part 1: Aggregates for concrete – Guidance on the use of BS EN 12620*

Other publications

[1] DEPARTMENT FOR BUSINESS INNOVATION AND SKILLS. Conformity assessment and accreditation policy in the United Kingdom. April 2012.

[2] BUILDING RESEARCH ESTABLISHMENT. *Concrete in aggressive ground*. Special Digest 1. Third edition. Watford: BRE, 2005.

[3] WASTE RESOURCES ACTION PLAN (WRAP), ENVIRONMENT AGENCY. *Quality Protocol – Aggregates from inert waste.* WRAP, October 2013.

[4] WASTE RESOURCES ACTION PLAN (WRAP), ENVIRONMENT AGENCY. *Quality Protocol – Pulverised Fuel Ash (PFA).* WRAP, October 2010.

[5] QUILLIN, K. *Delayed ettringite formation – In-situ concrete*. Information Paper IP11/01. Watford: Building Research Establishment, 2001. [5)]

[6] QUILLIN, K., NIXON, P.J., MATTHEWS, J.D. and LONGWORTH, T.I. *Concretes with high ggbs contents for use in hard/firm secant piling*. Information paper IP 17/05. Watford: Building Research Establishment, 2005.

[7] EUROPEAN COMMUNITIES. Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC. Luxembourg: Office for Official Publications of the European Communities, 2011.

[8] LIVESEY, P. *BRE Digest 330: Alkali-silica reaction in concrete – the case for revision, published in two parts.* Part 1 is published in CONCRETE Vol.43, No. 6, July 2009 and Part 2 is published in CONCRETE Vol.43, No. 7, August 2009. [6)]

[9] UK QUALITY ASH ASSOCIATION. *UKQAA Technical Datasheet 1.7*. [7)]

---

5) Available from BRE Bookshop, 151 Rosebery Avenue, London EC1R 4QX. Website: <http://www.brebookshop.com> [last viewed 20 April 2015].

6) Available from the MPA Cement website, at: <http://cement.mineralproducts.org/downloads/technical_papers_and_articles.php> [last viewed 20 April 2015].

7) Available from UKQAA website at: <http://www.ukqaa.org.uk> [last viewed 20 April 2015].

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