

Concrete — Complementary British Standard to BS EN 206-1 —

Part 2: Specification for constituent materials and concrete

ICS 91.100.30

Committees responsible for this British Standard

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Association of Lightweight Aggregate Manufacturers
British Cement Association
British Civil Engineering Test Equipment Manufacturers' Association
British Precast Concrete Federation Limited
Cement Admixtures Association
Cementitious Slag Makers Association
Civil Engineering Contractors Association
Construction Confederation
Department of Trade and Industry — Building Research Establishment
Department of Transport, Local Government and the Regions —
Highways Agency
Federation of Piling Specialists
Federation of Resin Formulators and Applicators
Institute of Concrete Technology
Institution of Structural Engineers
National House-Building Council
Quarry Products Association
Society of Chemical Industry
United Kingdom Quality Ash Association
United Kingdom Steel Association
Co-opted members

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Foreword

This part of BS 8500 has been prepared by Subcommittee B/517/1, under the direction of Technical Committee B/517. Together with BS EN 206-1 and BS 8500-1, it supersedes BS 5328 (all parts), which is to be withdrawn on 1 December 2003.

BS 8500 contains additional United Kingdom provisions to be used in conjunction with BS EN 206-1. Together they form a complete package for the specification, production and conformity of fresh concrete. A Published Document containing a combined version of these standards with guidance on their use is under preparation and is intended for publication in 2003.

BS 8500 is published in the following parts:

- BS 8500-1, *Method of specifying and guidance for the specifier*;
- BS 8500-2, *Specification for constituent materials and concrete*.

Further guidance on the application and use of this British Standard and BS EN 206-1 is given in *Specifying concrete to BS EN 206-1/BS 8500* [1].

The terms “fly ash” and “pulverized-fuel ash (pfa)” are generally synonymous. In BS 8500 they are used according to the terminology in the relevant material standard.

BS 5328 placed restrictions on the use of Portland-limestone cement due to the lack of information on performance in certain environments. Since then further data are available. Within the context of the recommendations and requirements given in both parts of BS 8500, the performance of concrete made with Portland-limestone cement types CEM II/A-L or LL and combination types CIIA-L or LL is equivalent to some of the other permitted cement and combination types. Restrictions on the use of cement and combination types IIA-L or LL remain for aggressive chemical environments.

This part of BS 8500 was drafted on the assumption that the execution of its provisions is entrusted to appropriately qualified and competent people.

Amendment No. 1:2003 incorporates:

- changes resulting from a forthcoming amendment to BS EN 206-1¹⁾;
- recommendations in PD 6682-1;
- changes to the requirements for the use of RA;
- provisions to resist damaging alkali-silica reaction with RCA;
- provisions for standardized prescribed concrete with slump class S4;
- a revision and extension of Table 12;
- clarification of requirements;
- changes resulting from new European Standards published since 2002;
- corrections.

Since the publication of BS 8500 in 2002, producers of concrete have indicated that the restrictions on the uses of RA did not make it a viable material to stock. A proposal to extend the uses of RA was made, but concern over the potentially very wide range of composition of RA and the lack of research data resulted in BSI deciding to provide some generic requirements for use, whilst recognizing that project specifications need to include additional requirements specific to the type of RA.

The start and finish of text introduced or altered by Amendment No. 1:2003 is indicated in the text by tags A1 A1. Minor editorial changes are not tagged.

¹⁾ Amendment A1 to EN 206-1:2000 passed its formal vote in September 2003 and is in production at the time of publication of this amendment to BS 8500.

At the CEN TC 104/SC1 meeting held in Prague, June 2003, BSI requested that the term “conformity to EN 206-1” be clarified. The following resolution was agreed:

“Resolution Prague 2003-4

Conformity to EN 206-1 means conformity to the specification of the concrete to be assessed by application of the conformity criteria in Clause 8. It also requires the producer to comply with the requirements for the production process and the production control.

Concerning the requirements on the production process and the production control, EN 206-1 gives sufficient flexibility to be adjusted to the size of production, the works, the particular equipment and procedures.

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 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-compliance with the requirements on the production process and production control shall be investigated and corrected without delay.”

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 may 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.

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 does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and iv, pages 1 to 33 and a back cover.

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Introduction

The requirements in this part of BS 8500 are given for defined materials with an established or accepted adequate performance in United Kingdom conditions. These requirements might not be appropriate for use in exposure conditions outside the United Kingdom, particularly in hot climates. Some European Standards, in particular BS EN 197-1, encompass a wide range of products, including several for which there is no experience of use in the United Kingdom. Until experience is gained, their use should be by agreement between the producer and specifier on a case-by-case basis. Some guidance on the performance of these products can be obtained by relative performance testing, as discussed in Concrete Society publication CS 109 [2].

The package of standards that includes BS 8500 and BS EN 206-1 may be adopted ahead of the European Standard design codes and therefore this package of standards operates in the context of current British Standard design codes. This requires the designer to take account of:

- the different way of expressing strength i.e. by strength class;
- the different ways of expressing workability, e.g. by consistence class;
- the different names for constituent materials;
- the different requirements or classes for constituent materials;
- the different format for specifying concrete;
- the new responsibilities of the concrete producer for conformity.

BS 8500 and BS EN 206-1 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 206-1. It provides United Kingdom national provisions where required or permitted by BS EN 206-1. It also covers materials, methods of testing and procedures that are outside the scope of BS EN 206-1, but within national experience.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of BS 8500. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 146, *Specification for blastfurnace cements with strength properties outside the scope of BS EN 197-1*.

[A] BS 812-104, *Testing aggregates — Part 104: Method for qualitative and quantitative petrographic examination of aggregates*. **[A]**

BS 812-119, *Testing aggregates — Part 119: Method for determination of acid-soluble material in fine aggregate*.

BS 882:1992, *Specification for aggregates from natural sources for concrete*.

BS 1047, *Specification for air-cooled blastfurnace slag aggregate for use in construction*.

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 3797, *Specification for lightweight aggregates for masonry units and structural concrete*.

BS 3892-1, *Pulverized-fuel ash — Part 1: Specification for pulverized-fuel ash for use with Portland cement*.

BS 3892-2, *Pulverized-fuel ash — Part 2: Specification for pulverized-fuel ash to be used as a Type 1 addition*.

BS 4027, *Specification for sulfate-resisting Portland cement*.

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 6610, *Specification for Pozzolanic pulverized-fuel ash cement*.

BS 6699, *Specification for ground granulated blastfurnace slag for use with Portland cement*.

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 8500-1:2002, including Amendment No. 1:2003 ^{A1}, *Concrete — Complementary British Standard to BS EN 206-1 — 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 196-21:1992, *Methods of testing cement — Part 21: Determination of the chloride, carbon dioxide and alkali content of cement.*

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

BS EN 206-1:2000²⁾ ^{A1}, *Concrete — Part 1: Specification, performance, production and conformity.*

BS EN 450, *Fly ash for concrete — Definitions, requirements and quality control.*

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 932-1:1997, *Tests for general properties of aggregates — Part 1: Methods for sampling.*

BS EN 932-5, *Tests for general properties of aggregates — Part 5: Common equipment and calibration.*

BS EN 933-2, *Tests for geometrical properties of aggregates — Part 2: Determination of particle size distribution — Test sieves, nominal size of apertures.*

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.* ^{A1}

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

BS EN 1367-2, *Tests for thermal and weathering properties of aggregates — Part 2: Magnesium sulfate test.*

BS EN 1367-4, *Tests for thermal and weathering properties of aggregates — Part 4: Determination of drying shrinkage.*

BS EN 1744-1:1998, *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.* ^{A1}

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

BS EN 12620, *Aggregates for concrete.* ^{A1}

BS EN 12878, *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.* ^{A1}

BS EN ISO 9001, *Quality management systems — Requirements.*

²⁾ Amendment A1 to EN 206-1:2000 passed its formal vote in September 2003 and is in production at the time of publication of this amendment to BS 8500.

Alkali-silica reaction in concrete. Digest 330. Watford: Building Research Establishment.³⁾

NOTE This publication comprises:

- Part 1: *Background to the guidance notes*, 1999;
- Part 2: *Detailed guidance for new construction*, 1999;
- Part 3: *Worked examples*, 1999;
- Part 4: *Simplified guidance for new construction using aggregates of normal reactivity*, 1999.

Alkali-silica reaction — Minimising the risk of damage to concrete. Technical Report No. 30, 3rd edition. Slough: The Concrete Society, 1999.⁴⁾

Alkali-silica reaction — Testing protocol for greywacke aggregates — Protocol of the BSI B/517/1/20 ad hoc group on ASR. Crowthorne, Berkshire: British Cement Association, 1999.⁴⁾

Concrete in aggressive ground — Part 2: Specifying concrete and additional protective measures. Special Digest 1, Part 2. Watford: Building Research Establishment, Second edition 2003.³⁾

Minimising the risk of alkali-silica reaction — Alternative methods. Information Paper IP1/02. Watford: Building Research Establishment, 2002.³⁾

3 Terms and 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 206-1:2000, 3.1 and BS 8500-1:2002, 3.1 and the following apply.

NOTE The definition of the term “site (construction site)” given in BS EN 206-1:2000, 3.1.35 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

certified average alkali content

average of 25 consecutive determinations of equivalent alkali content carried out on samples, each of which is representative of a day's production

3.1.2

declared mean alkali content

alkali content, expressed as the sodium oxide (Na₂O) equivalent, which is not exceeded without prior notice from the cement or addition manufacturer

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

3.1.3

density of fresh concrete

mass of a quantity of compacted fresh concrete divided by its volume, expressed in kilograms per cubic metre (kg/m³)

NOTE For the method of determining 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.

3.1.4

guaranteed alkali limit

alkali limit, expressed as the sodium oxide (Na₂O) equivalent, which the constituent material supplier guarantees will not be exceeded by any test result on any spot sample

3.1.5

production day

A) for strength testing: day on which 20 m³ or more of concrete from a family or a designed or designated concrete outside of a family has been produced

NOTE 1 The day on which a cumulative 20 m³ has been produced since the last production day or since commencing production is also defined as one production day. **A1)**

³⁾ Available from BRE Bookshop, 151 Rosebery Avenue, London EC1R 4QX. Website: <http://www.brebookshop.com>.

⁴⁾ Available from The Concrete Bookshop, Century House, Telford Avenue, Crowthorne, Berkshire RG45 6YS. Tel: 01344 762676. Website: <http://www.concretebookshop.com>.

A₁ for air content testing: day on which 50 m³ or more of concrete with a specified air content has been produced

NOTE 2 The day on which a cumulative 50 m³ has been produced since the last production day or since commencing production is also defined as one production day. **A₁**

3.1.6

production week

period of 7 consecutive days comprising at least 5 production days or the period taken to complete 5 production days, whichever is longer

3.1.7

time of loading

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

3.2

Symbols and abbreviations

For the purposes of this part of BS 8500, the symbols and abbreviations given in BS EN 206-1:2000, 3.2 and BS 8500-1:2002, 3.2 and the following apply.

NOTE The abbreviations used to denote cement and combination types are given in Table 1.

eq equivalent

4 Complementary requirements for constituent materials

4.1 General

Constituent materials that conform to the relevant European Standards cited in BS EN 206-1 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 may 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 only.

4.2 Cement and combinations

In addition to the cements covered by BS EN 206-1:2000, 5.1.2, general suitability is established for the following cements:

- sulfate-resisting Portland cement conforming to BS 4027;
- blastfurnace cements conforming to BS 146;
- pozzolanic cement conforming to BS 6610.

NOTE In the future, further parts of BS EN 197 or other European Standards are likely to cover all these cements, in which case these British Standards will be withdrawn.

General suitability for use in concrete conforming to BS EN 206-1 and this part of BS 8500 is established for combinations conforming to Annex A.

Specific suitability of cements and combinations is given in Table 1.

The use of composite (CEM V) cements or combinations of CEM I with two or more additions shall be used only when specified [see BS 8500-1:2002, 4.3.3a] or when the producer's proposals have been accepted by the specifier and incorporated into the specification.

The producer shall select a cement or combination type from the group (see Table 1) or types of cement or combination specified. Where only the main type of cement or combination has been specified, the producer shall use one of its sub-classes and second main constituents listed in Table 1. Where only the main type and second main constituents have been specified, the producer shall use one of its sub-classes listed in Table 1, e.g. if II-S is specified, the producer shall use CEM II/A-S, CEM II/B-S, CIIA-S or CIIB-S.

Table 1 — Cements and combinations

Type	Designation	Standard	Grouping with respect to sulfate resistance	Grouping with respect to XD2, XD3 and XS exposure
Portland cement	CEM I	BS EN 197-1	1	4
Portland-silica fume cement	CEM II/A-D	BS EN 197-1	1	4
Portland-limestone cement	CEM II/A-L	BS EN 197-1	1	4
	CEM II/A-LL	BS EN 197-1	1	4
Portland-pozzolana cement	CEM II/A-Q ^a	BS EN 197-1	1	4
	CEM II/B-Q ^a	BS EN 197-1	b	b
Portland-slag cements	CEM II/A-S	BS EN 197-1	1	4
	CEM II/B-S	BS EN 197-1	1	4
Portland-fly ash cements	CEM II/A-V	BS EN 197-1	1	4
	CEM II/B-V ^c	BS EN 197-1	2a ^d	5
Blastfurnace cements ^e	CEM III/A	BS EN 197-1	1	5
	CEM III/B ^f	BS EN 197-1	2b ^g	6
Pozzolanic cement ^{h, i}	CEM IV/B ^c	BS EN 197-1	2a ^j	6
Sulfate-resisting Portland cement	SRPC	BS 4027	3	4
Blastfurnace slag cements ^e	BIIIA	BS 146	1	5
	BIIB ^f	BS 146	2b ^g	6
Pozzolanic pulverized-fuel ash cement	PIV/B-V ^c	BS 6610	2a ^j	6
<i>Combinations conforming to Annex A manufactured in the concrete mixer from Portland cement and fly ash, pfa, ggbs or limestone fines:</i>				
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 (Option A) or pfa conforming to BS 3892-1 (Option B)	CIIA-V	Annex A	1	4
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 (Option A)	CIIB-V	Annex A	1	5
CEM I cement conforming to BS EN 197-1 with a mass fraction of 21 % to 35 % of combination of pfa conforming to BS 3892-1 (Option B)	CIIB-V ^c	Annex A	2a ^d	5
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 (Option A)	CIVB-V	Annex A	1	6
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36 % to 55 % of combination pfa conforming to BS 3892-1 (Option B)	CIVB-V ^c	Annex A	2a ^j	6
CEM I cement conforming to BS EN 197-1 with a mass fraction of 6 % to 35 % of combination of ggbs conforming to BS 6699	CIH-S ^k	Annex A	1	4
CEM I cement conforming to BS EN 197-1 with a mass fraction of 36 % to 65 % of combination of ggbs conforming to BS 6699	CIHIA	Annex A	1	5
CEM I cement conforming to BS EN 197-1 with a mass fraction of 66 % to 80 % ^e of combination of ggbs conforming to BS 6699	CIHIB ^f	Annex A	2b ^g	6
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	CIHA-L CIHA-LL	Annex A	1	4
^a Metakaolin only. ^b No guidance provided. ^c Where the proportions for sulfate resistance are required, i.e. not less than 25 % and not more than 40 % pfa, add to the abbreviation “+SR”. ^d Provided the pfa content is a mass fraction of not less than 25 % of cement or combination. Where it is less than 25 %, the cement or combination falls within group 1. ^e Cements or combinations with higher levels of slag than permitted in this table may be used for certain specialist applications, but no guidance is provided in this part of BS 8500. ^f Where the proportions for sulfate resistance are required (see ^g), add to the abbreviation “+SR”. ^g Where the alumina content of the slag exceeds 14 %, the tricalcium aluminate content of the Portland cement fraction shall not exceed 10 %. Where this is not the case, the grouping with respect to sulfate resistance is “1”. ^h CEM IV/A cement with siliceous fly ash should be classified as CEM II-V cement. ⁱ Siliceous fly ash only. ^j Provided the pfa content is a mass fraction of not more than 40 % of cement or combination. Where it exceeds 40 %, no guidance is provided. ^k Where necessary, this class can be subdivided into CIHA-S (6 % to 20 % ggbs) and CIIB-S (21 % to 35 % ggbs).				