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

Part 2: Specification for constituent materials and concrete
Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/517, Concrete, to Subcommittee B/517/1, Concrete production and testing, upon which the following bodies were represented:

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

Amendments issued since publication

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<th>Date</th>
<th>Comments</th>
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<tr>
<td>14640</td>
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<td>See national foreword</td>
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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 Together with BS EN 206-1 and BS 8500-1, it supersedes BS 5328 (all parts), which is to be withdrawn on 1 December 2003.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 206-1[1];
— 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 $\text{\copyright}_1$. Minor editorial changes are not tagged.

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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-compliance 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.

The BSI copyright notice displayed in this document indicates when the document was last issued.
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.
BS 1047, Specification for air-cooled blastfurnace slag aggregate for use in construction.
BS 1704, Specification for solid-stem general purpose thermometers.
BS 3797, Specification for lightweight aggregates for masonry units and structural concrete.
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 6068-2.43, 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 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 EN 196-1, Methods of testing cement — Part 1: Determination of strength.


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


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 mortars 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 932-5, 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.

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 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 12620, Aggregates for concrete.

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.

BS EN ISO 9001, Quality management systems — Requirements.

20 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.

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;


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)


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
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. 3)

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

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Designation</th>
<th>Standard</th>
<th>Grouping with respect to sulfate resistance</th>
<th>Grouping with respect to XD2, XD3 and XS exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland cement</td>
<td>CEM I</td>
<td>BS EN 197-1</td>
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<td>Portland-silica fume cement</td>
<td>CEM II/A-D</td>
<td>BS EN 197-1</td>
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<td>BS EN 197-1</td>
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<td>CEM II/A-LL</td>
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<td>CEM II/B-Q 1</td>
<td>BS EN 197-1</td>
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<td>CEM II/B-S</td>
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<td>Portland-fly ash cements</td>
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<td>BS EN 197-1</td>
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<td>CEM II/B-Va</td>
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<td>Blastfurnace cement</td>
<td>CEM III/A</td>
<td>BS EN 197-1</td>
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<td>CEM III/B 3</td>
<td>BS EN 197-1</td>
<td>2b 6</td>
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<tr>
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<td>CEM IV/B 3</td>
<td>BS EN 197-1</td>
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<td>6</td>
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<td>Sulfate-resisting Portland cement</td>
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<td>BS 146</td>
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<td>BIII B 6</td>
<td>BS 146</td>
<td>2b 6</td>
<td>6</td>
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<tr>
<td>Pozzolanic cement</td>
<td>PIV/B-V 2</td>
<td>BS 6610</td>
<td>2a 6</td>
<td>6</td>
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<tr>
<td>Combinations conforming to Annex A manufactured in the concrete mixer from Portland cement and fly ash, pfa, ggbs or limestone fines:</td>
<td></td>
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<tr>
<td>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)</td>
<td>CIIA-V 4</td>
<td>Annex A</td>
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<td>4</td>
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<tr>
<td>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)</td>
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<td>Annex A</td>
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<td>Annex A</td>
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<tr>
<td>CEM I cement conforming to BS EN 197-1 with a mass fraction of 36 % to 65 % of combination of pfa conforming to BS 3892-1 (Option B)</td>
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<td>Annex A</td>
<td>2a 6</td>
<td>6</td>
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<tr>
<td>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)</td>
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<td>Annex A</td>
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<td>Annex A</td>
<td>2a 6</td>
<td>6</td>
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<tr>
<td>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)</td>
<td>CIIIB-V 6</td>
<td>Annex A</td>
<td>2a 6</td>
<td>6</td>
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<tr>
<td>CEM I cement conforming to BS EN 197-1 with a mass fraction of 6 % to 35 % of combination of pfa conforming to BS 3892-1 (Option B)</td>
<td>CIIIB-V 6</td>
<td>Annex A</td>
<td>2a 6</td>
<td>6</td>
</tr>
<tr>
<td>CEM I cement conforming to BS EN 197-1 with a mass fraction of 66 % to 80 % of combination of ggbs conforming to BS 6699</td>
<td>CIIA-V 6</td>
<td>Annex A</td>
<td>1</td>
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<td>CEM I cement conforming to BS EN 197-1 with a mass fraction of 66 % to 80 % of combination of ggbs conforming to BS 6699</td>
<td>CIIIB-V 6</td>
<td>Annex A</td>
<td>2a 6</td>
<td>6</td>
</tr>
<tr>
<td>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</td>
<td>CIIA-V 6</td>
<td>Annex A</td>
<td>1</td>
<td>4</td>
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<tr>
<td></td>
<td>CIIA-L</td>
<td>BS 7979</td>
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<tr>
<td></td>
<td>CIIA-LL</td>
<td>BS 7979</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

- Metakaolin only.
- No guidance provided.
- 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”.
- 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.
- 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.
- Where the proportions for sulfate resistance are required (see 9), add to the abbreviation “+SR”.
- 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”.
- CEM IV/A cement with siliceous fly ash should be classified as CEM II-V cement.
- Siliceous fly ash only.
- 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.
- Where necessary, this class can be subdivided into CIIA-S (6 % to 20 % ggbs) and CIIB-S (21 % to 35 % ggbs).
4.3 Aggregates

In addition to the aggregates listed in BS EN 206-1:2000, 5.1.3, general suitability is established for the following aggregates:

— aggregates conforming to BS 882;
— aggregates conforming to BS 1047;
— aggregates conforming to BS 3797;
— coarse RCA conforming to this part of BS 8500.

NOTE 1 BS 882, BS 1047 and BS 3797 have been superseded by BS EN 12620 and BS EN 13055-1, but they will not be withdrawn until June 2004. When using the European Standards:

a) the use of normal-weight and heavyweight aggregates should follow the recommendations given in PD 6682-1;
b) for lightweight aggregates specified in accordance with BS EN 13055-1, the producer should specify to the aggregate supplier the requirements for lightweight aggregates given in this clause, together with the following:

— maximum aggregate size;
— grading including tolerances;
— target loose bulk density.

Lightweight aggregates shall conform to the following requirements:

1) the acid soluble sulfate content shall be not more than 1 % when measured in accordance with BS EN 1744-1;
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 2 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.

Note deleted.

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 (see BS 8500-1:2002, 5.2).

NOTE 3 There is no standard test method; the most appropriate technique will depend on the type of lightweight aggregate used. The specifier may require a different method to be used.

NOTE 4 The method given in BS EN 1097-6:2000, Annex C is not applicable to aggregates with particle sizes less than 4 mm.

For use in DC-classes DC-2 to DC-4m** and designated concretes FND2 to FND4M**, the combined aggregates shall be classified by carbonate content into range A, B or C in accordance with BRE Special Digest 1, Part 2. The determination of the equivalent calcium carbonate content of aggregate shall be in accordance with BS 812-104 and/or by chemical analysis in accordance with BS EN 196-21. The laboratory sample to be used for the BS EN 196-21 test shall be taken in accordance with BS EN 932-1. The carbonate content shall be expressed as equivalent calcium carbonate content in accordance with the recommendations in BRE Special Digest 1: Part 2.

The acid-soluble sulfate content of normal-weight air-cooled blastfurnace slag aggregate shall be not more than 1 % when measured in accordance with BS EN 1744-1.

Note deleted.

Where freeze/thaw resisting normal-weight or heavyweight aggregates are specified, the percentage loss of mass when tested in accordance with BS EN 1367-2 shall be not greater than 25 % for use in XF3 exposures and not greater than 18 % for use in XF4 exposures except for porous flint aggregates (see BS 8500-1:2002, A.10.5). 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.

The aggregate drying shrinkage shall be not more than 0.075 % when determined in accordance with BS EN 1367-4, 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 LA40.

NOTE 5 Aggregates having Los Angeles coefficient values above 40 might also perform satisfactorily in normal concrete, but their strength performance should be established in concrete trials before use.

Coarse RCA and coarse RA (referred to henceforth as RCA and RA) shall conform to the requirements specified in Table 2. Composites of RCA or RA and natural aggregates shall conform to the general requirements for aggregate specified in BS 882 or BS EN 12620 as appropriate and to the general requirements for normal-weight aggregates specified in this subclause.

NOTE 6 Provisions for the use of fine RCA and fine RA is not covered are not given in BS 8500. While some requirements for coarse RA are specified, they are insufficient to form an adequate specification. As the potential composition of RA is so wide, the additional specification requirements should be assessed on a case-by-case basis taking into account the specific composition of the RA. In particular the project specification for RA should include:

- maximum acid-soluble sulfate;
- method for determination of the chloride content;
- classification with respect to alkali–aggregate reactivity;
- method for determination of the alkali content;
- any limitations on use in concrete.

When the composition of RCA and RA is tested in accordance with Annex B, the test result obtained for each type of particle shall not exceed the maximum value specified in Table 2.

When determined in accordance with BS EN 1744-1, the acid-soluble sulfate content of RCA and RA shall not exceed the maximum value specified in Table 2.

Table 2 — Requirements for coarse RCA and coarse RA

<table>
<thead>
<tr>
<th>Type of aggregate</th>
<th>Requirement&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum masonry content</td>
</tr>
<tr>
<td>RCA&lt;sup&gt;a, c&lt;/sup&gt;</td>
<td>5</td>
</tr>
<tr>
<td>RA</td>
<td>100</td>
</tr>
</tbody>
</table>

<sup>a</sup> Where the material to be used is obtained by crushing hardened concrete of known composition that has not been contaminated by use, the only requirements are those for grading and maximum fines.

<sup>b</sup> Material with a density less than 1 000 kg/m³.

<sup>c</sup> The provisions for RCA may be applied to mixtures of natural course aggregates blended with the listed constituents.

<sup>d</sup> The appropriate limit needs to be determined on a case-by-case basis (See 4.3, Note 5.)

When determining that the maximum chloride content of concrete specified in BS EN 206-1: 2000, 5.2.7 has not been exceeded, the chloride content of RCA and RA and its variability shall be established and taken into account.

RA 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.

Table 3 — Limitations on the use of coarse RCA

<table>
<thead>
<tr>
<th>Type of aggregate</th>
<th>Limitations on use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum strength class</td>
</tr>
<tr>
<td>RCA&lt;sup&gt;a&lt;/sup&gt;</td>
<td>C40/50</td>
</tr>
</tbody>
</table>

<sup>a</sup> Material obtained by crushing hardened concrete of known composition that has not been contaminated by use may be used in any strength class.

<sup>b</sup> 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, etc.
4.4 Additions

In addition to the additions listed in BS EN 206-1:2000, 5.1.6, general suitability as a Type II addition is established for the following:

— ggbs conforming to BS 6699;
— pfa conforming to BS 3892-1;
— metakaolin with an appropriate Agrément Certificate\(^5\).

In addition to the additions listed in BS EN 206-1:2000, 5.1.6, general suitability as a Type I addition is established for pfa conforming to BS 3892-2.

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

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:

— fly ash conforming to BS EN 450 with a loss-on-ignition of not more than 7 %;
— ggbs conforming to BS 6699;
— limestone fines conforming to BS 7979;
— pfa conforming to BS 3892-1.

The equivalent concrete performance concept (see BS EN 206-1:2000, 5.2.5.3) shall not be used unless the producer’s proposals for demonstrating equivalence and ensuring conformity have been approved by the specifier.

Where the \(k\)-value concept is used (see BS EN 206-1:2000, 5.2.5.2), the starting point for limiting values shall be those specified in the specification for a CEM I cement concrete.

4.5 Admixtures

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 \(\pm 1\) % of the target, shall be not greater than 0.20 mm.

NOTE 1 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.

NOTE 2 Initial tests as required by BS EN 206-1:2000, 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 206-1 and this part of BS 8500 is established for fibres for concrete conforming to an Agrément Certificate\(^6\) or a European Technical Approval.

NOTE European Standards for steel and polymer fibres for concrete are in preparation.

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 clarified.

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 206-1.\(^7\)

\(^{5}\) Available from the British Board of Agrément.

\(^{6}\) Available from the British Board of Agrément.

\(^{7}\) Concrete shall conform to 5.2, 5.3, 5.4, 5.5 and 5.6 and the relevant requirements of BS EN 206-1.\(^7\)
5.2 Resistance to alkali–silica reactions

5.2.1 General

The risk of damaging alkali–silica reaction shall be minimized in accordance with one of the sets of conditions given in 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.7 and 5.2.8 except:

— for prescribed concrete (see BS 8500-1:2002, A.12.1 for guidance);
— 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 have, by specification, placed this requirement on the producer (see BS 8500-1:2002, A.12.1).

When the alkali content of RCA is taken into account in accordance with 5.2.6, it shall be classed as having normal reactivity.

5.2.2 Low reactivity aggregate, option 1

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

a) The aggregate type or aggregate combination is classed as low reactivity in BRE Digest 330.

b) The cement or combination content is not more than 550 kg/m³ of concrete.

c) The declared mean alkali content of the CEM I or the CEM I type component of other cements and combinations is not more than 0.75 % Na₂O eq.

d) When tested in accordance with Annex C, the alkali from constituents other than the cement or combination is not more than 0.60 kg Na₂O eq per cubic metre (m³) of concrete.

e) The guaranteed alkali limit of any ggbs is not more than 1.0 % Na₂O eq and the guaranteed alkali limit of any fly ash or pfa is not more than 5.0 % Na₂O eq.

f) Where used, the pfa conforms to BS 3892-1 and the fly ash conforms to BS EN 450 and has a loss-on-ignition of not more than 7 %.

5.2.3 Low reactivity aggregate, option 2

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

a) The aggregate type or aggregate combination is classed as low reactivity in BRE Digest 330.

b) The cement or combination content is not more than 500 kg/m³ of concrete.

c) The declared mean alkali content of the CEM I or the CEM I type component of other cements and combinations that contain mass fractions of not less than 40 % ggbs or not less than 25 % pfa or fly ash is more than 0.75 % Na₂O eq but not more than 1.00 % Na₂O eq.

d) When tested in accordance with Annex C, the alkali from constituents other than the cement or combination is not more than 0.20 kg Na₂O eq per cubic metre (m³) of concrete.

e) The guaranteed alkali limit of any ggbs is not more than 1.0 % Na₂O eq and the guaranteed alkali limit of any fly ash or pfa is not more than 5.0 % Na₂O eq.

f) Where used, the pfa conforms to BS 3892-1 and the fly ash conforms to BS EN 450 and has a loss-on-ignition of not more than 7 %.
5.2.4 Normal reactivity aggregate excluding RCA

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

a) The aggregate type is not classed as:

1) highly reactive (see BRE Digest 330), e.g. contains more than a mass fraction of 10 % of total aggregate comprising crushed material as greywacke, greywacke-type sandstones, greywacke-type siltstones and/or mudstones or combinations of these material; or

2) extremely reactive (see BRE Digest 330), e.g. calcined flint or glass (artificial or volcanic); or

3) RCA or a combination of RCA with other aggregates.

b) The cement or combination content of the concrete is not more than the value given in Table 4 or Table 5 depending on the alkali contribution to the fresh concrete from constituents other than the cement or combination. This alkali contribution shall be calculated from the declared mix proportions and the determined alkali contents (see Annex C).

NOTE Linear interpolation between Table 4 and Table 5 is permitted for intermediate alkali contributions from other constituents.

c) The guaranteed alkali limit of any ggbs is not more than 1.0 % Na₂O eq and the guaranteed alkali limit of any fly ash or pfa is not more than 5.0 % Na₂O eq.

d) Where used, the pfa conforms to BS 3892-1 and the fly ash conforms to BS EN 450 and has a loss-on-ignition of not more than 7 %.

Table 4 — Maximum values of cement or combination contents for not more than 0.20 kg Na₂O eq per cubic metre (m³) of concrete from other constituents

| Cement or combination | Guaranteed ≤0.60 % Na₂O eq | Declared mean alkali content of a cement or the CEM I component of a combination,%
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.50</td>
<td>0.55</td>
</tr>
<tr>
<td>CEM I, SRPC or low alkali SRPC</td>
<td>550</td>
<td>550</td>
</tr>
<tr>
<td>CEM I plus ≥40 % ggbs</td>
<td>—</td>
<td>550</td>
</tr>
<tr>
<td>CEM I plus ≥25 % pfa or ≥30 % fly ash</td>
<td>—</td>
<td>550</td>
</tr>
</tbody>
</table>

* Where the alkali content is determined in accordance with Annex C and where a cement or combination contains ggbs, pfa or fly ash, classification is on the basis of the declared mean alkali content of its CEM I type component.

b Linear interpolation is permitted for declared mean alkali contents in the range 0.50 % to 0.75 % and 0.76 % to 1.00 %.

* Proportions expressed as a mass fraction of cement or combination as appropriate.

c Where the proportion of ggbs is less than 40 % or the proportion of pfa or fly ash is less than 25 %, the alkali contributions from these materials shall be calculated in accordance with BRE Digest 330.

* For quantities of ggbs greater than 40 % or quantities of pfa or fly ash greater than 25 %, calculations based on BRE Digest 330 can give higher values of limiting cement or combination content.
Table 5 — Maximum values of cement or combination contents for 0.60 kg Na₂O eq per cubic metre (m³) of concrete from other constituents

<table>
<thead>
<tr>
<th>Cement or combination</th>
<th>Maximum value of cement or combination content, kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Guaranteed ≤0.60 % Na₂O eq</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>CEM I, SRPC or low alkali SRPC</td>
<td>550</td>
</tr>
<tr>
<td>CEM I plus ≥40 % ggbs, d, e</td>
<td>—</td>
</tr>
<tr>
<td>CEM I plus ≥25 % pfa, d, e or ≥30 % fly ash</td>
<td>—</td>
</tr>
</tbody>
</table>

* Where the alkali content is determined in accordance with Annex C and where a cement or combination contains ggbs, pfa or fly ash, classification is on the basis of the declared mean alkali content of its CEM I type component.

b Linear interpolation is permitted for declared mean alkali contents in the range 0.50 % to 0.75 % and 0.76 % to 1.00 %.

d Where the proportion of ggbs is less than 40 % or the proportion of pfa or fly ash is less than 25 %, the alkali contributions from these materials shall be calculated in accordance with BRE Digest 330.

e For quantities of ggbs greater than 40 % or quantities of pfa or fly ash greater than 25 %, calculations based on BRE Digest 330 can give higher values of limiting cement or combination content.

5.2.5 Service record option

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 the past 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.

5.2.6 Recycled concrete aggregate (RCA)

Where the concrete is to contain RCA, the alkali contribution from RCA shall be either:

a) 0.20 kg Na₂O eq per 100 kg of RCA; or

b) where the composition of the RCA is known (e.g. surplus precast units; fresh concrete returned to a plant, allowed to harden and then crushed), the alkali content calculated for the original concrete.

NOTE 1 The 0.20 kg Na₂O eq per 100 kg of RCA is based on:

\[(4.8 \text{ kg Na}_2\text{O eq/m}^3) \times (1 \text{m}^3/400 \text{ kg})\times 100 \text{ kg RCA} = 0.20 \text{ kg Na}_2\text{O eq per 100 kg RCA.}\]

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

1) The aggregate other than the RCA is not classed as highly or extremely reactive (see BRE Digest 330).

2) The guaranteed alkali limit of any ggbs is not more than 1.0 % Na₂O eq and the guaranteed alkali limit of any fly ash or pfa is not more than 5.0 % Na₂O eq.

3) Where used, the pfa conforms to BS 3892-1 and the fly ash conforms to BS EN 450 and has a loss-on-ignition of not more than 7 %.

4) The calculated total alkali content does not exceed:

— 3.5 kg/m³ Na₂O eq where the declared mean alkali content of a cement or the CEM I component of a combination is not greater than 0.75 %;

— 3.0 kg/m³ Na₂O eq where the declared mean alkali content of a cement or the CEM I component of a combination is 0.76 % or greater.
Where the proportion of ggbs is at least 40 % or the proportion of pfa or fly ash is at least 25 %, the alkali contribution from the cement or combination shall be calculated from the CEM I type component of a cement or the CEM I content of a combination.

NOTE 2 In these cases, the alkali contents of the ggbs, pfa or fly ash are not taken into account.

Where the proportion of ggbs is less than 40 % or the proportion of pfa or fly ash is less than 25 %, the alkali contributions from these constituents shall be calculated in accordance with BRE Digest 330.

5.2.7 Testing of crushed greywacke or crushed greywacke-type aggregate from an identified source

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

a) The aggregate type is a crushed greywacke, crushed greywacke-type sandstone, siltstone and/or mudstone or a combination containing more than 10 % as crushed particles of these aggregates.

b) The aggregate comes from a source that has been tested and assessed in accordance with Alkali-silica reaction — Testing protocol for greywacke aggregates.

c) Where the test data obtained in accordance with the testing protocol in 5.2.7b) give not more than 0.08 % expansion at 2 years at 3.5 kg, 4.0 kg, 4.5 kg or 5.0 kg Na₂O eq per cubic metre (m³) of concrete, the alkali content of the concrete is not greater than 2.0 kg, 2.5 kg, 3.0 kg or 3.5 kg Na₂O eq per cubic metre (m³), respectively.

NOTE The alkali content of the concrete is calculated using the declared mean alkali content of either the CEM I or the CEM I type component of other cements and combinations that contain mass fractions of not less than 50 % ggbs or not less than 40 % pfa or fly ash, using the procedures given in Concrete Society Technical Report No. 30:1999, F.6, Clause 39, Clause 40 or Clause 41 as appropriate.

d) When tested in accordance with Annex C, the alkali from constituents other than the cement or combination is not more than 0.20 kg Na₂O eq/m³ of concrete.

e) The guaranteed alkali limit of any ggbs is not more than 1.0 % Na₂O eq and the guaranteed alkali limit of any fly ash or pfa is not more than 5.0 % Na₂O eq.

f) Where used, the pfa conforms to BS 3892-1 and the fly ash conforms to BS EN 450 and has a loss-on-ignition of not more than 7 %.

5.2.8 Other conditions

Where silica fume, metakaolin or lithium compounds are to be used, the concrete shall conform to the guidance given in BRE Information Paper IP1/02. Where the concrete does not contain these materials and none of the conditions given in 5.2.2, 5.2.3, 5.2.4, 5.2.5 and 5.2.7 are met, the producer shall ensure that the concrete is prepared following the guidance given in BRE Digest 330 or Concrete Society Technical Report No. 30.

NOTE Deleted

5.3 Chloride content

When determining conformity of chloride content in accordance with BS EN 206-1:2000, 8.2.3.2, the method for determining the chloride content of constituent materials shall be in accordance with Table 6.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Method specified in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement, fly ash, ggbs, limestone fines, pfa, metakaolin</td>
<td>BS EN 196-21</td>
</tr>
<tr>
<td>Aggregate excluding RCA</td>
<td>BS EN 1744-1</td>
</tr>
<tr>
<td>RCA</td>
<td>BS 1881-124</td>
</tr>
<tr>
<td>Admixture</td>
<td>BS EN 480-10</td>
</tr>
<tr>
<td>Watera</td>
<td>BS EN 196-21b or BS 6068-2.37b (ISO 9297)</td>
</tr>
</tbody>
</table>

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. 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 below, the temperature of the fresh concrete at
the time of delivery shall not exceed:

— where specified, the specified value;
— 35 °C in all other cases.

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

a) 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.

b) 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 206-1, 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 206-1:2000, 8.2.3.2, 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 (m³) 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 use the constituent materials specified in 6.2 to
make concrete conforming to 6.3 and to the appropriate options given in the specification.

6.2 Constituent materials

6.2.1 Cements and combinations

The cement or combination shall be selected from those given in Table 1 for the specified designated
concrete except where the specification places additional restrictions on the cement or combination types.
In this case, the cement or combination shall be selected from the specified restricted range.
6.2.2 Aggregates

Aggregates shall be normal-weight and shall conform to 4.3 and to any specified requirements for special properties. For designated concretes RC50XF, PAV1 and PAV2, the aggregates shall be freeze/thaw resisting as specified in 4.3 for XF4 exposures.

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 (see BS 8500-1:2002, 4.2.3 and BS 8500-1:2002, A.10).

Where RCA is to be used:

— it shall conform to 4.3;
— in designated concretes RC25 to RC50, 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.

NOTE 2 RCA may comprise any mass fraction of the coarse aggregate in designated concretes GEN0 to GEN3.

RCA shall not be used in any of the FND or PAV designated concretes nor in designated concrete RC50XF.

RA shall not be used in designated concrete.

NOTE 3 This restriction is due to the fact that 4.3 does not give a complete specification for RA.

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

Fine aggregate used in PAV2 concretes shall have a mass fraction of not more than 25 % of acid soluble material as determined by BS 812-119 in either the fraction retained on or the fraction passing a 600 μm sieve.

6.2.3 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 (see BS 8500-1:2002, 4.2.3).

6.2.4 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.

Where the k-value concept is to be used (see BS EN 206-1:2000, 5.2.5.2), the fly ash shall conform to BS EN 450 and shall have a loss-on-ignition of not more than 7 %.

Where Type I additions, e.g. pfa conforming to BS 3892-2, are to be used, they shall not be regarded as part of the combination content or used in the k-value concept.

Fibres for concrete conforming to an Agrément Certificate or a European Technical Approval shall be used only where specified.

6.3 Concrete requirements

Designated concretes shall conform to the requirements specified in Table 7 and Table 8, and to all the requirements specified in Clause 4, Clause 5 and BS EN 206-1:2000, Clause 5 that are applicable to designed concrete.

The cement or combination content of concrete shall not exceed 550 kg/m³.

The chloride content class shall be:

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

b) where a class has not been specified, Cl 1.0 for the GEN series of designated concretes or Cl 0.40 for other designations for all cements except SRPC, in which case it shall be Cl 0.20.

7) Available from the British Board of Agrément.
### Table 7 — Requirements for designated concretes

<table>
<thead>
<tr>
<th>Concrete designation</th>
<th>Minimum strength class N/mm²</th>
<th>Slump class a</th>
<th>Cement/combination group b</th>
<th>Minimum cement or combination content kg/m³</th>
<th>Maximum w/c ratio</th>
<th>Carbonate range of the aggregates d</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN0</td>
<td>C6/8</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>120</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>GEN1</td>
<td>C8/10</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>180</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>GEN2</td>
<td>C12/15</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>200</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>GEN3</td>
<td>C16/20</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>220</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>FND2</td>
<td>C28/35</td>
<td>S3</td>
<td>1e, 2, 3</td>
<td>340</td>
<td>0.50</td>
<td>Any</td>
</tr>
<tr>
<td>FND2Z</td>
<td>C28/35</td>
<td>S3</td>
<td>2, 3</td>
<td>300</td>
<td>0.55</td>
<td>Any</td>
</tr>
<tr>
<td>FND3</td>
<td>C28/35</td>
<td>S3</td>
<td>2a</td>
<td>400</td>
<td>0.40</td>
<td>A</td>
</tr>
<tr>
<td>FND3*</td>
<td>C28/35</td>
<td>S3</td>
<td>2b, 3</td>
<td>380</td>
<td>0.45</td>
<td>A</td>
</tr>
<tr>
<td>FND3**</td>
<td>C28/35</td>
<td>S3</td>
<td>2, 3</td>
<td>380</td>
<td>0.45</td>
<td>B or C</td>
</tr>
<tr>
<td>FND3Z</td>
<td>C28/35</td>
<td>S3</td>
<td>1e, 2, 3</td>
<td>340</td>
<td>0.45</td>
<td>C</td>
</tr>
<tr>
<td>FND4</td>
<td>C28/35</td>
<td>S3</td>
<td>2a</td>
<td>400</td>
<td>0.35</td>
<td>A</td>
</tr>
<tr>
<td>FND4*</td>
<td>C28/35</td>
<td>S3</td>
<td>2b, 3</td>
<td>380</td>
<td>0.40</td>
<td>A</td>
</tr>
<tr>
<td>FND4**</td>
<td>C28/35</td>
<td>S3</td>
<td>2, 3</td>
<td>400</td>
<td>0.40</td>
<td>B or C</td>
</tr>
<tr>
<td>FND4Z</td>
<td>C28/35</td>
<td>S3</td>
<td>1e, 2, 3</td>
<td>380</td>
<td>0.45</td>
<td>C</td>
</tr>
<tr>
<td>FND4M</td>
<td>C28/35</td>
<td>S3</td>
<td>2b, 3</td>
<td>380</td>
<td>0.40</td>
<td>A</td>
</tr>
<tr>
<td>FND4M*</td>
<td>C28/35</td>
<td>S3</td>
<td>3</td>
<td>380</td>
<td>0.45</td>
<td>B or C</td>
</tr>
<tr>
<td>FND4M**</td>
<td>C28/35</td>
<td>S3</td>
<td>3</td>
<td>400</td>
<td>0.40</td>
<td>B</td>
</tr>
<tr>
<td>PAV1</td>
<td>C25/30</td>
<td>S2</td>
<td>1b, 2a b, 3</td>
<td>See Table 8</td>
<td>0.60</td>
<td>Not applicable</td>
</tr>
<tr>
<td>PAV2</td>
<td>C28/35</td>
<td>S2</td>
<td>1b, 2a b, 3</td>
<td>See Table 8</td>
<td>0.55</td>
<td>Not applicable</td>
</tr>
<tr>
<td>RC25</td>
<td>C20/25</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>See Table 8</td>
<td>0.70</td>
<td>Not applicable</td>
</tr>
<tr>
<td>RC30</td>
<td>C25/30</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>See Table 8</td>
<td>0.65</td>
<td>Not applicable</td>
</tr>
<tr>
<td>RC35</td>
<td>C28/35</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>See Table 8</td>
<td>0.60</td>
<td>Not applicable</td>
</tr>
<tr>
<td>RC40</td>
<td>C32/40</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>See Table 8</td>
<td>0.55</td>
<td>Not applicable</td>
</tr>
<tr>
<td>RC45</td>
<td>C35/45</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>See Table 8</td>
<td>0.50</td>
<td>Not applicable</td>
</tr>
<tr>
<td>RC50</td>
<td>C40/50</td>
<td>S3</td>
<td>1, 2a, 3</td>
<td>See Table 8</td>
<td>0.45</td>
<td>Not applicable</td>
</tr>
<tr>
<td>RC50XF</td>
<td>C40/50</td>
<td>S3</td>
<td>1, 3</td>
<td>See Table 8</td>
<td>0.45</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

a Except were a different consistence class has been specified. In this case, the concrete shall conform to the specified consistence class or target value.
b See Table 1.
c See 6.3.
d See 4.3.
e Excluding II/A-L or LL.
f Where this is specified, the producer may supply concrete conforming to the “double-starred” class.
g The concrete shall contain an air-entraining admixture to give a minimum air content by volume of 3.0 %, 3.5 % or 5.5 % with aggregate of 40 mm, 20 mm and 10 mm maximum aggregate size respectively at delivery.
h With not more than 40 % fly ash or pfa.
i See 6.2.2.
6.4 Conformity

6.4.1 Conformity control

Conformity control of designated concretes shall be in accordance with the conformity control requirements for designed concretes specified in BS EN 206-1:2000, Clause 8.

6.4.2 Quality systems

The producer shall hold current product conformity certification based on product testing and surveillance coupled with approval of the quality system to BS EN ISO 9001 by a certification body accredited by the Secretary of State (or equivalent) for the relevant areas of product and systems conformity certification. On request from the specifier, the producer shall make available the technical regulations of the accredited certification body for examination.

NOTE Producers who do not operate a third-party quality assurance scheme are not permitted to supply designated concrete.

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.

<table>
<thead>
<tr>
<th>Specified maximum w/c ratio</th>
<th>Minimum cement or combination content (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum aggregate size ≥40 mm</td>
</tr>
<tr>
<td>0.70</td>
<td>240</td>
</tr>
<tr>
<td>0.65</td>
<td>240</td>
</tr>
<tr>
<td>0.60</td>
<td>260</td>
</tr>
<tr>
<td>0.55</td>
<td>280</td>
</tr>
<tr>
<td>0.50</td>
<td>300</td>
</tr>
<tr>
<td>0.45</td>
<td>320</td>
</tr>
</tbody>
</table>
7 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

<table>
<thead>
<tr>
<th>DC-class</th>
<th>Aggregate carbonate range</th>
<th>Cement or combination group</th>
<th>Dense fully compacted concrete</th>
<th>Minimum cement or combination content</th>
<th>Maximum w/c ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC-1</td>
<td>A, B, C</td>
<td>1, 2, 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC-2</td>
<td>A, C, B, C</td>
<td>1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>340</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2, 3</td>
<td>300</td>
<td></td>
<td>0.55</td>
</tr>
<tr>
<td>DC-2z</td>
<td>A, B, C</td>
<td>1&lt;sup&gt;d&lt;/sup&gt;, 2, 3</td>
<td>300</td>
<td></td>
<td>0.55</td>
</tr>
<tr>
<td>DC-3</td>
<td>A</td>
<td>2a</td>
<td>400</td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>2b, 3</td>
<td>380</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2, 3</td>
<td>340</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>DC-3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>B</td>
<td>2, 3</td>
<td>380</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td>DC-3**</td>
<td>C</td>
<td>2, 3</td>
<td>380</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td>DC-3z</td>
<td>A, B, C</td>
<td>1&lt;sup&gt;d&lt;/sup&gt;, 2, 3</td>
<td>340</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>DC-4</td>
<td>A</td>
<td>2a</td>
<td>400</td>
<td></td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>2b, 3</td>
<td>400</td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2, 3</td>
<td>380</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td>DC-4&lt;sup&gt;e&lt;/sup&gt;</td>
<td>B</td>
<td>2, 3</td>
<td>400</td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td>DC-4**</td>
<td>C</td>
<td>2, 3</td>
<td>400</td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td>DC-4z</td>
<td>A, B, C</td>
<td>1&lt;sup&gt;d&lt;/sup&gt;, 2, 3</td>
<td>380</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td>DC-4m</td>
<td>A</td>
<td>2b, 3</td>
<td>400</td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>3</td>
<td>380</td>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td>DC-4m&lt;sup&gt;e&lt;/sup&gt;</td>
<td>B</td>
<td>3</td>
<td>400</td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td>DC-4m**</td>
<td>C</td>
<td>3</td>
<td>400</td>
<td></td>
<td>0.40</td>
</tr>
</tbody>
</table>

<sup>a</sup> See 4.3.

<sup>b</sup> See Table 1.

<sup>c</sup> In addition, the strength class shall be not less than C28/35.

<sup>d</sup> H/D1 or L1 may be used only where the specifier has informed the producer that the sulfate classification (design sulfate class for the site) is DS-1.

<sup>e</sup> Where this is specified, the producer may supply concrete conforming to the “double-starred” class.

When requested, the producer shall provide the items of information selected from the list in BS 8500-1:2002, 5.2.

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

— in terms of the cement or combination type and strength class to be used; or
— by a strength development curve at 20 °C between 2 days and not less than 28 days; or
— by a strength development class (see BS EN 206-1:2000, 7.2).

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

— constituent materials are stored at (20 ± 5) °C for 2 days prior to their use to make concrete;
— 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.
8 Standardized prescribed concrete

8.1 General

NOTE Clause 8 applies to small site production of concrete for housing and similar applications.

Where standardized prescribed concrete is specified, the producer shall use the materials specified in 8.2 to make concrete conforming to 8.3 and to any further restriction given in the specification.

8.2 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:

- cement and combination types I, SRPC (see Note 1), IIA-L or LL, II-S, II-V, IIIA;
- normal-weight aggregate conforming to 4.3, excluding RA;
- for ST1, ST2 or ST3 only, all-in aggregate conforming to 4.3;
- admixtures conforming to BS EN 934-2 (see Note 2);
- mixing water conforming to BS EN 1008.

NOTE 1 Standardized prescribed concrete produced using sulfate-resisting Portland cement is not intended to produce sulfate-resistant concrete.

NOTE 2 Air-entraining admixtures are not permitted (see BS EN 206-1:2000, 5.2.1).

Where the concrete is to contain embedded metal or to be reinforced, the chloride content of the aggregate, expressed as a mass fraction (%) of the water-soluble chloride ion content of combined aggregate determined in accordance with BS EN 1744-1, shall be not more than 0.06 %.

8.3 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) the concrete conforming to one of the sets of conditions in 5.2;

b) the cement having a declared mean alkali content not exceeding the value given in Table 11;

c) a low alkali cement (guaranteed alkali limit \( \leq 0.60 \) %) being used.

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 8500-1:2002, Table A.9 plus 12 N/mm², i.e. it satisfies the criterion in BS EN 206-1:2000, 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 will normally provide concrete having the characteristic strengths given in BS 8500-1:2002, Table A.9.

Adjustments shall be made to the mass of aggregate selected from Table 10 for the appropriate standardized prescribed concrete as described in Table 10, 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.
### Table 10 — Mix proportions for standardized prescribed concretes

<table>
<thead>
<tr>
<th>Standardized prescribed concrete</th>
<th>Constituent</th>
<th>Quantity or proportion of constituent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum aggregate size 40 mm or 45 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slump class S1 or S2</td>
</tr>
<tr>
<td>ST1a</td>
<td>Cement or combination</td>
<td>200 kg</td>
</tr>
<tr>
<td></td>
<td>Total aggregate</td>
<td>1 990 kg</td>
</tr>
<tr>
<td>ST2a</td>
<td>Cement or combination</td>
<td>230 kg</td>
</tr>
<tr>
<td></td>
<td>Total aggregate</td>
<td>1 960 kg</td>
</tr>
<tr>
<td>ST3a</td>
<td>Cement or combination</td>
<td>265 kg</td>
</tr>
<tr>
<td></td>
<td>Total aggregate</td>
<td>1 930 kg</td>
</tr>
<tr>
<td>ST4</td>
<td>Cement or combination</td>
<td>310 kg</td>
</tr>
<tr>
<td></td>
<td>Total aggregate</td>
<td>1 900 kg</td>
</tr>
<tr>
<td>ST5</td>
<td>Cement or combination</td>
<td>350 kg</td>
</tr>
<tr>
<td></td>
<td>Total aggregate</td>
<td>1 870 kg</td>
</tr>
</tbody>
</table>

Fine aggregateb, c as a mass fraction of total aggregate

<table>
<thead>
<tr>
<th>ST4</th>
<th>ST5</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 % to 45 %</td>
<td>35 % to 50 %</td>
</tr>
<tr>
<td>35 % to 50 %</td>
<td>40 % to 55 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grading limits 0/4 (CP)</th>
<th>Grading limits 0/4 (MP) or 0/2 (MP)</th>
<th>Grading limits 0/2 (FP) or 0/1 (FP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 % to 40 %</td>
<td>25 % to 35 %</td>
<td>25 % to 35 %</td>
</tr>
<tr>
<td>35 % to 45 %</td>
<td>30 % to 40 %</td>
<td>25 % to 35 %</td>
</tr>
</tbody>
</table>

a The aggregates may be batched by volume (see Table 12).
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.

### Table 11 — Maximum values for the declared mean alkali contentb of bagged cement based on the use of natural aggregates

<table>
<thead>
<tr>
<th>Standardized prescribed concrete</th>
<th>Declared mean alkali content, % Na₂O eq</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard strength class of cement 42.5</td>
</tr>
<tr>
<td></td>
<td>Normalb reactivity aggregates</td>
</tr>
<tr>
<td>ST1</td>
<td>1.26</td>
</tr>
<tr>
<td>ST2</td>
<td>1.11</td>
</tr>
<tr>
<td>ST3</td>
<td>0.97</td>
</tr>
<tr>
<td>ST4</td>
<td>0.88</td>
</tr>
<tr>
<td>ST5</td>
<td>0.80</td>
</tr>
</tbody>
</table>

a The declared mean alkali content of a cement can be obtained from the supplier or manufacturer.
b See 5.2.4.
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, BS 882 or BS 1047 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 12.

### Table 12 — Mix proportions for volume batching of ST1, ST2 and ST3

<table>
<thead>
<tr>
<th>Standard strength class of cement</th>
<th>Standardized prescribed concrete</th>
<th>Slump class</th>
<th>Number of (25 kg) bags of cement</th>
<th>Fine aggregate litres</th>
<th>Coarse aggregate litres</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1</td>
<td>S1, S2</td>
<td>1</td>
<td>60</td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>ST2</td>
<td>S1, S2</td>
<td>1</td>
<td>50</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>ST2</td>
<td>S3</td>
<td>1</td>
<td>50</td>
<td></td>
<td>65*</td>
</tr>
<tr>
<td>ST2</td>
<td>S4</td>
<td>1</td>
<td>45</td>
<td></td>
<td>60*</td>
</tr>
<tr>
<td>ST3</td>
<td>S1, S2</td>
<td>1</td>
<td>45</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>ST3</td>
<td>S3</td>
<td>1</td>
<td>40</td>
<td></td>
<td>55*</td>
</tr>
<tr>
<td>ST3</td>
<td>S4</td>
<td>1</td>
<td>40</td>
<td></td>
<td>50*</td>
</tr>
<tr>
<td>ST1</td>
<td>S1, S2</td>
<td>1</td>
<td>50</td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>ST2</td>
<td>S1, S2</td>
<td>1</td>
<td>45</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>ST2</td>
<td>S3</td>
<td>1</td>
<td>45</td>
<td></td>
<td>55*</td>
</tr>
<tr>
<td>ST2</td>
<td>S4</td>
<td>1</td>
<td>45</td>
<td></td>
<td>50*</td>
</tr>
<tr>
<td>ST3</td>
<td>S1, S2</td>
<td>1</td>
<td>40</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>ST3</td>
<td>S3</td>
<td>1</td>
<td>35</td>
<td></td>
<td>50*</td>
</tr>
<tr>
<td>ST3</td>
<td>S4</td>
<td>1</td>
<td>35</td>
<td></td>
<td>45*</td>
</tr>
</tbody>
</table>

* Fine aggregates MP and CP only.

### 8.4 Production control

Production control shall be in accordance with BS EN 206-1 and Clause 11 as appropriate, except for the case of small quantities of volume-batched production using bagged cements where it shall be in accordance with either BS EN 206-1 and Clause 11 or BS 8000-2.1.

### 9 Delivery of fresh concrete

#### 9.1 Delivery ticket for ready-mixed concrete

In addition to the requirements specified in BS EN 206-1:2000, 7.3, the delivery ticket for each load of concrete shall contain a declaration of conformity to BS 8500-2.

NOTE 1 As Clause 10 requires conformity to and compliance with the relevant clauses of BS EN 206-1, a declaration of conformity to BS 8500-2 is sufficient.

In addition to the requirements specified in BS EN 206-1:2000, 7.3, the delivery ticket for each load of standardized prescribed concrete and designated concrete shall contain:

- the designation of the specified standardized prescribed or designated concrete;
- the consistence class or, where specified, target consistence;
- the chloride class, if specified;
- the maximum aggregate size;
- any additional specified requirements.

* Marking BS EN 206-1:2000 or BS 8500-2:2002 (including Amendment No. 1:2003) 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.
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. Additional information given in BS EN 206-1:2000, 7.3a) and 7.3b) 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.

10 Conformity testing and conformity criteria

10.1 General
Conformity testing and conformity criteria shall be in accordance with 10.2, 10.3 and 10.4 and the relevant requirements of BS EN 206-1.

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 206-1:2000, 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.

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.

10.2 Conformity control for compressive strength
Conformity testing of ready-mixed concrete shall be based on samples taken at or before delivery (see BS EN 206-1:2000, 8.1 and BS EN 206-1:2000, 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 given for 150 mm cubes in BS EN 206-1:2000, Table 7 and BS EN 206-1:2000, Table 8.

The criteria given in BS EN 206-1:2000, Table 14 and BS EN 206-1:2000, Table 16 for \( n = 15 \) shall be applied to higher values of \( n \).

NOTE 1 It should be recognized that even for well controlled concrete in continuous production with normal or enhanced design margins, statistical analysis of strength data will give a small probability of non-conformity with the mean strength criteria in BS EN 206-1:2000. Actions to be taken in the case of non-conformity are specified in BS EN 206-1:2000, 8.4.

NOTE 2 When BS EN 206-1 is first adopted, the continuous production conformity criteria can be applied immediately where existing production data meet the requirements for continuous production.

10.3 Conformity criteria for properties other than strength
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.

The risk of damaging alkali–silica reaction shall be deemed to be minimized if one of the following conditions is met:

a) the concrete conforms to any one of the sets of conditions in 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.6 or 5.2.7;

b) the concrete conforms to the guidance in BRE Digest 330, BRE Information Paper IP1/02 or Concrete Society Technical Report No. 30.

10.4 Conformity control for prescribed concrete including standardized prescribed concrete
Conformity control for prescribed concrete including standardized prescribed concrete shall be in accordance with BS EN 206-1:2000, 8.3.

9) This requirement was agreed by CEN TC 104/SC1 (see Foreword).
10.5 Action in the event of non-conformity

Where there is a 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 206-1:2000, 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 206-1:2000, C.3.2).

11 Production control

NOTE BS EN 206-1: 2000, 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 206-1: 2000, 9.2 to 9.9 give procedures that amplify some aspects of the general requirements. BS EN 206-1: 2000, 9.1 allows for any of these procedures to be varied to take account of:

— the kind and size of the production;
— the works;
— the particular equipment being used;
— procedures and rules in use at the place of production;
— the use of the concrete.

What is not specifically stated, but is understood by CEN TC 104/SC1, is that any alternative procedure should achieve effective control of that aspect of production and be documented.

In summary:

— the producer is required to have a documented production control system;
— there is flexibility in the procedures that may be used, provided they achieve effective control of each aspect of production and the procedure is documented;
— the producer is required to follow this production control system.

11.1 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.

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

11.2 Batching of constituent materials

NOTE 1 The term “weighing equipment” used in BS EN 206-1:2000, 9.6.2.2 is deemed to include volumetric measuring equipment.

Where batching is electronically controlled, the documented batching instruction shall be held at the controlling office.

NOTE 2 The requirements in BS EN 206-1:2000, 9.7 for a documented batching instruction at the place of batching of the concrete applies to manual batching. “Documented” includes the option of holding this information electronically.

11.3 Production control procedures

Production control procedures shall be carried out to ensure that RCA continues to conform to the requirements specified in 4.3. These procedures shall include the tests specified in Table 13.
Table 13 — Materials control for RCA

<table>
<thead>
<tr>
<th>Property</th>
<th>Test method</th>
<th>Requirement specified in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose bulk density(^b)</td>
<td>BS EN 1097-3</td>
<td>Production control manual</td>
</tr>
<tr>
<td>Composition</td>
<td>Annex B</td>
<td>Table 2</td>
</tr>
<tr>
<td>Acid-soluble sulfate content</td>
<td>BS EN 1744-1:1998, Clause 12</td>
<td>Table 2</td>
</tr>
<tr>
<td>Acid-soluble chloride content</td>
<td>BS 1881-124</td>
<td>4.3(^c)</td>
</tr>
</tbody>
</table>

\(^a\) RCA shall be sampled and tested at a frequency sufficient to give enough data to demonstrate a compliant 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.

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

12 Transport of concrete

12.1 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 8500-1:2002, B.1);
— loss of any constituent;
— ingress of foreign matter or water.

12.2 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.

NOTE A longer time after loading can be appropriate in cool, humid weather or where ggbs, pfa or retarding admixtures have been used. A shorter time can be essential in hot weather with cement-rich concretes, or where accelerating admixtures have been used.
Annex A (normative)

Conformity procedure for combinations

NOTE 1 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.

NOTE 2 The specification may place further restrictions on the proportion of fly ash, ggbs, limestone fines or pfa, depending on the use of the concrete.

NOTE 3 This annex meets the requirements for establishing suitability for the use of additions in concrete conforming to BS EN 206-1.

A.1 Procedure

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

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 with a loss-on-ignition of not more than 7 %;

b) ggbs conforming to BS 6699;

c) limestone fines conforming to BS 7979;

d) pfa conforming to BS 3892-1.

Each month, samples shall be obtained that are representative of each lot of 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 may 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

<table>
<thead>
<tr>
<th>Strength class of combination</th>
<th>Early strength</th>
<th>Standard strength</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 day N/mm²</td>
<td>7 day N/mm²</td>
</tr>
<tr>
<td>22.5</td>
<td>—</td>
<td>≥12</td>
</tr>
<tr>
<td>32.5L</td>
<td>—</td>
<td>≥12</td>
</tr>
<tr>
<td>32.5N</td>
<td>—</td>
<td>≥16</td>
</tr>
<tr>
<td>32.5R</td>
<td>≥10</td>
<td>—</td>
</tr>
<tr>
<td>42.5L</td>
<td>—</td>
<td>≥20</td>
</tr>
<tr>
<td>42.5N</td>
<td>≥10</td>
<td>—</td>
</tr>
<tr>
<td>42.5R</td>
<td>≥20</td>
<td>—</td>
</tr>
<tr>
<td>52.5L</td>
<td>≥10</td>
<td>—</td>
</tr>
<tr>
<td>52.5N</td>
<td>≥20</td>
<td>—</td>
</tr>
</tbody>
</table>

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

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/mm² on the lower limits for standard strength and +3 N/mm² 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 pfa or fly ash.

A.2 Issue of certificates

Where a certificate of conformity to this annex is issued, it shall relate to fly ash, ggbs, limestone fines or pfa 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;

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

\[10^\text{Marking BS 8500-2:2002, Annex A on or in relation to a product represents a declaration of conformity, i.e. a claim that the product meets the requirements of the annex. The accuracy of the claim is solely the responsibility of the issuer of the certificate. Such a declaration is not to be confused with third-party certification of conformity, which may also be desirable.}\]
Annex B (normative)
Test method for determining the composition of RCA and RA

B.1 General
This method shall be used to identify and quantify the constituent materials in RCA and RA.

NOTE  This test method is applicable to particle sizes not less than 10 mm and not more than 63 mm.

B.2 Principle
The method consists of sorting particles by hand into:

— concrete and normal-weight aggregates;
— masonry;
— lightweight block materials;
— asphalt;
— other foreign matter.

The mass of each of these groups is determined and expressed as a mass fraction (%) of the test portion. Tests are carried out on duplicate test portions and the test result is the average percentage from the two tests.

B.3 Apparatus

B.3.1 Test sieves of sizes 63 mm and 10 mm, of nominal size of apertures conforming to BS EN 933-2.

B.3.2 Tightly fitting pan and lids for the sieves, conforming to the general requirements in BS EN 932-5.

B.3.3 Ventilated oven, thermostatically controlled to maintain a temperature of (40 ± 5) °C, conforming to the general requirements in BS EN 932-5.

B.3.4 Balance or scale, of suitable capacity, readable to ±0.1 % of the mass to be weighed, conforming to the general requirements in BS EN 932-5.

B.3.5 Sieving machine, optional, conforming to the general requirements in BS EN 932-5.

B.4 Sampling and preparation of test portions
Take the sample in accordance with BS EN 932-1:1997, 8.8 and reduce it in accordance with the procedure specified in BS EN 932-1:1997, 9.4 or BS EN 932-1:1997, 9.5.

NOTE 1 To assist the visual examination of particles, it can be beneficial to wash off any adhering coating prior to drying.

Dry the sample to constant mass at a temperature of (40 ± 5) °C and then sieve the entire sample through 63 mm and 10 mm sieves. Discard all particles retained on the 63 mm sieve and all particles passing the 10 mm sieve.

Further reduce the sample in accordance with BS EN 932-1:1997, 9.4 to produce duplicate test portions, each of which consists of not less than 500 particles.

NOTE 2 Table B.1 gives the recommended minimum test portion mass for a range of maximum aggregate sizes.

NOTE 3 The mass required to provide at least 500 particles is dependent on the particle size distribution and the particle density of the aggregate.

<table>
<thead>
<tr>
<th>Maximum aggregate size</th>
<th>Test portion mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>kg</td>
</tr>
<tr>
<td>63</td>
<td>50</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>28</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
</tr>
</tbody>
</table>
B.5 Procedure

Weigh and record the mass of a test portion. This is given the designation $M_{\text{total}}$.

Spread the particles in a test portion onto a flat surface and separate by hand into the following types of particles:

- concrete and normal-weight aggregates;
- masonry;
- lightweight block materials;
- asphalt;
- other foreign matter, e.g. wood, glass, plastics.

NOTE Masonry includes both brick and block masonry. Lightweight block materials are those with an apparent particle density less than 1 000 kg/m$^3$ when assessed visually. If there is difficulty in classifying a particle visually, it may be placed into a water-filled glass beaker. If the particle sinks rapidly, it is classified as masonry. If it floats or sinks slowly in a stream of bubbles, it is classified as lightweight block material. Any particles tested in this way should be weighed prior to testing or be re-dried at $(40 \pm 5)\,^\circ\text{C}$ to constant mass.

Weigh each group of particles and record the mass, $M_{\text{subscript}}$. Check that the sum of these masses equals $M_{\text{total}}$. Calculate the mass fraction expressed as a percentage, $P_{\text{subscript}}$, of each group of particles from the equation:

$$P_{\text{subscript}} = \frac{100M_{\text{subscript}}}{M_{\text{total}}}$$

Repeat the procedure with the second test portion.

For each type of particle, calculate the average percentage from the two test portions. Round the result to the nearest 0.2 %.

B.6 Test report

The test report shall include the following information:

a) reference to the test method;

b) identification of the sample;

c) identification of the laboratory;

d) date of sampling;

e) for each type of particle, the results of each individual test portion and the test result, expressed as a mass fraction (%) of the total test portion;

f) a statement confirming whether the aggregate sample conforms to Table 2;

g) additional observations and comments.
Annex C (normative)
Determination of the alkali content of constituent materials

C.1 General
Alkalis shall be expressed as the sodium oxide equivalent, Na₂O eq, using the equation:

\[ \text{Na}_2\text{O eq} = (\text{Na}_2\text{O}) + 0.658 (\text{K}_2\text{O}) \]

The alkali content of a CEM I cement or the CEM I cement type component of other cements and combinations shall be expressed as either the guaranteed alkali limit or the declared mean alkali content as appropriate.

Provided the guaranteed alkali limit of any ggbs, fly ash and pfa does not exceed the relevant value given in 5.2.2e) and the mass fraction (%) of ggbs is not less than 40 % or the mass fraction (%) of fly ash conforming to BS EN 450 or pfa conforming to BS 3892-1 is not less than 25 %, the alkali content of the ggbs, fly ash or pfa shall not be taken into account when the alkali content of the cement or combination is determined.

The alkali content of other constituents, e.g. admixtures etc., shall be either:

- the measured value;
- the specified maximum value given in the constituent material standard; or
- the guaranteed alkali limit (see Note).

NOTE In BS EN 934-2, this is called the manufacturer’s declared maximum value.

C.2 Test methods for alkali contents
Except for low alkali SRPC cement conforming to BS 4027, the alkali content of a CEM I cement or the CEM I cement type component of other cements and combinations shall be determined either by the method given in BS EN 196-21:1992, NA.5.1 or by a secondary X-ray fluorescence method calibrated against that method.

The alkali content of a low alkali SRPC cement conforming to BS 4027 shall be determined either by the method given in BS EN 196-21 or by a secondary X-ray fluorescence method calibrated against that method.

The alkali content of ggbs conforming to BS 6699 shall be determined either by the method given in BS EN 196-21:1992, NA.5.1 or by a secondary X-ray fluorescence method calibrated against that method.

The alkali content of fly ash conforming to BS EN 450 or pfa conforming to BS 3892-1 or BS 3892-2 shall be determined either by the method given in BS EN 196-21:1992, 7.5.2 or by a secondary X-ray fluorescence method calibrated against that method.

The alkali content of aggregates other than RCA or RA shall be determined from the chloride ion content. The chloride content of the aggregates measured by the method given in either BS EN 1744 1:1998, Clause 7 or BS EN 1744-1:1998, Clause 8 shall be converted to a sodium oxide equivalent by multiplying the mass fraction (%) of chloride ions by 0.76.

The alkali content of RCA shall be in accordance with 5.2.6. Where testing is required, the alkali content of RCA shall be determined in accordance with BS 1881-124. (C)

The chloride ion 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 either BS EN 1744-1:1998, Clause 7 or BS EN 1744-1:1998, Clause 8.

NOTE When the chloride ion content is less than 0.01 % it shall be regarded as zero, and routine testing is not required for the purposes of this procedure.

The alkali content of admixtures shall be determined by the method given in BS EN 480-12.

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

D.1 General
As an example, Annex D contains a convenient plan for the declaration of conformity to combination strength class 42,5N. 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 D.2).

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 D.3).

c) The statistical margins are established (see D.4).

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

D.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 D.1.

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

| Table D.1 — Mass fraction of addition\(^a\) in combinations for strength testing |
|-----------------|-----------------|-----------------|
| ggbs\(^b\) | % | Fly ash or pfa\(^b\) | % | Limestone fines\(^b\) | % |
| 0 | 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.

D.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:

— 50:50 for ggbs to CEM I cement;
— 15:85 for limestone fines to CEM I cement; or
— 30:70 for fly ash or pfa 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.
D.4 Estimation of statistical margin

The highest possible standard deviation 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 D.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:

- 50:50 for ggbs to CEM I cement;
- 15:85 for limestone fines to CEM I cement; or
- 30:70 for fly ash or pfa to CEM I cement.

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

$$ m = k_As $$

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 197-1:2000, 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.

D.5 Establishment of limits on proportions

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

Then mark the point corresponding to the mean strength, $M$, determined in accordance with D.3. Draw a line through this point, commensurate with the relationship between 28-day strength and proportion. Conformity with strength class 42.5N 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 42.5N 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 or pfa.
Figure D.1 — Determination of conformity limits for combinations
Bibliography

Standards publications

BS EN 196-7:1992, Methods of testing cement — Part 7: Methods of taking and preparing samples of cement.

BS EN 1097-6:2000, Tests for mechanical and physical properties of aggregates — Determination of particle density and water absorption.


Other publications


NOTE This publication comprises ten modules:
— Concrete for normal uses;
— Concrete resistant to chemical attack;
— Guide to the selection of concrete quality and cover to reinforcement for normal concrete structures;
— Examples of the specification of designated concrete;
— Examples of the specification of designed concrete;
— Guidance on the additional requirements for designed concrete;
— Lightweight concrete;
— Visual concrete;
— Coloured concrete;
— Concrete for industrial floors.


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