

Concrete —

Part 2: Methods for specifying concrete mixes

ICS 91.100.30

Committees responsible for this British Standard

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

British Aggregate Construction Materials Industries
 British Cement Association
 British Precast Concrete Federation Ltd.
 British Ready Mixed Concrete Association
 Building Employers Confederation
 Cement Admixtures Association
 Department of Transport (Highways Agency)
 Federation of Civil Engineering Contractors
 Federation of Resin Formulators and Applicators (Ferfa)
 Institute of Concrete Technology
 National House-Building Council
 Sand and Gravel Association Limited
 Society of Chemical Industry

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Lightweight Aggregate Manufacturers
 British Civil Engineering Test Equipment Manufacturers' Association
 Cementitious Slag Makers Association
 Chartered Institution of Water and Environmental Management
 Concrete Society
 County Surveyors' Society
 Department of the Environment (Building Research Establishment)
 Electricity Association
 Federation of Piling Specialists
 Institution of Structural Engineers
 Quality Ash Association

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Foreword

This Part of BS 5328 has been prepared by Technical Committee B/517. This Part, which includes designated mixes, is a new edition of BS 5328-2:1991, which is withdrawn, and, together with BS 5328-1, BS 5328-3 and BS 5328-4, forms a comprehensive standard for the specification of concrete to which codes of practice and contractual documents can refer. It includes recommendations originating from BS 8110-1.

This edition introduces technical changes but does not reflect a full review or revision of the standard. This edition makes provision for Portland limestone cement conforming to BS 7583.

Amendment number 2 takes account of the recent consensus reached by experts on provisions to resist damaging ASR in the UK. These recommendations are published in BRE Digest 330:1999. The technical content of this amendment has been derived from these recommendations.

Amendment number 3 takes account of the guidance in BRE Special Digest 1:Part 2 [4].

BS 5328 is due to be withdrawn in December 2003 and consequently BSI have decided not to revise this standard to reflect the new cement descriptions given in BS EN 197-1. Where traditional cements are specified the producer may use the equivalent BS EN 197-1, *Cements — Composition, specifications and conformity criteria for common cements*, see national annex NA to BS EN 197-1:2000 for guidance on equivalents.

As this standard involves selection by the specifier from a number of options and, in certain instances, agreement on requirements between the purchaser and producer, any requirement for conformity to BS 5328 or any claim of compliance with it has to be qualified by reference to the selection and to any such agreements.

This standard covers the methods for specifying and producing concrete as a construction material up to the point of delivery into the construction. The standard is in four Parts:

- | | |
|--------|---|
| Part 1 | <i>Guide to specifying concrete;</i> |
| Part 2 | <i>Methods for specifying concrete mixes;</i> |
| Part 3 | <i>Specification for the procedures to be used in producing and transporting concrete;</i> |
| Part 4 | <i>Specification for the procedures to be used in sampling, testing and assessing compliance of concrete.</i> |

Part 1 provides guidance, to the specifier and purchaser of concrete, on the selection of requirements for materials and concrete mixes. Part 2 provides a choice of methods by which the purchaser can convey the selected requirements to the producer. Part 3 specifies for the producer the procedures to be used in producing and transporting the concrete. Part 4 specifies the procedures to be used in sampling, testing and assessing concrete for conformity.

This standard provides methods for specifying concrete mixed on site or in a precast concrete factory and for the purchase and supply of ready-mixed concrete. It takes account of the distinct and different responsibilities of the purchaser and the producer. There are a number of instances in which the purchaser has to select from the various options given in this standard in order to specify the concrete required. The purchaser is responsible for passing on to the producer the requirements of the specifying body, e.g. the engineer's or architect's specification, together with any additional requirements. Throughout this standard the terms 'specify' and 'specification' are used in relation to both sets of requirements. There may be occasions where it is advantageous for economic or technical reasons to propose changes to the specification. In such cases the producer and purchaser should agree the proposed amendments for approval and sanction by the specifying body.

Precautions need to be taken when working with cement and fresh concrete and attention is drawn to these in BS 5328-3 and BS 5328-4.

This standard covers concrete produced by normal methods, but it does not apply to precast concrete products where the concrete is specified in other British Standards. Many of the requirements of this standard, e.g. the use of materials and the control of production, apply equally to precast concrete and to in situ concrete. However, some of the requirements concerning the responsibilities of the purchaser and the producer may not apply in the case of precast concrete. The specification of designated mixes is unlikely to be appropriate for factory produced precast concrete products.

It is necessary for the purchaser to take into account the requirements of specialized codes of practice and any influences of the construction process. Provisions are made in this standard for the inclusion of any special requirements.

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.

This Corrigendum is issued to correct the error on page 14 in AMD 10365, issued in May 1999, where “Minimum” in Item 8 of Form A should have been “Maximum”.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 25 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Sideline in this document indicates the most recent changes by amendment.

Section 1. General

Introduction

This Part of BS 5328 gives the methods to be used by the purchaser for specifying concrete. The standard is in five sections:

Section 1	General;
Section 2	Designed mixes;
Section 3	Prescribed mixes;
Section 4	Standard mixes;
Section 5	Designated mixes.

Section 5 gives a new method of specifying concrete, the designated mix. This method of specification is primarily aimed at in situ concrete applications and it is unlikely to be applicable to factory produced precast concrete products. The purchaser specifies a mix designation appropriate to the end use and this is an instruction to the producer to comply with the specification given in section 5. There is also a requirement that the producer holds current conformity certification based on product testing and surveillance coupled with approval of the producer's 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, as this is the prime means of controlling conformity.

The methods, involving use of relevant information from BS 5328:Part 1:1997, enable the purchaser to specify clearly to the producer the requisite properties of the concrete. Ordinary prescribed mixes are now described as standard mixes using the prefix ST to avoid confusion with the grade designation of designed mixes. Standard mixes of 14 mm maximum size aggregate have been omitted as they are rarely used.

Annex A contains forms which may be used to specify either designed, prescribed, standard or designated mixes. The use of these forms should ensure that the purchaser specifies all necessary requirements and that the producer is in possession of all the relevant technical data.

Methods of assessing conformity to specifications for concrete mixes drawn up in accordance with this Part of BS 5328 are given in BS 5328:Part 4:1990.

Purchasers ordering in accordance with this standard are advised to specify quality assurance requirements for materials or for concrete in their purchasing contracts to assure themselves that products specified in accordance with BS 5328 consistently achieve the required level of quality. Purchasers of ready-mixed concrete are advised to specify certification meeting the requirements of the United Kingdom Accreditation Service, National Accreditation of Certification Bodies, for product conformity. They are similarly advised to specify that, where they are available, constituent materials should be obtained from suppliers operating quality systems in accordance with BS EN ISO 9000.

1.1 Scope

This Part of BS 5328 gives methods for specifying concrete. It does not apply when the concrete is specified as being in accordance with another British Standard.

1.2 References

1.2.1 Normative references

This Part of BS 5328 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 23. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Part of BS 5328 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This Part of BS 5328 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this Part of BS 5328 the definitions given in BS 5328:Part 1 and BS 6100 apply.

1.4 Minimizing the risk of damaging alkali-silica reaction

1.4.1 General

Unless otherwise agreed with the purchaser, the producer shall minimize the risk of damaging alkali-silica reaction in accordance with one of the sets of requirements given in 1.4.2, 1.4.3, 1.4.4, 1.4.5, 1.4.6 and 1.4.7.

1.4.2 Low reactivity aggregate, option 1

No action is required if the following six conditions are satisfied:

- a) the aggregate type or aggregate combination is classed as low reactivity by BRE Digest 330[1];
- b) the cement or combination content is $\leq 550 \text{ kg/m}^3$ of concrete;
- c) the declared mean alkali content of the Portland cement or the Portland cement type component of other cements and combinations is $\leq 0.75 \text{ \% Na}_2\text{O eq}$;
- d) the alkali from constituents other than the cement or combination $\leq 0.60 \text{ kg Na}_2\text{O eq/m}^3$ of concrete;
- e) the guaranteed alkali limit of any ggbs is $\leq 1.0 \text{ \% Na}_2\text{O eq}$ and the guaranteed alkali limit of any pfa is $\leq 5.0 \text{ \% Na}_2\text{O eq}$;
- f) the concrete does not contain pfa other than that conforming to BS 3892-1.

NOTE See 3.8.1 of BS 5328-4:1990 for the calculation of equivalent alkali content.

1.4.3 Low reactivity aggregate, option 2

No action is required if the following six conditions are satisfied:

- a) the aggregate type or aggregate combination is classed as low reactivity by BRE Digest 330;
- b) the cement or combination content is $\leq 500 \text{ kg/m}^3$ of concrete;
- c) the declared mean alkali content of the Portland cement or the Portland cement type component of other cements and combinations that contain $\geq 40 \text{ \% ggbs}$ or $\geq 25 \text{ \% pfa}$ by mass of cement, is $>0.75 \text{ \%} \leq 1.00 \text{ \% Na}_2\text{O eq}$;
- d) the alkali from constituents other than the cement or combination is $\leq 0.20 \text{ kg Na}_2\text{O eq/m}^3$ of concrete;
- e) the guaranteed alkali limit of any ggbs is $\leq 1.0 \text{ \% Na}_2\text{O eq}$ and the guaranteed alkali limit of any pfa is $\leq 5.0 \text{ \% Na}_2\text{O eq}$;
- f) the concrete does not contain pfa other than that conforming to BS 3892-1.

1.4.4 Normal reactivity aggregate

No action is required provided the following four conditions are satisfied:

- a) the aggregate type is not classed as:
 - i) highly reactive, e.g. does not contain:
 - more than 10 % of crushed material as greywacke, greywacke-type sandstones, greywacke-type siltstones/mudstones or combinations of these materials;
 - recycled demolition waste;
 - ii) or extremely reactive, e.g. does not contain:
 - calcined flint;
 - aggregates containing opal;
 - glass (artificial or volcanic).
- b) the cement or combination of the concrete is not more than the value given in table 0A or 0B depending on the alkali contribution to the fresh concrete from constituents other than the cement or combination (linear interpolation between the tables is permitted for intermediate alkali contributions from other constituents);

- c) the guaranteed alkali limit of any ggbs is ≤ 1.0 % Na_2O eq and the guaranteed alkali limit of any pfa is ≤ 5.0 % Na_2O eq;
- d) the concrete does not contain pfa other than pfa conforming to BS 3892-1.

1.4.5 Service record option

No action is required if it is agreed between the producer and the purchaser or a third party certification body, that the service record of the particular cement/aggregate combinations is well established and does not include any instances of cracking due to alkali-silica reaction. For such cases, the combination of coarse and fine aggregate used shall have had a satisfactory performance record for at least the past 10 years when used 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.

1.4.6 Testing the source of crushed greywacke or crushed greywacke type aggregate

No action is required if the following six conditions apply:

- a) the aggregate type is a crushed greywacke, crushed greywacke-type sandstone/siltstone/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 *Testing protocol for greywacke aggregates* [2];
- c) where the test data obtained in accordance with the testing protocol in 1.4.6b) give ≤ 0.08 % expansion at 2 years at 3.5, 4.0, 4.5 or 5.0 kg/m^3 Na_2O eq, the alkali content of the concrete is ≤ 2.0 , ≤ 2.5 , ≤ 3.0 or ≤ 3.5 kg/m^3 Na_2O eq respectively based on a calculation using the declared mean alkali content of either the Portland cement or the Portland cement type component of other cements and combinations that contain ≥ 50 % ggbs or ≥ 35 % by mass of cement;
- d) the alkali from constituents other than the cement or combination is ≤ 0.20 $\text{kg Na}_2\text{O eq/m}^3$ of concrete;
- e) the guaranteed alkali limit of any ggbs is ≤ 1.0 % Na_2O eq and the guaranteed alkali limit of any pfa is ≤ 5.0 % Na_2O eq;
- f) the concrete does not contain pfa other than that conforming to BS 3892-1.

1.4.7 Other conditions

Where none of the sets of conditions given in 1.4.2, 1.4.3, 1.4.4, 1.4.5, and 1.4.6 are satisfied, the producer shall ensure that the concrete conforms to the guidance given in BRE Digest 330 or Concrete Society Report 30 [3]. Where constituent materials not covered by these documents e.g. silica fume, metakaolin or lithium compounds, are to be used, suitable provisions shall be agreed between the purchaser and producer.

Table 0A — Limiting values of cement or combination contents (kg/m^3) for not more than 0.20 $\text{kg Na}_2\text{O eq/m}^3$ of concrete from other constituents

Cement or combination	Guaranteed ≤ 0.60 % Na_2O eq	Declared mean alkali content of a cement ¹⁾ or the PC component of a combination, % ⁵⁾										
		0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
PC, SRPC or LASRPC	550	550	550	550	540	500	465	375	355	335	315	300
PC plus ≥ 40 % ggbs ²⁾³⁾⁴⁾	—	550	550	550	550	550	550	550	550	550	525	500
PC plus ≥ 25 % pfa ²⁾³⁾⁴⁾	—	550	550	550	550	550	550	500	470	445	420	400
NOTE In the case of designated mixes, see 5.5.4 for maximum limiting values for cement or combination content.												
¹⁾ Where a cement contains ggbs or pfa, classification is on the basis of the declared mean alkali content of its PC type component.												
²⁾ Proportions by mass of cement or combination as appropriate.												
³⁾ Where the proportion of ggbs is less than 40 % or the proportion of pfa is less than 25 %, the alkali contributions from these materials shall be calculated in accordance with BRE Digest 330.												
⁴⁾ For quantities of ggbs greater than 40 % and pfa greater than 25 %, calculations based on BRE Digest 330 may give higher values.												
⁵⁾ Linear interpolation is permitted for declared mean alkali contents in the range 0.50 to 0.75 and 0.76 to 1.00.												

Table 0B — Limiting values of cement or combination contents (kg/m³) for 0.60 kg Na₂O eq/m³ of concrete from other constituents

Cement or combination	Guaranteed ≤ 0.60 % Na ₂ O eq	Declared mean alkali content of a cement ¹⁾ or the PC component of a combination, % ⁵⁾										
		0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
PC, SRPC or LASRPC	550	550	525	485	445	415	385	300	280	265	255	240
PC plus ≥ 40 % ggbs ²⁾³⁾⁴⁾	—	550	550	550	550	550	550	500	470	445	420	400
PC plus ≥ 25 % pfa ²⁾³⁾⁴⁾	—	550	550	550	550	505	470	400	375	355	335	320

NOTE In the case of designated mixes, see 5.5.4 for maximum limiting values for cement or combination content.

¹⁾ Where a cement contains ggbs or pfa, classification is on the basis of the declared mean alkali content of its PC type component.

²⁾ Proportions by mass of cement or combination as appropriate.

³⁾ Where the proportion of ggbs is less than 40 % or the proportion of pfa is less than 25 %, the alkali contributions from these materials shall be calculated in accordance with BRE Digest 330.

⁴⁾ For quantities of ggbs greater than 40 % and pfa greater than 25 %, calculations based on BRE Digest 330 may give higher values.

⁵⁾ Linear interpolation is permitted for declared mean alkali contents in the range 0.50 to 0.75 and 0.76 to 1.00.