

Concrete —

Part 1: Guide to specifying concrete

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

This British Standard, having been prepared under the direction of the Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 15 March 1997

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Amendments issued since publication

Amd. No.	Date	Text affected
10364	May 1999	
13876	10 September 2002	Indicated by a sideline
14163 Corrigendum No. 1	17 October 2002	Correction to reference in Clause 10, Note 1

The following BSI references relate to the work on this standard:
 Committee reference B/517
 Draft for comment 95/107689 DC

ISBN 0 580 26722 9

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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 This Part, which includes designated mixes, is a new edition of BS 5328-1:1991, which is withdrawn, and, together with BS 5328-2, BS 5328-3 and BS 5328-4, forms a comprehensive standard for the specification of concrete to which codes of practice and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 8110-1:1985.

This edition introduces technical changes but does not reflect a full review or revision of the standard. This edition makes provision for the use of Portland limestone cement conforming to BS 7583 and incorporates amendments 7174 and 8758.

Amendment number 1 takes account of the recent consensus reached by experts on provisions to resist damaging ASR in the UK. These recommendations are published in the BRE Digest 330:1999. The technical content of this amendment has been derived from these recommendations.

Amendment number 2 takes account of the guidance given in BRE Special Digest 1 [1]. The changes introduced by this amendment are limited and should therefore be used in conjunction with the comprehensive guidance given in BRE Special Digest 1 [1]. Part 2 of the Special Digest describes the procedure to be used to determine the design chemical class for in-situ concrete construction and, where necessary, it details the number of additional protective measures that are needed. BRE Special Digest 1 [1] Part 4 gives design guides for special precast products. This Part of BS 5328 gives the recommendations for the concrete quality that is required for the design chemical class to resist the ACEC class.

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, *Cement — Composition specifications and conformity criteria for common cements*, see national annex NA to BS EN 197:2000 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 *Guide to specifying concrete;*
- Part 2 *Methods for specifying concrete mixes;*
- Part 3 *Specification for the procedures to be used in producing and transporting concrete;*
- Part 4 *Specification for the procedures to be used in sampling, testing and assessing compliance of concrete.*

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 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.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 27 and a back cover.

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

Introduction

This Part of BS 5328 gives advice on the selection of the quality of concrete suitable for many general purposes not covered by other British Standard specifications or codes of practice.

This Part of BS 5328 is primarily a guide for the specifier in choosing the appropriate materials and mix. It gives the range of constituent materials that can be used. It describes the properties of fresh and hardened concrete, with considerable emphasis on durability. Distinction is made between structural and non-structural concrete and between unreinforced, reinforced and prestressed concrete. Also included is guidance on sampling for strength conformity testing and action to be taken in the event of non-conformity.

Account is taken of standard specifications relating to ground granulated blastfurnace slag or pulverized-fuel ash used in composite cements or in equivalent combinations.

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 Certification Bodies, for product conformity.

Purchasers ordering designated mixes in accordance with BS 5328-2:1997 need not specify quality assurance requirements for concrete, as it is obligatory that the producer holds current product 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. Purchasers 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 Scope

This Part of BS 5328 gives guidance on the selection of materials for concrete and on the mixes to be specified to produce concrete having the required properties in the fresh and hardened state. It also gives guidance on sampling for strength conformity testing and action to be taken in the event of non-conformity.

2 References

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 26. 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.

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.

3 Definitions

For the purposes of this Part of BS 5328, the definitions given in BS 6100 apply, together with the following.

3.1

batch

quantity of concrete mixed in one cycle of operations of a batch mixer, or the quantity discharged during 1 min from a continuous mixer, or the quantity of concrete conveyed ready-mixed in a vehicle.

3.2

cement

hydraulic binder that sets and hardens by chemical interaction with water and is capable of doing so under water.

NOTE The cements covered by this standard are listed in Table 1.

3.3

cement content

mass of cement contained in a cubic metre of fresh, fully compacted concrete, expressed in kg/m^3 .

3.4

cement type

classification of a cement on its main constituents.

3.5

alkali content

3.5.1

certified average alkali content

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

3.5.2

declared mean alkali content

the mean alkali content, expressed as the sodium oxide equivalent, which will not be exceeded without prior notice from the manufacturer. This is the certified alkali content plus a margin that reflects the manufacturer's variability of production.

3.5.3

guaranteed alkali limit

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

3.6

characteristic strength

that value of strength below which 5 % of the population of all possible strength measurements of the specified concrete are expected to fall.

3.7

density of fresh concrete

mass of quantity of compacted fresh concrete divided by its volume, expressed in kg/m^3 .

NOTE For the method of determining the density of fresh concrete, see BS 1881-107. Compaction by the method described in BS 1881-107 is not appropriate for semi-dry concrete mixes. The method for determining the density of partially compacted semi-dry concrete is described in BS 1881-129.

3.8

lightweight concrete

hardened concrete having an oven-dried density not greater than 2000 kg/m^3 .

NOTE For the method of determining oven-dried density, see BS 1881-114.

3.9

normal-weight concrete

hardened concrete having an oven-dried density greater than 2000 kg/m^3 but not exceeding 2600 kg/m^3 .

NOTE For the method of determining oven-dried density, see BS 1881-114.

3.10

heavyweight concrete

hardened concrete having an oven-dried density greater than 2600 kg/m^3 .

NOTE For the method of determining oven-dried density, see BS 1881-114.

3.11**designed mix**

mix for which the purchaser is responsible for specifying the required performance and the producer is responsible for selecting the mix proportions to produce the specified performance.

3.12**prescribed mix**

mix for which the purchaser specifies the proportions of the constituents and is responsible for ensuring that these proportions produce a concrete with the required performance.

3.13**standard mix**

mix selected from the restricted list given in Section 4 of BS 5328-2:1997 and made with a restricted range of materials.

3.14**designated mix**

mix produced in accordance with the specification given in Section 5 of BS 5328-2:1997 and requiring the producer to hold current product conformity certification based on product testing and surveillance coupled with approval of the producer's quality system to BS EN ISO 9001.

3.15**free water/cement ratio**

ratio of the mass of free water (that is, excluding the water absorbed by the aggregate to reach a saturated surface dry condition) to the mass of cement in a concrete mix.

3.16**grade (of concrete)**

numerical value of 28 day characteristic strength, expressed in N/mm^2 , preceded by the letter C (compressive) or F (flexural) to denote the type.

3.17**equivalent grade**

grade of concrete selected to provide reasonable assurance of conformity to parameters such as minimum cement content or maximum free water/cement ratio.

NOTE See 8.5.

3.18**laitance**

thin layer comprising water, cement and fine particles of aggregate that may form on the surface of concrete.

3.19**producer**

person or authority entering a contract to supply concrete.

NOTE For example, a producer of ready-mixed or precast concrete supplying a contractor or a contractor supplying a client.

3.20**purchaser**

person or authority entering a contract to buy concrete.

NOTE For example, a client purchasing from a contractor or a contractor purchasing from a subcontractor or material supplier.

3.21**ready-mixed concrete**

concrete mixed in a stationary mixer or in a truck-mixer and supplied in the fresh condition to the purchaser, either at the site or into the purchaser's vehicles.

3.22

standard strength class (of cement)

classification of a cement based on its compressive strength at 28 days measured on mortar prisms in accordance with BS EN 196-1.

NOTE 1 There are five standard classes, 22.5, 32.5, 42.5, 52.5 and 62.5. British Standard specifications for cements incorporate one or more of these classes. There are in addition two intermediate standard strength classes, 37.5 and 47.5, for mixer combinations of Portland cement (PC) conforming to BS 12 with ground granulated blastfurnace slag (ggbfs) conforming to BS 6699.

NOTE 2 The standard strength classes for some cements are subdivided according to their early strength development. The letters L (low), N (normal) and R (rapid) are added to the standard strength class to indicate the early strength. Specifications for cement indicate which, if any, of these subclasses are available.

3.23

time of loading

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

3.24

aggressive chemical environment for concrete (ACEC)

classification used to describe the aggressiveness of the ground conditions that takes account of the design sulfate class, the type of ground (natural or brownfield) and the mobility and pH of the groundwater.

3.25

design chemical class (DC-class)

designation used to describe a concrete quality capable of resisting the selected aggressive chemical environment for concrete (ACEC), provided any specified additional protective measures (APMs) are correctly applied to the structure.

3.26

design sulfate class

classification for sites based on the sulfate content of the soil and/or groundwater, taking into account the presence or absence of minerals that may oxidize to sulfates (e.g. pyrite), magnesium ions and, for brownfield sites with pH <5.5, chloride and nitrate ions.

3.27

additional protective measure

measure taken in addition to concrete quality in order for the structure to resist the ACEC class.

3.28

structural performance level

classification of a structure based on the intended working life and the consequence of failure.

Table 1 — Cements

Type	Standard
Portland cements:	
Portland (PC)	BS 12
Low heat (LHPC)	BS 1370
Sulfate-resisting (SRPC)	BS 4027
Low alkali sulfate-resisting (LASRPC)	BS 4027
Cements containing:	
ground granulated blastfurnace slag (ggbs), pulverized-fuel ash (pfa) or limestone:	
Portland blastfurnace (PBFC)	BS 146
High slag blastfurnace	BS 4246
Portland pulverized-fuel ash (PPFAC)	BS 6588
Pozzolanic pulverized-fuel ash	BS 6610
Portland limestone (PLC) ^{ab}	BS 7583
Combinations manufactured in the concrete mixer from Portland cement and ggbs or pfa:	Combination of which the proportions and properties conform to clauses 6 to 9 ^{cd} of:
PC conforming to BS 12 with ggbs conforming to BS 6699	BS 146:1996 ^e (except 6.3)
	BS 4246:1996 ^e (except 6.2)
PC conforming to BS 12 with pfa conforming to BS 3892:Part 1	BS 6588:1996 (except 6.3)
	BS 6610:1996 (except 6.2)
Other cements:	
High alumina cement (HAC) ^{fg}	BS 915
Supersulfated cement (SSC) ^f	BS 4248
Modified Portland cements, e.g. coloured, ultra-high early strength, water-repellent, hydrophobic	Conforming to the physical properties for Portland cement in BS 12
^a Portland limestone cement should not be used in concrete containing embedded metal exposed to a chloride-bearing environment, e.g. most severe and chloride-bearing very severe environments. ^b Portland limestone cement should not be used in concrete exposed to conditions of freezing and thawing, unless the concrete is air-entrained in accordance with 5.3.3 ^c The combination should be subject to procedures to demonstrate conformity. ^d For the purposes of demonstrating equivalence, conformity to strength classes 37.5 or 47.5 of BS 6699 is deemed to be conformity to strength classes 32.5 or 42.5 of BS 146 respectively. ^e As an alternative to conforming to the strength requirements in Clause 7 of these standards, the combinations may conform to the standard strength classes in Table 7 of BS 6699. ^f High alumina cement conforming to BS 915 or supersulfated cement conforming to BS 4248 should not be mixed with any other type of cement in the production of concrete. ^g High alumina cement should be used with caution (see 4.2.4). The hydrated cement undergoes chemical changes, including a process known as conversion, which lead to loss of concrete strength and reduced resistance to aggressive chemicals. The precise way in which conversion occurs and the effects on concrete properties depend on the initial free water/cement ratio, the temperature and/or humidity of the concrete during curing and throughout its subsequent life. Guidance on the correct use of high alumina cement should be sought from the manufacturers and current specialized publications.	
NOTE 1 Not all cements may be readily available. For example, supersulfated cement has not been produced in Britain since 1969, and specifiers should check for availability. NOTE 2 The abbreviations OPC and RHPC are no longer used. The corresponding cements are PC 42.5 and PC 52.5 respectively. The abbreviation PC is now adopted for all cements conforming to BS 12.	