BRITISH STANDARD

BS 146:2002

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

ICS 91.100.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/516, Cement and lime, upon which the following bodies were represented:

British Cement Association

British Precast Concrete Federation Ltd.

Cement Admixtures Association

Cementitious Slag Makers Association

County Surveyors Society

Department of the Environment, Transport and the Regions — Building Research Establishment

Department of the Environment, Transport and the Regions — Highways Agency

Environment Agency

Mortar Industry Association

Quarry Products Association

Society of Chemical Industry

UK Quality Ash Association

The following body was also represented in the drafting of the standard, through Subcommittee B/516/6, Cement specifications:

Electricity Association

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Contents

Foreword

This British Standard has been prepared by Technical Subcommittee B/516/6. It supersedes BS 146:1996 and BS 4246:1996, which are withdrawn.

This revision of BS 146:1996 has been published as a consequence of the publication of BS EN 197-1, which implements in the UK the harmonised European Standard EN 197-1, *Cement — Part 1: Composition, specifications and conformity criteria for common cements*. BS EN 197-1 covers many of the common cements used in the UK and, following a transition period lasting until April 2002, conflicting British Standards will be withdrawn. However, BS EN 197-1 does not include in its scope the low early strength classes of Portland blastfurnace cements specified in the previous edition of this standard or the high slag blastfurnace cement previously specified in BS 4246.

This standard covers those blastfurnace slag cements that conformed either to the previous edition of this standard or to BS 4246 but remain outside the scope of BS EN 197-1.

The requirements in this standard for composition and for physical and chemical properties are within the ranges permitted by BS EN 197-1. The requirements for early strength differ. As a consequence, for a given standard strength class, cements conforming to this standard will have a lower early strength but a greater gain of strength between early age and 28 days when compared to similar cements conforming to BS EN 197-1.

Product certification. Users of this British Standard are advised to consider the desirability of third-party certification testing of product conformity with this British Standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 7 and a back cover.

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1 Scope

This British Standard specifies requirements for two types of blastfurnace cement, BIIIA and BIIIB, which are outside the scope of BS EN 197-1:2000. The requirements for the composition, strength and physical and chemical properties are specified as characteristic values. Requirements for manufacture, marking and provision of information are also specified.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. 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 EN 196-1*, Methods of testing cement — Part 1: Determination of strength.*

BS EN 196-2:1995*, Methods of testing cement — Part 2: Chemical analysis of cement.*

BS EN 196-3*, Methods of testing cement — Part 3: Determination of setting time and soundness.*

BS EN 196-21:1992*, Methods of testing cement — Part 21: Determination of the chloride, carbon dioxide and alkali content of cement.*

BS EN 197-1:2000*, Cement — Part 1: Composition, specifications and conformity criteria for common cements.*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS EN 197-1:2000 and the following apply.

3.1
standard strength
compressive strength of a blastfurnace cement at 28 days

3.2
early strength
compressive strength of a blastfurnace cement at either 2 or 7 days

4 Cement

Blastfurnace cements shall conform to the general requirements of BS EN 197-1:2000, clause **4**.

5 Constituents

The constituents of the blastfurnace cements shall be as defined in BS EN 197-1:2000, clause **5**.

6 Composition, notation and manufacture

6.1 Composition

The compositions of the blastfurnace cements shall be in accordance with Table 1, where the requirements for composition shall refer to the sum of all main and minor constituents.

NOTE The final cement composition would comprise the main and minor additional constituents plus calcium sulfate as necessary and any additives (see clause **5**).

Table 1 — Composition

	BIIIA % (*m*/*m*)	**BIIIB** % (*m*/*m*)
Portland cement clinker	35 to 64	20 to 34
Granulated blastfurnace slag	36 to 65	66 to 80
Minor additional constituents	0 to 5	0 to 5

6.2 Notation and strength class

Blastfurnace cements shall be identified by at least the notation, i.e. BIIIA or BIIIB, followed by a figure indicating the standard strength class and a letter indicating the subclass of early strength (see note to Table 2).

6.3 Manufacture

The materials shall be thoroughly and intimately mixed together in a dry state to form a uniform mixture.

7 Compressive strength

When determined in accordance with BS EN 196-1, the compressive strength shall conform to Table 2.

Table 2 — Compressive strength

Strength class	Early strength		Standard strength	
	2 days MPa	7 days MPa	28 days MPa	
32.5L	—	≥ 12.0	≥ 32.5	≤ 52.5
42.5L	—	≥ 20.0	≥ 42.5	≤ 62.5
52.5L	≥ 10.0	—	≥ 52.5	—

NOTE Although this standard and BS EN 197-1:2000 cover the same three classes of standard strength: class 32.5, class 42.5 and class 52.5, they differ in their classes of early strength. BS EN 197-1:2000 covers two classes of early strength: "high" indicated by "R" and "ordinary" indicated by "N". This standard covers a class of early strength outside the scope of BS EN 197-1:2000, "lower" indicated by "L".

8 Physical properties

8.1 Initial setting time

The initial setting time shall be not less than 60 min when tested in accordance with BS EN 196-3.

8.2 Soundness

The expansion shall be not more than 10 mm when tested in accordance with BS EN 196-3.

9 Chemical properties

The chemical properties shall conform to Table 3 when tested in accordance with the relevant tests specified in Table 3.

Table 3 — Chemical properties

Property	Test reference	Requirement[a]
Loss on ignition	BS EN 196-2:1995, clause **7**	≤ 5.0 %
Insoluble residue	BS EN 196-2:1995, clause **9**	≤ 5.0 %
Sulfate (expressed as SO_3)	BS EN 196-2:1995, clause **8**	≤ 4.0 %
Chloride	BS EN 196-21:1992, clause **4**	≤ 0.1 %

[a] Requirements are given as percentages by mass of the final cement.

10 Conformity criteria

Conformity of the blastfurnace cements shall be continually evaluated on the basis of the testing of spot samples and shall be in accordance with BS EN 197-1:2000, clause **9**, and in particular, the requirements for CEM III cements, except that the limit values for single results shall be those in Table 4 of this standard, rather than those in Table 8 of BS EN 197-1:2000.

Table 4 — Limit values

Property		Strength class		
		32.5 L	42.5 L	52.2 L
Early strength (MPa) lower limit value	2 days	—	—	8.0
	7 days	10.0	18.0	—
Standard strength (MPa) lower limit value	28 days	30.0	40.0	50.0
Initial setting time (min) lower limit value		50		
Soundness (mm) upper limit value		10		
Sulfate content (as % SO_3 by mass) upper limit value		4.5		
Chloride content (% by mass) upper limit value		0.10		
Loss on ignition (% by mass) upper limit value		5.1		
Insoluble residue (% by mass) upper limit value		5.1		

NOTE Sampling and testing for acceptance inspection at delivery should be in accordance with BS EN 197-1:2000, Annex NC, except that the limiting values applicable to acceptance inspection should be those in Table 4 of this standard.

11 Marking

Blastfurnace cements shall be marked on the bag or the delivery note, and on any test report, with the following particulars:

a) the name, trade mark or other means of identification of the manufacturer to facilitate traceability to the factory in which the cement was manufactured;

b) the name, notation and strength class of the material, e.g. blastfurnace cement BIIIB, class 42.5 L;

c) the number and date of this British Standard, i.e. BS 146:2002[1)];

d) the standard notation of any admixture, where applicable.

[1)] Marking BS 146:2002 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 that standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification.

12 Information to be provided

If a test report is requested from the manufacturer, it shall include:

a) the method of manufacture, i.e. intergrinding or dry blending;

b) the proportion of blastfurnace slag as a target mean, reported to the nearest 1 % by mass;

c) the results of the following tests, relating to the material delivered:

1) compressive strength at either 2 days or 7 days as appropriate, and at 28 days (see clause **7**);

2) initial setting time (see **8.1**);

3) soundness (see **8.2**);

4) chloride content (see clause **9**).

NOTE 1 If requested at the time of ordering, additional information should be made available in accordance with BS EN 197-1:2000, NB4, and in particular, the recommendations for CEM III cements.

NOTE 2 Guidance on the use of cement can be found in Annex A.

Annex A (informative)
Product guidance

A.1 General

Guidance on the use of cements in concrete can be found in BS 5328-1:1997 and in BS 8000-2:1990.

NOTE As a consequence of the publication of BS EN 206-1:2000 and the complementary standards BS 8500-1:2002 and BS 8500-2:2002, which give national provisions where they are permitted, BS 5328-1:1997 will be withdrawn in December 2003.

Guidance on the use of cements in mortar can be found in BS 5262:1991, BS 5628-3:2001 and BS 8000-3:2001.

A.2 Safety warning

A.2.1 *Manual handling of bags*

Manual handling activities are subject to the Manual Handling Operations Regulations 1992 [1]. Where manual handling operations cannot be avoided, the Regulations require that the risks be assessed and reduced so far as is reasonably practicable. The Health and Safety Executive (HSE) has issued guidance on how to assess and reduce risk [2] and specifically encourages the use of 25 kg bags of cement whilst discouraging the use of 50 kg bags, in order to reduce the risk of injury [3].

A.2.2 *Safety in use*

A.2.2.1 *Regulations*

Work with cement is subject to the Control of Substances Hazardous to Health Regulations (COSHH) 1999 [4]. Portland cement has been classified as an irritant under the Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP) 1994 [5].

These regulations require that:

a) the health risks of the cement in use are assessed and then prevented or controlled;

b) product health and safety information sheets are made available by the manufacturer/supplier;

c) bags containing material of which Portland cement is a component are labelled with a health and safety warning indicating that it is an irritant.

A.2.2.2 *Hazards*

When cement is mixed with water, e.g. when making concrete or mortar, or when cement becomes damp, a concentrated alkaline solution is produced. If this comes into contact with the eyes or skin it may cause serious burns and ulceration. The eyes are particularly vulnerable and the extent of injury will increase with contact time.

Concentrated alkaline solutions in contact with skin tend to damage the nerve endings before damaging the skin. Chemical burns can therefore develop without pain being felt at the time.

Cementitious grouts, cement-mortar and concrete mixes may, until they have set, cause both irritant and allergic contact dermatitis.

Irritant contact dermatitis results from a combination of the moisture content of the grout, mortar or mix, and the alkalinity and abrasiveness of the construction materials. Allergic contact dermatitis results mainly as a consequence of the sensitivity of an individual's skin to hexavalent chromium salts in solution.

Repeated exposure to high levels of airborne cement in excess of the Occupational Exposure Standard (OES) [6] have been linked with rhinitis and coughing.

A.2.2.3 *First-aid measures*

The following first-aid procedures are recommended.

a) In the event of eye contact, wash eyes immediately with copious amounts of clean water for a period of at least 15 minutes and seek medical advice without delay.

b) In the event of skin contact, wash the affected area thoroughly with soap and water before continuing the activity. If irritation, pain or skin trouble occurs, seek medical advice.

c) In the event of ingestion, do not induce vomiting but wash out the mouth with water and give plenty of water to drink. If pain occurs, seek medical advice.

A.2.2.4 *Use of personal protective equipment (PPE)*

Where the risk of cement becoming airborne can neither be prevented nor completely controlled, appropriate respiratory protective equipment should be worn to ensure that exposure is less than the regulatory limit [6]. Dust-proof goggles should be worn to protect the eyes.

Where the risks from contact with wet cement or wet cement-containing construction materials can neither be prevented nor completely controlled, protective equipment should be worn as follows.

a) Protective clothing should be worn in order that cement, or any cement/water mixture, e.g. concrete or mortar, does not come into contact with the skin. In some circumstances, such as when laying concrete, waterproof trousers and wellington boots may be necessary. Particular care should be taken to ensure that wet concrete does not enter the boots and that individuals do not kneel on wet concrete. Should wet concrete (mortar or grout) enter boots, gloves or other protective clothing, then the item(s) of clothing should be removed immediately and the skin thoroughly washed with soap and water. Items of clothing should be washed before re-use.

b) Wherever there is a risk of cement, or any wet cement mixture entering the eye, dust-proof goggles should be worn.

A.3 Storage

To protect cement from premature hydration after delivery, bulk silos should be waterproof and internal condensation should be minimized.

Where cement is supplied in paper bags these should be stored clear of the ground, not more than eight bags high and protected by a waterproof structure. Since significant strength losses begin after 4 weeks to 6 weeks of storage in paper bags under normal atmospheric conditions, and considerably sooner under adverse weather conditions or high humidity, deliveries should be controlled and used in order of receipt. If requested, manufacturers can provide a system of marking a high proportion of the bags in each delivery to indicate when they were filled.

A.4 Test temperature

BS EN 196-1 and BS EN 196-3 require that the strength and setting time tests are carried out at a temperature of (20 ± 1) °C. When cement is tested at a different temperature the results are likely to be affected. In these circumstances, advice might be obtained from the manufacturer.

A.5 Grouting and rendering

Where cement is to be used in grouts or renders that are pumped through small apertures, such as spray nozzles, it is recommended that the cement or suspension is passed through a screen of suitable mesh aperture to retain any occasional coarse particles.

A.6 Heat generation

The cement hydration process generates heat, particularly in the first few days. Cements with a higher early strength usually have a higher initial rate of heat generation than those with a low early strength. A higher initial rate of heat generation may be an advantage for thinner concrete sections in cold weather because this reduces the need for extended striking times and the tendency for early-age frost damage. Conversely, it may be a disadvantage for larger concrete sections in either hot or cold weather because of the temperature gradients that are set up.

A.7 Alkali–silica reaction

Blastfurnace cements may be beneficial in minimizing the risk of damage to concrete caused by the alkali–silica reaction.

A.8 Sulfate attack (including the thaumasite form)

Blastfurnace cements BIIIB can confer concrete with sulfate-resisting properties, particularly against the thaumasite form of sulfate attack.

Bibliography

Standards publications

BS 5262:1991, *Code of practice for external renderings*.

BS 5328-1:1997, *Concrete — Part 1: Guide to specifying concrete*.

BS 5628-3:2001, *Code of practice for the use of masonry — Part 3: Materials and components, design and workmanship*.

BS 8000-2:1990, *Workmanship on building sites — Part 2: Code of practice for concrete work*.

BS 8000-3:2001, *Workmanship on building sites — Part 3: Code of practice for masonry*.

BS 8500-1:2002, *Concrete — Complementary British Standard to BS EN 206-1 — Part 1: Method of specifying and guidance for the specifier*.

BS 8500-2:2002, *Concrete — Complementary British Standard to BS EN 206-1 — Part 2: Specification for constituent materials and concrete*.

BS EN 206-1:2000, *Concrete — Part 1: Specification, performance, production and conformity*.

Other documents

[1] GREAT BRITAIN. Manual Handling Operations Regulations 1992. SI 2793. London: The Stationery Office.

[2] HEALTH AND SAFETY EXECUTIVE. *Manual handling (Manual Handling Operations Regulations 1992): Guidance on regulations*. Legislation Series No. 23. Sudbury: HSE Books, 1998.

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