

Specification for

Ground granulated blastfurnace slag for use with Portland cement

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Technical Sector Board for Building and Civil Engineering (B/-) to Technical Committee CAB/1, upon which the following bodies were represented:

- Association of Consulting Engineers
- Association of Quality Pulverised Fuel Ash Suppliers
- Brick Development Association
- British Aggregate Construction Materials Industries
- British Cement Association
- British Precast Concrete Federation
- British Ready Mixed Concrete Association
- British Steel Industry
- Cementitious Slag Makers Association
- Concrete Society
- County Surveyors' Society
- Department of the Environment (Building Research Establishment)
- Department of the Environment (Property Services Agency)
- Department of Transport
- Electricity Industry in United Kingdom
- Federation of Civil Engineering Contractors
- Institute of Concrete Technology
- Institution of Civil Engineers
- Institution of Structural Engineers
- Mortar Producers Association
- Royal Institution of Chartered Surveyors
- Society of Chemical Industry
- Water Services Association of England and Wales

This British Standard, having been prepared under the direction of the Technical Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 1 April 1992

© BSI 01-1999

First published September 1986
Second edition April 1992

The following BSI references relate to the work on this standard:
Committee reference CAB/1
Draft for comment 90/15655 DC

ISBN 0 580 20456 1

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Definitions	1
3 Composition and manufacture	1
4 Fineness	1
5 Glass content	1
6 Compressive strength	1
7 Initial setting time	1
8 Soundness	1
9 Chemical composition	2
10 Moisture content	2
11 Marking	2
12 Information to be provided	2
13 Sampling and testing for acceptance inspection at delivery	3
14 Conformity criteria (manufacturer's autocontrol)	3
Appendix A Conformity criteria (manufacturer's autocontrol)	4
Appendix B Product guidance	6
Appendix C Equivalence of within-mixer combinations to Portland blastfurnace cements	8
Appendix D Method of determining the glass content of ggbs by X-ray diffraction	11
Appendix E Method of determining the moisture content of ggbs	13
Figure 1 — Determination of conformity limits for combinations	11
Figure 2 — Schematic representation of a portion of an X-ray diffraction pattern of a ggbs	13
Table 1 — Acceptance inspection limits	3
Table 2 — Minimum testing frequencies	4
Table 3 — Parameters determining the conformity procedure	5
Table 4 — Major defects	6
Table 5 — Acceptability constant k_A	6
Table 6 — Acceptable number of defects c_A	6
Table 7 — Compressive strength classes for combinations	10
Publication(s) referred to	Inside back cover

Foreword

This British Standard is published under the authority of the Technical Sector Board for Building and Civil Engineering and supersedes BS 6699:1986 which is withdrawn. This revision takes account of the June 1989 draft European Prestandard specification for cements, ENV 197. Whilst the draft European Prestandard does not include ground granulated blastfurnace slag as a separate material, it does introduce the principle of conformity criteria by continuous inspection during manufacture for cements. This principle has been included in this revision in order that manufacturers may be provided with a similar system for the purpose of demonstrating compliance. Also the test methods in EN 196 have been adopted.

Blastfurnace slag is the by-product produced simultaneously with iron in the blastfurnace and is composed chiefly of calcium and magnesium silicates and aluminosilicates. It is granulated by rapid quenching of the molten material. The resulting granules, which are mainly glassy in composition, are subsequently dried and ground to a fine powder.

Ground granulated blastfurnace slag (ggbS) has been used in composite cements and as a cementitious component of concrete for many years. This standard specifies ggbS for use in combination with Portland cement in concrete, mortar and grout.

Guidance on its use in concretes, either as a component of composite cements such as Portland blastfurnace cements conforming to BS 146 and BS 4246¹⁾ or as a direct addition to the concrete mix, can be found in BS 5328, BS 6543 and BS 8110-1. Guidance on its use in mortar as a component of composite cements, such as those conforming to BS 146 and BS 4246¹⁾ or as a direct addition to the mortar mix, can be found in BS 5262 and BS 5628. Information that may be supplied to aid the control of such uses is given in appendix C of this standard.

This revision introduces the following changes.

- a) Additives to improve the manufacture or the properties of the ggbS are permitted up to a level of 1 % (*m/m*).
- b) A limit for chloride content has been introduced and the chloride content has now to be declared on the certificate.
- c) Additional information on chemical composition is now available if requested at the time of ordering.
- d) The methods of sampling and testing are now in accordance with EN 196.
- e) The requirements are specified as characteristic values and conformity is assessed by means of a statistical procedure for continuous inspection, operated by the ggbS manufacturer (autocontrol). This includes the concept of major defects which are “likely to reduce materially the usability of the ggbS for its intended purpose”. In addition, limits are given for inspection testing to provide a means of assessing compliance at delivery.
- f) The 3-day requirement for compressive strength has been replaced by a 7-day requirement since this relates more closely to the early performance of the ggbS.
- g) The change in test method for compressive strength, from using concrete cubes in accordance with BS 4550 to using mortar prisms in accordance with EN 196-1²⁾, has necessitated a change in the numerical limit for 28-day strength to maintain the same performance. The new limit has been set at a level which corresponds to that in BS 4246 and is effectively a 10 % higher requirement than in BS 6699:1986.

¹⁾ Also ENV 197 when published.

²⁾ The Parts of EN 196 will be published as Parts of BS EN 196.

h) The requirements for compressive strength are based on combination with a Portland cement, class 42.5 conforming to BS 12 and with a restricted alkali content. There is now a requirement for the 7-day and 28-day strengths of this Portland cement to be included in the certificate.

i) The requirement for initial setting time is now related to the setting time of the Portland cement with which the ggbs is tested. A requirement is not given for final setting time.

j) A maximum limit of 2.5 % (m/m) has been specified for sulfur present as sulfate.

k) The definition of the chemical modulus has been changed from

$$\frac{(\text{CaO}) + (\text{MgO}) + (\text{Al}_2\text{O}_3)}{(\text{SiO}_2)} \text{ to } \frac{(\text{CaO}) + (\text{MgO})}{(\text{SiO}_2)} \text{ in order to align with ENV 197.}$$

The minimum permitted value is unchanged so that this is a more stringent requirement than in BS 6699:1986.

l) The microscope counting method for determination of glass content has been deleted.

m) Additional guidance on use, safety requirements and storage has been included in appendices B and C.

Product certification. Users of this British Standard are advised to consider the desirability of third party certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate Part of BS 5750.

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

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.

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 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies requirements for the composition and the manufacture, and for the chemical and physical properties as characteristic values, of ground granulated blastfurnace slag (ggbfs) for use in combination with Portland cement as a cementitious component of concrete, mortar and grout. Requirements for marking, provision of information, and sampling and testing for acceptance at delivery are also specified. It specifies the procedures for the manufacturer's autocontrol system to ensure conformity with the standard.

NOTE 1 Granulated blastfurnace slag may be taken to include pelletized blastfurnace slag.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard, the definitions given in BS 6100-6.1 apply, together with the following.

2.1

characteristic value

that value of a property corresponding to an acceptable percentage of defects, generally 10 %, but 5 % for the lower strength limits

2.2

lot

quantity of ggbfs produced under conditions presumed uniform. After specified tests, this quantity is regarded as a whole "conforming" or "not conforming" to the requirements

2.3

spot sample

sample taken at one time and from one and the same place relating to the intended tests. It can be obtained by combining one or more immediately consecutive increments

3 Composition and manufacture

The ggbfs shall be obtained by quenching molten iron blastfurnace slag, e.g. in water or steam, to produce a glassy granular product which is then dried and ground to a fine powder. The ggbfs shall contain no added materials except up to 1 % (*m/m*) of additives, e.g. grinding aids to improve the manufacture or the properties of the ggbfs. Such additives shall not promote corrosion of reinforcement or impair the properties of the ggbfs or of concrete, mortar or grout made using the ggbfs. Metallic iron from the grinding process shall not be regarded as an additive.

4 Fineness

The specific surface, determined in accordance with clause 4 of EN 196-6:1989, shall be not less than 275 m²/kg.

5 Glass content

The glass content, determined in accordance with appendix D, shall be not less than 67 % (*m/m*).

6 Compressive strength

A combination of 30 % (*m/m*) of Portland cement, class 42.5 conforming to BS 12 and having an alkali content, when determined in accordance with EN 196-21, of not less than 0.5 % (*m/m*) and not greater than 0.9 % (*m/m*) and 70 % (*m/m*) of the ggbfs when intimately mixed together and determined in accordance with EN 196-1³⁾, shall have compressive strengths, expressed as the mean of three results, as follows:

- a) at 7 days: not less than 12 N/mm²;
- b) at 28 days: not less than 32.5 N/mm².

7 Initial setting time

The initial setting time of the combination of ggbfs and Portland cement specified in clause 6, determined in accordance with EN 196-3, shall be not less than the setting time of the Portland cement when tested on its own.

8 Soundness

The expansion of the combination of ggbfs and Portland cement specified in clause 6, determined in accordance with EN 196-3, shall be not more than 10 mm.

³⁾ EN 196-1 describes strength tests on mortar prisms but for 2 years from the date of publication of BS 6699, the strength values may be derived from tests on concrete cubes in accordance with BS 4550-3.4. BS 4550-3.4 will be superseded by BS EN 196-1.