BRITISH STANDARD

BS 1370:1979

Incorporating Amendment No. 1

Specification for

Low heat Portland cement

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Cooperating organizations

The Cement, Gypsum, Aggregates and Quarry Products Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Association of Consulting Engineers*
Autoclaved Aerated Concrete Products Association
British Precast Concrete Federation Limited*
British Quarrying and Slag Federation*
British Railways Board
British Ready Mixed Concrete Association*
British Steel Industry
Cement Admixtures Association
Cement and Concrete Association*
Cement Makers' Federation*
Chemical Industries Association
Concrete Society Limited*
Department of the Environment (Building Research Establishment)*
Department of the Environment (Housing and Construction)
Department of the Environment (PSA)*
Department of the Environment (Transport and Road Research Laboratory)*
Department of Transport
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Federation of Stone Industries
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Gypsum Products Development Association
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Sand and Ballast Hauliers and Allied Trades Alliance
Sand and Gravel Association Limited
Society of Chemical Industry*

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

Brick Development Association
British Steel Corporation
Electricity Supply Industry in England and Wales

This British Standard, having been prepared under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Committee, was published under the authority of the Executive Board and comes into effect on
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First revision March 1958
Second revision, as Part 2, June 1974
Third revision, as BS 1370, July 1979

The following BSI references relate to the work on this standard:
Committee reference CAB/1
Draft for comment 77/14421 DC

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Amendments issued since publication

Amd. No.	Date	Comments
4416	March 1984	Indicated by a sideline in the margin

Contents

Foreword

This British Standard has been revised under the direction of the Cement, Gypsum, Aggregates and Quarry Products Standards Committee, in order to bring it into line with present practice followed in the production and testing of cement. The previous edition, published in 1974 as BS 1370-2 which is now withdrawn, was a metric version of the amended 1958 edition.

This standard covers low heat Portland cement which is intended for use in structures where large masses of concrete have to be placed. The types of concrete work for which the cement is specially suited include concrete dams and many other types of water-retaining structures, bridge abutments, massive retaining walls, piers, slabs, etc. In large masses of concrete there is often a considerable rise in temperature resulting from the heat evolved as the cement sets and hardens and from the slow rate at which it is dissipated from the surface. The contraction which occurs on subsequent cooling sets up tensile stresses in the concrete which may result in cracking. The use of a cement of the type covered by this standard is advantageous since it evolves heat more slowly than ordinary or rapid-hardening Portland cement. The rate of strength development of low heat Portland cement is lower than that of ordinary Portland cement, but the ultimate strength is comparable.

The detailed test methods previously described in the appendices to cement standards have been revised and are now included in BS 4550-2 and BS 4550-3 so that this standard gives only the specification requirements with cross references to the appropriate clauses of BS 4550. The methods of sampling cement for test are now specified in BS 4550-1. It should be noted in particular that various details of the concrete cube strength test, introduced in 1958, have been made more stringent in order to produce more consistent results.

Specified minima for compressive strength are now only given at ages of 3 days and 28 days. The 28-day strength requirement is considered to provide a better indication of cement quality than the 7-day strength. Most of the specified minima for compressive strength represent substantial increases over the values in the previous edition.

The specified minimum fineness, expressed as specific surface, has been revised to permit a reduction in early heat of hydration of cements complying with this standard.

The clause dealing with the composition and manufacture of the cement has been brought into line with the definition now given in BS 4627.

Propylene glycol may be added to the cement clinker before grinding to reduce the energy required. It is driven off by the heat generated during grinding and only traces remain. A method for determining the amount of any propylene glycol in the ground cement has been included in BS 4550-2.

The requirements for lime have been expressed in terms of the lime saturation factor, in line with BS 12. The specified limiting values correspond to those given for lime in the 1974 edition of BS 1370 and are more restrictive than those for ordinary Portland cement and rapid-hardening Portland cement in BS 12.

The limits for total sulphur, expressed as SO_3, are related to a revised threshold level of tri-calcium aluminate.

The clause in the 1974 edition of this standard, referring to the consistence of standard cement paste, has been incorporated into the clause on setting time.

The clause on delivery in the 1974 edition has been omitted as being a contractual arrangement but a requirement for marking has been introduced.

If necessary cement manufacturers may be consulted informally about the provision of information additional to that required by this 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.

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 4, 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.

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1 Scope

This British Standard specifies requirements for the composition, the manufacture, and the chemical and physical properties of low heat Portland cement.

2 References

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

3 Composition and manufacture of low heat Portland cement

The cement shall be obtained by pulverizing clinker, consisting mostly of calcium silicates, obtained by heating to partial fusion a predetermined and homogeneous mixture of materials containing principally lime (CaO) and silica (SiO_2) with a smaller proportion of alumina (Al_2O_3) and iron oxide (Fe_2O_3). (See item no. 301 of BS 4627:1970.)

The cement shall contain no additions except as provided for below.

a) Water or gypsum or anhydrite, or other derivatives of calcium sulphate, or any combination of these substances, the amount of addition to be such that the limits shown for sulphuric anhydride and loss on ignition shall not be exceeded.

b) Propylene glycol in a proportion by mass that shall not exceed 0.10 %, as determined by the method described in clause **18** of BS 4550-2:1970.

Metallic iron from the grinding process shall not be regarded as an addition.

4 Tests

The sample or samples, taken as described in clause **13**, shall be tested in the manner specified for:

a) fineness (clause **5**);

b) chemical composition (clause **6**);

c) compressive strength (clause **7**);

d) setting time (clause **8**);

e) soundness (clause **9**);

f) heat of hydration (clause **10**).

5 Fineness

The cement shall be tested for fineness by the method described in BS 4550-3.3 and shall have a specific surface of not less than 275 m^2/kg.

6 Chemical composition

The chemical composition of the cement shall comply with the following requirements.

6.1 Lime saturation factor (LSF). The lime saturation factor shall not be greater than 0.88 and not less than 0.66 when calculated by the formula:

$$LSF = \frac{(CaO) - 0.7\ (SO_3)}{2.8\ (SiO_2) + 1.2\ (Al_2O_3) + 0.65\ (Fe_2O_3)}$$

where each symbol in parentheses refers to the percentage (by mass of total cement) of the oxide, as determined by the methods described in BS 4550-2:1979 as follows: **4.2** for SiO_2, **6.2** for CaO, **7.2** for Al_2O_3, clause **8** for Fe_2O_3 and clause **10** for SO_3, excluding any contained in the insoluble residue referred to in **6.2** of this standard.

6.2 Insoluble residue. The mass of insoluble residue, as determined by the method described in clause **3** of BS 4550-2:1970, shall not exceed 1.5 %.

6.3 Magnesia. The mass of magnesia, as determined by the method described in **9.2** of BS 4550-2:1970, shall not exceed 4.0 %.

6.4 Sulphuric anhydride. The mass of total sulphur, expressed as SO_3 and determined by the method described in clause **12** of BS 4550-2:1970, shall not exceed the appropriate value shown in Table 1.

Table 1 — Maximum total sulphur expressed as SO_3

	%
When tri-calcium aluminate is 5 % or less	2.5
When tri-calcium aluminate is more than 5 %	3.0

The tri-calcium aluminate content (C_3A) is calculated by the formula:

$$C_3A = 2.65\ (Al_2O_3) - 1.69\ (Fe_2O_3)$$

where C = CaO, A = Al_2O_3 and each symbol in parentheses refers to the percentage (by mass of total cement) of the oxide, as determined by the methods described in BS 4550-2:1970 as follows: **7.2** for Al_2O_3 and clause **8** for Fe_2O_3 excluding any Al_2O_3 and Fe_2O_3 contained in the insoluble residue referred to in **6.2** of this standard.

6.5 Loss on ignition. The loss on ignition, as determined by the method described in **13.2** of BS 4550-2:1970, shall not exceed 3.0 % for cement in temperate climates or 4.0 % for cement in tropical climates.

7 Compressive strength

7.1 General. The cement shall be tested for compressive strength by one of the methods specified in **7.2** and **7.3**. The method of test shall be agreed between the vendor[1)] and the purchaser at the time of placing the order. In the event of a dispute a retest shall be carried out in the presence of representatives of the two parties concerned.

7.2 Method 1. The average compressive strength of three concrete cubes, prepared, stored and tested as described in clause **1** of BS 4550-3.4:1978, shall be:

at 3 days (72 ± 1 h):	not less than 5 N/mm^2
at 28 days:	higher than the compressive strength at 3 days and not less than 19 N/mm^2

7.3 Method 2. The average compressive strength of three mortar cubes, prepared, stored and tested as described in clause **2** of BS 4550-3.4:1978, shall be:

at 3 days (72 ± 1 h):	not less than 10 N/mm^2
at 28 days:	higher than the compressive strength at 3 days and not less than 28 N/mm^2

8 Setting times

The setting times of cement paste of standard consistence as determined by the methods described in BS 4550-3.5 and BS 4550-3.6, shall be:

initial setting time:	not less than 1 h
final setting time:	not more than 10 h

9 Soundness

The cement, when tested for soundness by the method described in BS 4550-3.7, shall have an expansion of not more than 10 mm.

If the cement fails to comply with this requirement, a further test shall be made in the manner described. For this test another portion of the same sample shall be used after it has been aerated by being spread out to a depth of 70 mm to 80 mm at a relative humidity of 50 % to 80 % for a total period of 7 days. The expansion of this aerated sub-sample shall not exceed 5 mm.

10 Heat of hydration

The heat of hydration of the cement, as determined by the method described in BS 4550-3.8, shall be:

7 days:	not more than 250 kJ/kg
28 days:	not more than 290 kJ/kg

11 Manufacturer's certificate

The manufacturer shall be satisfied that the cement at the time of its delivery complies with the requirements of this British Standard and, if requested, he shall forward a certificate to this effect to the purchaser or his representative. The certificate shall include the results of tests on samples of cement relating to the material delivered. The following test information shall be provided; fineness, compressive strength at 3 days and 28 days, initial and final setting times and soundness.

If requested, the compressive strength at 7 days shall be made available.

12 Independent tests

If the purchaser or his representative requires independent tests, they shall be carried out in accordance with this British Standard on the written instructions of the purchaser or his representative.

13 Sampling

If a sample is required for independent tests, it shall be taken at the option of the purchaser or his representative, before delivery or within one week after delivery of the cement by the method described in BS 4550-1. The tests shall be commenced within 4 weeks of delivery. If the vendor[1)] so desires he or his representative shall be present at the sampling

14 Facilities for sampling and identifying

When a sample of cement for testing is to be taken on the premises of the vendor, he shall afford every facility and provide all labour and materials for taking and packing the sample and, as far as possible, for subsequently identifying the cement sampled.

NOTE It is recognized that there may sometimes be difficulty in complying with the last requirement since it may not be possible to identify a particular consignment of cement after it has been placed with other cement in a silo on the user's site.

[1)] The term "vendor" in this standard means the seller of the cement whether he be the manufacturer of the cement or not.

15 Compliance

Any consignment, or part of a consignment, which, when sampled in accordance with clause **13**, fails to comply with any one or more of the requirements of this standard shall be deemed not to comply with the requirements of this British Standard.

16 Cement in tropical climates

The temperatures specifically mentioned in BS 4550 are applicable to temperate climates. Cement intended for use in tropical climates may be tested at temperatures exceeding 21 °C but not exceeding 35 °C[2)]. When so tested, cement complying with the requirements herein specified for temperate climates shall be deemed to comply with the requirements of this British Standard.

17 Marking

Low heat Portland cement manufactured in compliance with this British Standard shall be marked in relation to the product (e.g. on the bag, the manufacturer's certificate, the delivery note or the invoice, etc.) with the following particulars.

a) The name, trade mark or other means of identification of the vendor.

b) The name of the material, i.e. low heat Portland cement.

c) The number and year of this British Standard, i.e. BS 1370:1979.

[2)] When cement is tested at temperatures above 21 °C the strength, setting time and heat of hydration requirements may be altered by agreement between purchaser and vendor. It should be noted that an increase in the testing temperature increases the early compressive strength and the heat of hydration and reduces the setting time.

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Publications referred to

BS 12, *Ordinary and rapid-hardening Portland cement*[3)].
BS 4550, *Methods of testing cement.*
BS 4550-1, *Sampling.*
BS 4550-2, *Chemical tests.*
BS 4550-3, *Physical tests.*
BS 4550-3.3, *Fineness test.*
BS 4550-3.4, *Strength test.*
BS 4550-3.5, *Determination of standard consistence.*
BS 4550-3.6, *Test for setting times.*
BS 4550-3.7, *Soundness test.*
BS 4550-3.8, *Test for heat hydration.*
BS 4627, *Glossary of terms relating to types of cements, their properties and components.*

[3)] Referred to in the foreword only.

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