BRITISH STANDARD

BS 890 : 1995

Specification for

Building limes

BSI
STANDARDS

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/516, Cement and lime, to Subcommittee B/516/11, Lime, upon which the following bodies were represented:

Autoclaved Aerated Concrete Products Association
British Aggregate Construction Materials Industries
British Lime Association
Department of the Environment (Building Research Establishment)
Ministry of Agriculture, Fisheries and Food
Mortar Producers' Association
Water Services Association of England and Wales

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Contents

Foreword

This British Standard has been prepared under the direction of Subcommittee B/516/11. It supersedes BS 890 : 1972 which is withdrawn.

This standard has been revised to align it more closely with developments in the work of Technical Committee 51, Cement and building limes, of the European Committee for Standardization (CEN) which is preparing a European Standard for building limes, EN 459. Part 1 of that standard, ENV 459-1, has the status of a prestandard and specifies requirements for air limes and hydraulic limes. Part 2, EN 459-2, comprises the supporting test methods. These tests complement those in EN 196 developed for cement.

The implementation of EN 459-2 and EN 196 as British Standards in the BS EN series necessitates the withdrawal of the corresponding tests in BS 890, BS 6463 and BS 4550. Consequently this revision of BS 890 specifies requirements based on test methods described in BS EN 459-2 and BS EN 196.

Building limes are in most cases not mixed products. Depending on the type, they harden by absorbing carbon dioxide from the air (carbonate hardening) and/or hydraulically. For this reason, and also on account of the different types being marketed (hydrated and calcined products), the classification criteria required for building limes differ from those needed for cements and masonry cements.

On mixing with water, building limes form a paste that improves the workability (flow and penetration) and water retention of mortars. During the life of lime based mortars carbonation occurs which results in the filling of small cracks and voids. This increases compressive, flexural and bond strength and reduces rain penetration. This beneficial process, which enhances durability, is known as autogenous healing.

This revision introduces the following changes.

a) The term 'air limes' is introduced and is defined as those limes mainly consisting of calcium oxide or hydroxide which slowly harden in air by reacting with atmospheric carbon dioxide. In the UK these were formerly termed non-hydraulic limes or semi-hydraulic limes as generally they do not harden under water or have only a limited ability so to do. As in the 1972 edition, hydraulic limes are not included.

b) The high-calcium lime, high-calcium by-product lime and semi-hydraulic lime defined in the 1972 edition are replaced by three types, CL 90, CL 80 and CL 70, covering a slightly wider range of lime and magnesia (CaO + MgO) contents. A type of dolomitic lime with higher magnesia content has also been introduced. For further comparative details see annex C.

c) All types of lime in this standard may contain up to 0.1 % of admixtures without the amount and type being declared. Where more than 0.1 % is introduced, the amount and type have to be declared (see clause 5).

d) Higher maximum carbon dioxide contents are permitted in the CL 70 and CL 80 types and also in the DL 80 and DL 85 types (see annex D).

e) Higher residues on both the 90 μm and the coarser mesh sieves are permitted (see annex D).

f) The Le Chatelier test method for soundness now adopted is similar to that described in clause 6 of BS 6463 : Part 4 : 1987 but differs from that in the 1972 edition of this standard. The higher expansions permitted in this revision take this change into account.

g) The changes made in the chemical requirements are given in detail in annex D. The chemical requirements for hydrated limes are expressed in terms of quicklime. The method for classifying hydrated limes is given in annex F.

h) The requirements for the workability of lime putty have been removed although the test method is retained in BS 6463 and guidance on the performance of limes using this test method is given in annex E. A mortar penetration test has been introduced to ensure that consistence is maintained within prescribed limits.

i) There is now a maximum requirement for the air content of a standard mortar.

j) The strength requirements associated with the semi-hydraulic type of lime have been removed.

k) Suppliers are now required, if requested, to make available typical values for the following properties using the methods described in BS EN 459-2:

- reactivity, T_{max} and t_u (quicklime);
- water retention;
- bulk density.

l) The bag, delivery note, invoice or other accompanying documentation are required to be marked with the number and year of the standard and other means of identification, while the provision in the 1972 edition requiring the manufacturer to provide a certificate at the request of the purchaser indicating that the lime conformed to the requirements of the standard has been removed.

m) In contrast to the European Prestandard DD ENV 459-1, the UK practice of defining requirements in terms of absolute (go-no-go) values for acceptance purposes is continued. The values adopted are the DD ENV 459-1 characteristic values plus or minus the major defect values. However, the opportunity has been taken to introduce the DD ENV 459-1 system of conformity criteria (manufacturer's autocontrol) for soundness. This will provide valuable operating experience when DD ENV 459-1 becomes BS EN 459-1 (see annex G).

n) Guidance on storage is given in annex H.

o) Guidance on protective measures to be taken when handling lime is given in annex J.

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 system against the appropriate Part of BS EN ISO 9000.

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of British 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.

Compliance with a British Standard does not of itself confer immunity from legal obligations

Specification

1 Scope

This British Standard specifies requirements for building limes used as binders, predominantly in mortar for masonry as well as for rendering and plastering, and for limes used for soil stabilization.

It gives a general definition of the different types of building limes and their classification. It also specifies requirements for their chemical, mechanical and physical properties, which depend on the type of building lime, and provides guidance on the manufacturer's autocontrol procedures to ensure conformity.

Hydraulic limes are not covered by this standard.

2 References

2.1 Normative references

This British Standard 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 the inside back cover. For dated references, only the edition cited applies: any subsequent amendments to or revisions of the cited publication apply to this British Standard 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 British Standard 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 British Standard the definitions given in BS ISO 3534-1 apply, together with the following.

3.1 lime

Any physical and chemical form of calcium oxide and/or hydroxide with lesser amounts of magnesium oxide and/or hydroxide.

3.2 building limes

Binders, the main constituents of which, on chemical analysis, are the oxides and hydroxides of calcium (CaO, $Ca(OH)_2$), with lesser amounts of the oxides and hydroxides of magnesium (MgO, $Mg(OH)_2$), silica (SiO_2), alumina (Al_2O_3) and ferric oxide (Fe_2O_3).

3.3 air limes[1)]

Limes mainly consisting of calcium oxide or hydroxide which slowly harden in air by reacting with atmospheric carbon dioxide.

NOTE. Generally they do not harden under water as they have no hydraulic properties.

3.4 quicklimes

Air limes mainly consisting of calcium oxide and magnesium oxide produced by calcination of limestone and/or dolomite rock.

NOTE. Quicklimes have an exothermic reaction when in contact with water. Quicklimes are offered in varying sizes ranging from lumps to finely ground materials.

3.5 burnt limes

Quicklimes mainly consisting of calcium oxide.

3.6 dolomitic limes

Quicklimes mainly consisting of calcium oxide and magnesium oxide.

3.7 slaked limes

Air limes mainly consisting of calcium and possibly magnesium hydroxide resulting from the controlled slaking of quicklime.

NOTE. Slaked limes have no exothermic reaction when in contact with water. Slaked limes are produced in the form of a dry powder or as a slurry.

3.8 hydrated calcium limes

Slaked limes mainly consisting of calcium hydroxide.

3.9 hydrated dolomitic limes

Slaked limes mainly consisting of calcium hydroxide, magnesium hydroxide and magnesium oxide.

3.10 semi-hydrated dolomitic limes

Hydrated dolomitic limes mainly consisting of calcium hydroxide and magnesium oxide.

3.11 completely hydrated dolomitic limes

Hydrated dolomitic limes mainly consisting of calcium hydroxide and magnesium hydroxide.

3.12 shell limes

Slaked limes produced by calcination of shells followed by slaking.

3.13 carbide limes

Slaked limes which are a by-product of the manufacture of acetylene from calcium carbide.

3.14 lime putties

Slaked limes mixed with water to a desired consistence, mainly consisting of calcium hydroxide with or without magnesium hydroxide.

[1)] Translation of a term used in most European countries

4 Classification and notation

The different types of building lime shall be classified and identified according to their lime plus magnesia content (CaO + MgO) as follows:

- Calcium lime 90 CL 90
- Calcium lime 80 CL 80
- Calcium lime 70 CL 70
- Dolomitic lime 85 DL 85
- Dolomitic lime 80 DL 80

NOTE 1. This classification refers to minimum characteristic requirements for each class (see tables 1 and 2). Each type of lime can be supplied in the form of quicklime, hydrated lime or lime putty.

NOTE 2. Annex F describes the method for determining the class of a hydrated lime.

5 Chemical properties

When tested in accordance with BS EN 459-2, the chemical properties of building limes shall conform to the values given in table 1. All types of lime listed in table 1 are permitted to contain admixtures in small quantities. If the admixture content exceeds 0.1 %, the actual amount and types shall be declared. Admixtures shall have no detrimental effect on the properties of mortars.

Table 1. Chemical properties of lime

Values (absolute) given in percentage by mass

Type of building lime	CaO + MgO	MgO	CO_2	SO_3
CL 90	≥85	≤6[1)2)]	≤6	≤2.5
CL 80	≥75	≤6[1)]	≤9	≤2.5
CL 70	≥65	≤6	≤14	≤2.5
DL 85	≥80	≥27 and ≤45	≤9	≤2.5
DL 80	≥75	>4[1)] and ≤45	≤9	≤2.5

[1)] For soil stabilization ≤10 %.

[2)] MgO content up to 7 % is acceptable if the soundness test given in BS EN 459-2 is passed.

NOTE. The values are applicable to all forms of lime. For quicklime these values correspond to the 'as delivered' condition; for all other forms of lime (hydrated lime and lime putty) the values are based on the water free and bound water free product.

6 Physical properties

When tested in accordance with BS EN 459-2, the physical properties of quicklimes and of hydrated limes shall conform to the values given in table 2 and table 3, respectively.

NOTE. Conformity to the requirement for soundness may be ensured by the manufacturer through the operation of a statistical quality control scheme based on the conformity criteria described in annex A.

Table 2. Physical properties of quicklime (absolute values)

Type of building lime	Soundness after slaking[1)] in accordance with 5.3.3 of BS EN 459-2	Yield in accordance with 5.9 of BS EN 459-2[2)] l/kg
CL 90	Pass	≥2.6
CL 80		
CL 70		
DL 85	-	-
DL 80	-	-

[1)] Slaking according to the instructions of the lime producer.

[2)] The slaking vessel used in the method described in **5.9** of BS EN 459-2 : 1995 is constructed so that the yield can be obtained directly in dm^3/10 kg of quicklime. Dividing the value obtained by 10 gives the yield in litres per kilogram.

Table 3. Physical properties of hydrated calcium lime, hydrated dolomitic lime and lime putty (absolute values, but see footnote[6] to the table)

Type of building lime	Fineness[1] (in accordance with 5.2 of BS EN 459-2 : 1995) % residue by mass		Soundness[2][3]		Free water content[4] (in accordance with 5.11 of BS EN 459-2 : 1995)	Mortar tests[5]	
	90 µm	200 µm	Lime putty and hydrated dolomitic limes (in accordance with 5.3.3 of BS EN 459-2 : 1995)	Building limes other than lime putty and hydrated dolomitic limes (in accordance with 5.3.2.1 of BS EN 459-2 : 1995) mm	%	Penetration (in accordance with 5.5 of BS EN 459-2 : 1995) mm	Air content (in accordance with 5.7 of BS EN 459-2 : 1995) %
CL 90	≤9	≤4	Pass	≤20[6]	≤2.5	>20 and <50	≤15
CL 80					≤2.5		
CL 70					≤2.5		
DL 85				Not applicable	≤2.5		
DL 80					≤2.5		

[1] Not for lime putty.

[2] See **5.3** of BS EN 459-2 : 1995.

[3] Hydrated calcium limes, calcium lime putties and hydrated dolomitic limes which include grains larger than 0.2 mm have additionally to be sound when tested in accordance with **5.3.4** of BS EN 459-2 : 1995.

[4] For lime putty: free water content ≤70 % and ≥45 %.

[5] Using standard mortar in accordance with **5.5.1** of BS EN 459-2 : 1995. Flow tables other than those described in **5.5.2.1.2** of BS EN 459-2 : 1995 may be used provided they can be shown to give comparable results.

[6] If the autocontrol procedure described in annex A is adopted for soundness, the characteristic value shall be 20 mm. If the autocontrol procedure is not adopted, the maximum absolute expansion shall be 20 mm.

7 Marking

Building lime conforming to this standard shall be marked, on the bag if so supplied, the delivery note[2], the invoice[2] or any other accompanying documentation, with the following information:

a) type of building lime;

b) commercial form of the type of building lime (i.e. quicklime, hydrated lime or lime putty);

c) manufacturer's name;

d) place of production;

e) working instructions if necessary;

f) safety information according to regulations;

g) type and amount of admixture if present in excess of 0.1 %;

h) number and year of this British Standard, i.e. BS 890 : 1995[3].

8 Information to be provided

The manufacturer shall, if so requested, state typical values for:

a) water demand (mortar test);

b) water retention (by mortar test);

NOTE 1. Typical values lie in the range between 65 % and 85 %.

c) bulk density in kg/m^3);

NOTE 2. Typical values lie in the following ranges CL 70/80/90: 300 to 600; DL 80/85: 400 to 600.

d) reactivity, T_{max} and t_u (quicklime);

NOTE 3. In general, no requirements are specified for reactivity. If reactivity requirements are specified for particular uses, this should be agreed between the supplier and the purchaser.

The following values may be appropriate for lime used in soil stabilization: ground calcium limes CL 90 should reach a maximum temperature T_{max} of not less than 60 °C and all other ground limes should reach a maximum temperature of not less than 50 °C. The reaction time t_u for conversion of 80 % of the CaO content capable of being slaked should be less than 15 min for all ground limes.

9 Sampling and testing for acceptance inspection

9.1 In order to assess conformity at delivery, when requested, a spot sample of the lime shall be taken in accordance with **3.6** and **6.2**, **6.3**, **6.4** or **6.5** of BS EN 196 : Part 7 : 1989 either before, or at the time of, delivery. A laboratory sample shall be prepared and packed in accordance with clauses **8** and **9** of BS EN 196 : Part 7 : 1989. A sampling report shall be completed at the time of sampling and shall be attached to the laboratory sample in accordance with clause **10** of BS EN 196 : Part 7 : 1989.

NOTE. Testing may be delayed for up to 5 weeks from the time of sampling provided that there is confirmation that the sample has been stored continuously as described in **9.2** of BS EN 196 : Part 7 : 1989.

9.2 When the lime is tested for chemical properties (see clause **5**), the sample shall be prepared by the method described in clause **6** of BS EN 196 : Part 2 : 1995.

2) Except items e) and f).

3) Marking BS 890 : 1995 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 the standard. The accuracy of the claim is solely the clamaint's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Annexes

Annex A (informative)
Conformity criteria (lime manufacturer's autocontrol)

A.1 General

A.1.1 A statistically formulated conformity criterion includes three elements:

a) a definition of the requirement, as given in clause **6**;

b) the acceptable percentage of 'defects', i.e. the quantile[4] of the normal (Gaussian) distribution to which the required value does not correspond. In this standard this is the 10 % quantile;

c) the probability of acceptance of a lot of lime that does not conform to the requirements.

A sampling inspection procedure can only produce an approximate value for the percentage of defects in a lot. The greater the number of samples, the better the approximation. The probability of acceptance, also known as consumer's risk, controls the degree of approximation by the sampling plan and in this case is 5 % for the continuous inspection which is the basis for the assessment of conformity.

A.1.2 The conformity criteria for continuous inspection (see **A.3**, **A.4** and **A.5**) are based upon the principles of **A.1.1**. This standard contains, however, an additional conformity criterion of a different type. In order to justify the rejection of lime which is likely to reduce materially the usability of the lime for the intended purpose, the standard specifies (see **A.4**), that a quantity of lime containing one or more so-called major defects does not conform to the requirements.

A.2 Application of conformity procedures

Where a manufacturer adopts conformity criteria for continuous inspection of soundness (expansion by the Le Chatelier test) the procedure given in this annex should be adopted. This inspection is operated by the lime producer (autocontrol).

A.3 General procedure for assessing conformity

A.3.1 The assessment for soundness should be based upon continuous sampling using spot samples of lime taken in accordance with clause **3** of BS EN 459-2 : 1995 and with BS EN 196-7.

A.3.2 The continuous inspection should take place at the lime plant and be operated by the producer (autocontrol).

The series of samples used for assessing the conformity should be taken over a period of not less than 6 months and not more than 12 months. Samples should be taken daily on each day of delivery.

A.3.3 An observed test value which does not conform to the appropriate value in table 3 is characterized as a defect. Distinction is made between minor and major defects. Recommended limits are given for major defects (see **A.4**).

A.3.4 The sampling plan (including the number of single spot samples to be taken) is established by means of two parameters as follows (see table A.1):

- acceptable overall percentage of defects;
- acceptable consumer's risk.

These are used together for the selection of sampling plans for continuous autocontrol.

Annex B gives sampling plans for inspection by attributes and variables. Any other plan satisfying the values in table A.1 is, in principle, acceptable for the conformity procedure.

Table A.1 Parameters determining the conformity procedure

Continuous inspection procedure	Physical properties (all limits) by attributes[1]
Percentage of defects	10 %
Consumer's risk	5 %

[1] By variables is also permitted.

NOTE. Sampling plans for additional acceptance inspection at delivery of a consignment of lime should, in accordance with **A.2**, be chosen on the basis of the producer's risk instead of the consumer's risk.

Consumer's risk: Risk to the consumer that a consignment will be declared as conforming to the standard and therefore will be accepted when the percentage of defects, p, is higher than the acceptable percentage of defects, p_0. It is defined as a point on the operating characteristic curve (OC-curve) corresponding to a predetermined low probability of acceptance (in this standard 5 %).

Producer's risk: Risk to the producer that a production will be declared as non-conforming to the standard and therefore will be rejected when the percentage of defects, p, is lower than the acceptable percentage of defects, p_0. It is defined as the probability of rejection (in this standard 5 %).

[4] Previously termed 'fractile'.

A.3.5 The requirement for soundness is given in table 3. The conformity procedure is based upon sampling inspection by attributes (see also ISO 2859-1).

The number of defective items is counted and compared with an estimated number of defects, calculated from the number of tests and the specified acceptable overall percentage of defects.

In order to improve inspection efficiency, the lime producer is allowed to employ inspection by variables. This is preferable when the test result is close to the specified limit.

The sampling plan (including the number of spot samples to be taken) is established on the same basis as in **A.3.4.**

A.4 Limits for major defects

In general terms, a major defect is defined as a deviation from the requirement in table 3 so large that the usability of the lime for its intended purpose is likely to be reduced and that in extreme cases even failure may be produced. Table A.2 gives more detailed recommendations.

If a test result deviates by more than the value in this table it is denoted major defective.

A.5 Definition of minor defects

Minor defects do not diminish essentially the usability of building limes for the intended use. Minor defects are assessed in accordance with table A.1.

Table A.2 Major defects

Property	Deviation from the requirements of tables 2 and 3
Soundness	
For building limes other than quicklime, lime putty, dolomitic lime and hydrated dolomitic lime: reference method (**5.3.2.1** of BS EN 459-2 : 1995)	+5 mm
For quicklime, lime putty, dolomitic lime and hydrated dolomitic lime (**5.3.3** of BS EN 459-2 : 1995)	no deviation
For hydrated calcium lime, calcium lime putty and hydrated dolomitic lime which include grains larger than 0.2 mm (**5.3.4** of BS EN 459-2 : 1995)	no deviation

Annex B (informative)
Sampling plans

B.1 Introduction

This annex contains a number of sampling plans for:

- continuous inspection by variables;
- continuous inspection by attributes.

The number of samples and the test frequency are recommended in **A.3.2.**

B.2 Inspection by variables

The mean value $\bar{x}$ and the standard deviation s of the complete series of test results (one result per sample) are calculated.

The conformity criteria are:

$$\bar{x} - k_A s \geq L \qquad \text{(B.1)}$$

and

$$\bar{x} + k_A s \leq U \qquad \text{(B.2)}$$

where

k_A is the acceptability constant;

L is the specified lower limit;

U is the specified upper limit.

The acceptability constant k_A depends on the parameters specified in table A.1 and on the number of test results, n. Values of k_A are listed in table B.1.

Table B.1 Acceptability constant k_A

Number of test results, n	Acceptable percentage of defects 10 %
40 to 49	1.70
50 to 59	1.65
60 to 79	1.61
80 to 99	1.56
100 to 149	1.53
150 to 199	1.48
≥200	1.45

B.3 Inspection by attributes

The number c_D of defective test results (one result per sample) in the complete series of samples is counted.

The conformity is checked by

$$c_D \leq c_A \qquad \text{(B.3)}$$

where the acceptable number of defects c_A depends on the parameters specified in table A.1 and on the number of test results, n. Values of c_A are given in table B.2.

Table B.2 Acceptable number of defects, c_A, at 5 % consumer's risk when the acceptable percentage of defects is 10 %

Number of test results, n	Acceptable number of defects, c_A
0 to 39	0
40 to 54	1
55 to 69	2
70 to 84	3
85 to 99	4
100 to 109	5
$n \geq 110$	$0.075(n - 30)$[1)]

[1)] To be rounded up to an integer.

Annex C (informative)

Changes in compositional requirements

The changes in compositional requirements for limes from the 1972 edition of BS 890 to the 1995 edition are given in table C.1.

Table C.1 Compositional requirements

BS 890 : 1972 designation	BS 890 : 1995 designation of near equivalent	Notes[1)]
Hydrated limes		
High-calcium lime	CL 90 hydrate	Generally similar
High-calcium by-product lime	CL 90 hydrate	Generally similar
Semi-hydraulic lime	CL 80 hydrate	Both have similar minimum (CaO + MgO) requirements of about 60 %
Semi-hydraulic lime	CL 70 hydrate	CL 70 has a minimum (CaO + MgO) requirement of about 55 % whereas semi-hydraulic lime required a minimum of 60 %
Magnesian lime	DL 80 hydrate	DL 80 has a minimum (CaO + MgO) requirement of about 60 % whereas magnesian lime required a minimum (CaO + MgO) of 65 %
Magnesian lime	DL 85 hydrate	DL 85 has a minimum MgO requirement of about 20 % and a minimum (CaO + MgO) requirement of about 65 %
Quicklimes		
High-calcium lime	CL 90	Generally similar
Semi-hydraulic lime	CL 80	CL 80 has a minimum (CaO + MgO) requirement of 75 % whereas semi-hydraulic lime required a minimum of 70 %
Semi-hydraulic lime	CL 70	CL 70 has a minimum (CaO + MgO) requirement of 65 % whereas semi-hydraulic lime required a minimum of 70 %
Magnesian lime	DL 80	DL 80 has a minimum (CaO + MgO) requirement of 75 % whereas magnesian lime required a minimum of 85 %
Magnesian lime	DL 85	DL 85 has a minimum MgO requirement of 27 % and a minimum (CaO + MgO) requirement of 80 % whereas magnesian lime required a minimum of 85 %

[1)] The data given for the chemical composition of hydrated limes are approximate. Actual values have to be calculated from the quicklime values using the method given in annex F.

Annex D (informative)

Changes in physical and chemical properties

The changes in physical and chemical properties for limes from the 1972 edition of BS 890 to the 1995 edition are given in tables D.1 and D.2, respectively.

Table D.1 Properties of types of lime

Property	BS 890 : 1972		BS 890 : 1995	
	Type	Requirement	Type	Requirement
a) *Physical properties*				
Fineness Sieve residue[1]	High calcium		CL 90	
	Semi-hydraulic		CL 80	
	Semi-hydraulic	≤1 %	CL 70	≤4 %
	Magnesian		DL 80	
	Magnesian		DL 85	
Sieve residue on 90 mm sieve	High calcium		CL 90	
	Semi-hydraulic		CL 80	
	Semi-hydraulic	≤6 %	CL 70	≤9 %
	Magnesian		DL 80	
	Magnesian		DL 85	
Soundness[2] Le Chatelier	High calcium		CL 90	≤25 mm[4]
	Semi-hydraulic		CL 80	≤25 mm[4]
	Semi-hydraulic	≤10 mm	CL 70	≤25 mm[4]
	Magnesian		DL 80	N/A
	Magnesian		DL 85	N/A
Pat	High calcium		CL 90	
	Semi-hydraulic		CL 80	
	Semi-hydraulic	Sound	CL 70	Sound
	Magnesian		DL 80	
	Magnesian		DL 85	
b) *Chemical properties*				
CO_2 content[3]	High calcium		CL 90	≤6 %
	Semi-hydraulic		CL 80	≤9 %
	Semi-hydraulic	≤6 %	CL 70	≤14 %
	Magnesian		DL 80	≤9 %
	Magnesian		DL 85	≤9 %

[1] BS 890 : 1972 residue on a 180 μm sieve but BS 890 : 1995 residue on a 200 μm sieve.

[2] The test method in this 1995 edition differs from that in the 1972 edition of BS 890.

[3] The BS 890 : 1995 requirements are expressed as a percentage of quicklime.

[4] This is the purchaser's acceptance requirement when autocontrol is adopted by the manufacturer. The autocontrol requirement is ≤20 mm with a major defect deviation of +5 mm (from table A.2). The acceptance requirement is ≤20 mm when autocontrol is not adopted.

Table D.2 Properties of forms of lime

Property	BS 890			
	1972		1995	
	Hydrated	Quicklime	Hydrated	Quicklime
a) *Physical properties*				
Yield (l/kg)	—	—	—	≥2.6
Workability of putty, bumps for 190 mm spread	12	14	—	—
Penetration (mortar) (mm)	—	—	20 to 50	—
Air content (%)	—	—	≤15	—
Flexural strength (semi-hydraulic) (N/mm^2)	≥0.7, ≤2.0	≥0.7, ≤2.0	—	—
Density of putty (g/ml)	≤1.50	≤1.45	—	—
b) *Chemical properties*				
Insoluble residue (HCl) (*m/m*)	≤1 %	≤3 %	—	—
Water soluble salts (high-calcium by-product only) (*m/m*)	≤0.5 %	—	—	—
Acid soluble silica (HCl) semi-hydraulic (*m/m*)	≥5 %	≥6 %	—	—
SO_3 (*m/m*)	—	—	≤2.5 %[1)]	≤2.5 %
Free water (*m/m*)	—	—	≤2.5 %[1)]	—
Magnesia (*m/m*)				
– high calcium, semi-hydraulic, CL 90, CL 80, CL 70	≤4 %	≤5 %	≤6 %[1)]	≤6 %
– magnesian DL 80	≥4 %	≥5 %	>4 %[1)]	>4 %
– magnesian DL 85	≥4 %	≥5 %	≥27 %[1)]	≥27 %

[1)] Expressed as a percentage of quicklime.

Annex E (informative)

Workability of lime putty

The workability of a lime putty of standard consistence may be determined using the procedure described in clause **9** of BS 6463 : Part 4 : 1987 to determine the number of drops (jolts) on the flow table required to produce a spread of (190 ± 1) mm. The following minimum numbers of drops are recommended:

- hydrated limes	12 drops
- quicklimes hydrated as described in **5.9** of BS EN 459-2 : 1995	14 drops

Annex F (informative)

Method for the classification of hydrated lime in terms of quicklime

The classification for limes is based on the lime plus magnesia (CaO + MgO) content of the unhydrated lime.

In dealing with hydrated limes and lime putties it is necessary to make the following calculation in order to establish the type.

a) Test a sample of the material in the 'as delivered' condition.

b) Measure the loss on ignition (LOI) at 975 °C as a percentage by the method described in BS EN 459-2.

c) Measure the carbon dioxide (CO_2) content as a percentage by the method described in BS EN 459-2.

d) Calculate as a percentage the total combined and free water content as follows:

$$x = (\text{LOI}) - (CO_2)$$

e) Multiply the (CaO + MgO) content by the factor $\frac{100}{(100 - x)}$

Example

(CaO + MgO) content of a hydrated lime = 65.0 %

Loss on ignition = 24.0 %

CO_2 content = 2.0 %

Total water content = 24.0 − 2.0 = 22.0 %

(CaO + MgO) as a percentage of the unhydrated lime $= 65 \times \frac{100}{(100 - 22)} = 83$ %

Classification:

CL 90 permits a range of 100 % to 85 %;

CL 80 permits a range of 100 % to 75 %.

The hydrated lime in question is therefore CL 80.

Annex G (informative)

Use of statistical conformity criteria

The standard specifications produced by CEN/TC 51 generally contain statistical conformity criteria. As these represent a new concept to many UK users this annex explains their use without going into the theoretical concepts upon which they are based. Some of the more complex issues, such as the question of customer's risk have been omitted from this simplified presentation but the general method of operation is not affected.

Most of the requirements in the standards developed by CEN/TC 51 are expressed in terms of characteristic values. This means that a preselected percentage of test results are permitted to be below any minimum characteristic value specified and/or above any maximum characteristic value. In most cases this percentage is 10 %, but in the more critical areas such as minimum strengths for cement it is not unusual for it to be 5 %.

In order to apply the concept it is necessary to define both a minimum sampling frequency and a means of dealing with the test data acquired. This operation is called 'autocontrol' and is carried out by the manufacturer.

The minimum sampling frequency, the maximum percentage of defects permitted and the period of time over which the results should be assessed is normally defined in the standard.

There are two methods adopted for assessment:

a) continuous inspection by attributes;

b) continuous inspection by variables.

In the case of inspection by attributes, the number of defective items (the number which fail to conform to the limiting characteristic value set in the standard, which, as far as this standard is concerned, is the maximum expansion of 20 mm using the Le Chatelier soundness test) is counted and compared with an estimated number of defects, calculated from the number of tests carried out and the specified acceptable overall percentage of defects.

Using table G.1 and permitting up to 10 % defects, then, if 39 or less results are available, each test, result is required to be above the standard 'characteristic minimum requirement' and/or below the standard 'characteristic maximum requirement'. If we are dealing with, for example, 55 to 69 test results in this period and permit 10 % defects then two test results are permitted to be outside the characteristic limits.

From what has been stated it will be noted that there is no definitive upper or lower limit where the material in question is judged to be unfit for use.

Table G.1 Number of defects permitted for acceptable percentage of defects of 10 %	
Number of results	**Number of defects permitted**
0 to 39	0
40 to 54	1
55 to 69	2
70 to 84	3

To deal with this problem the concept of 'major defects' has been introduced. These are test results which are considered as possessing 'a deviation from the requirements so large that the usability of the lime for its intended purpose is likely to be reduced and which, in extreme cases, may even produce failure'. In this standard the major defect level for the soundness result is taken to be 5 mm above the characteristic value of 20 mm. This value of 25 mm is also taken to be the 'absolute value' (or go-no-go value) given for acceptance purposes.

NOTE. Minor defects (defects considered to be unlikely to reduce materially the usability of the product for its intended purpose and in consequence not considered to be non-conformities) are usually considered to be test results which fall between the characteristic value and the major defect value.

The other method of assessing the conformity is that of continuous inspection by variables. This may be a more time-consuming approach but one which can improve inspection efficiency and is particularly useful where the measured variable is close to the specification limiting value.

The method involves the adoption of an acceptability constant (see table B.1) and the use of this constant in the formulae given in **B.2.** It is usual to operate this procedure on a running batch of at least 52 test results obtained over a previously selected period of between 6 months and 12 months.

Annex H (informative)

Storage

H.1 Storage of hydrated lime in bags

Hydrated lime normally contains less than 1 % of free moisture when manufactured and this will not rise above this level when stored within the normal range of relative humidity experienced in the UK. However, it absorbs carbon dioxide from the air and the consequent rate of deterioration depends on the amount of air passing through the store. If air movement is reduced to a practical minimum, hydrated lime can be stored for up to 3 months without appreciable change. For this reason hydrated lime should be stored under cover in a cool dry place with a minimum of air movement and exposure to combustion gases.

The ideal store is a brick or concrete building with a concrete floor, or a similar construction designed to eliminate draughts through walls, floor and roof. The store should not be heated, as this would create draughts.

Bags of hydrated lime should be stored flat and away from walls if condensation of moisture is likely to occur on them. It is essential that care is taken to ensure that stocks are rotated as very old stock will eventually deteriorate to the point of being unsuitable for many applications.

If hydrated lime is stored, temporarily or otherwise, in a general store, care should be taken to ensure that it does not come into contact with other chemicals with which it might react. Since this product is fully hydrated, no heat is evolved when water is added to it, and there is, therefore, no fire risk during storage.

Product quality can be preserved and the rate of deterioration due to carbon dioxide absorption further minimized if the sacks are covered with impervious sheeting. Polyethylene shrink-wrapping of palletized packs of sacks is an option available from some suppliers.

H.2 Storage of quicklime in bags

Quicklime is usually packed in plastics sacks which are resistant to moisture and air ingress.

The storage conditions described for hydrated lime are relevant to quicklime but, in addition, quicklime storage has to be designed to avoid any accidental contact with water which could enter the bags, for instance, at the point where they are sealed after packing. Since the product is not hydrated, any water entering the bags will cause slaking to occur and the heat generated could cause a fire. Therefore, quicklime should not be stored with, or close to, flammable materials.

Quicklime may be stored in plastics sacks under good storage conditions for up to 6 months without significant deterioration.

H.3 Intermediate bulk containers (big bags)

Both quicklime and hydrated lime can be supplied in intermediate bulk containers (IBCs) of various sizes up to 1 tonne capacity. Where such IBCs are of woven polypropylene with a polyethylene liner the bag acts essentially as a small bulk storage silo.

Provided that the bags are securely sealed after filling and are not stored on wet ground, the products will be adequately protected from deterioration for up to 6 months.

Annex J (informative)

Protective measures recommended when handling building limes

NOTE. The following information is for general guidance only and should be read in conjunction with detailed product safety data available from suppliers of building limes.

J.1 General

All building limes as defined in this standard are caustic alkalis in the presence of water and can cause chemical burns to the skin. In addition, when quicklime comes into contact with water a chemical reaction occurs which generates a considerable amount of heat. This reaction often occurs very rapidly and can be vigorous in character. The most violent reactions occur if quicklime is added to water without stirring to dissipate the heat generated, resulting in severe splashing of hot lime slurry which can cause heat burns to the skin.

All building limes need to be handled with caution. The following protective measures should be taken to minimize the possibility of discomfort or accident when handling building limes.

Dust from building limes supplied in the dry state should be prevented from coming into contact with any parts of the body where perspiration is excessive. Lime putty should be prevented from coming into contact with unprotected skin.

In all cases, prevention or adequate control of exposure should be achieved by measures other than personal protective equipment, so far as is reasonably practicable, taking into account the degree of exposure, circumstances of use of the substance, informed knowledge about its hazards and current technical developments.

However, where it is at present not technically feasible to achieve adequate control of exposure by process, operational and engineering resources alone, exposure should be reduced so far as is reasonably practicable by these measures and, in addition, suitable personal protective equipment conforming to international, European or British standards should be used.

J.2 Measures to be taken

J.2.1 *Eyes*

The eyes are particularly vulnerable to damage. Under no circumstances should operatives be allowed to handle building limes or operate quicklime slaking processes without wearing goggles.

Eye protection should conform to BS 2092. Attention is drawn to the Protection of Eyes Regulations 1974 [1].

J.2.2 *Mouth and nose*

Respiratory protective equipment should be capable of adequately controlling exposure, suitable for the purpose and of a type approved, or conform to a standard approved by the Health and Safety Executive. Such equipment should be correctly selected to match the job and the wearer, and be used in the correct manner.

NOTE. Approvals are published by the Health and Safety Executive and copies may be obtained from HMSO. BS 4275 and BS EN 149 are further sources of information and guidance.

J.2.3 *Face and neck*

The shaven parts of the face and neck are liable to be irritated by building lime dust, especially in warmer weather. These parts should be protected with a barrier cream. A cloth worn around the neck will give additional protection.

J.2.4 *Hands, arms and wrists*

The hands should be protected by gloves and it is suggested that a type with a tight-fitting wristband should be used. In wet conditions, or where the hands may come into contact with lime putty or milk of lime, waterproof gloves should be used. Plastics-coated gloves can be obtained to meet the various conditions. Any exposed parts of the arms, hands and wrists should be protected with a barrier cream.

J.2.5 *Feet*

Building lime should be prevented from reaching the feet to avoid burns or irritation. Gaiters or improvised leggings worn over the boot tops and bottom of the trousers in dry conditions, or oilskins worn over rubber boots in wet conditions, will provide suitable protection.

J.2.6 ***Fire hazard***

Owing to the intense heat generated when quicklime comes into contact with water, there is a risk of fire if the reaction takes place in the presence of, or adjacent to, flammable materials. Certain precautions should therefore be taken, e.g. the storage of quicklime on wooden floors should be avoided and care exercised in dealing with any quicklime 'sweepings' to ensure that they are not mixed with combustibles such as wood shavings, sawdust, etc.

J.2.7 ***First-aid treatment***

Building lime on the skin should be washed off without delay. If dust has been inhaled, the nose and throat should be thoroughly irrigated with water. It is essential to prevent this water entering the lungs.

Building lime in the eye should be removed immediately. Speed is essential. Particles should be removed with extreme care using a cotton wool bud and irrigation with eyewash solution or gently flowing clean mains water should commence immediately and continue until medical attention can be obtained.

In all cases affecting the eye, and in any severe cases of contamination, the person should receive immediate medical attention.

Wherever there is the slightest danger of building lime entering the eye it is advisable to have suitable eye irrigation bottles close to hand. The bottles and the water or saline solution they contain should be sterile. These bottles can be obtained in sterile pre-packed containers and should be discarded after use.

In all cases after first-aid treatment the patient should consult a qualified medical practitioner.

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS ISO 3534 :	*Statistics. Vocabulary and symbols*
BS ISO 3534-1 : 1993	*Probability and general statistical terms*
BS EN 196 :	*Methods of testing cement*
BS EN 196 : Part 2 : 1995	*Chemical analysis of cement*
BS EN 196 : Part 7 : 1992	*Methods of taking and preparing samples of cement*
BS EN 459 :	*Building lime*
BS EN 459 : Part 2 : 1995	*Test methods*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 2092 : 1987	*Specification for eye-protectors for industrial and non-industrial uses*
BS 4275 : 1974	*Recommendations for the selection, use and maintenance of respiratory protective equipment*
BS 4550 :	*Methods of testing cement*
BS 6463 :	*Quicklime, hydrated lime and natural calcium carbonate*
BS 6463 : Part 4 : 1987	*Methods of test for physical properties of hydrated lime and lime putty*
BS EN ISO 9000 :	*Quality systems*
BS EN 149 : 1992	*Specification for filtering half masks to protect against particles*
BS EN 196 :	*Methods of testing cement*
BS EN 196 : Part 1 : 1995	*Determination of strength*
DD ENV 459 : Part 1 : 1995	*Building lime: Definitions, specifications and conformity criteria*

ISO publications

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO), Geneva. (All publications are available from Customer Services, BSI.)

ISO 2859-1 : 1989	*Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection*

Other references

[1] GREAT BRITAIN. Protection of Eyes Regulations 1974. London: HMSO.

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