

**PS:5314-2014**

ICS No.91.100.10

## **PAKISTAN STANDARD**

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## **MASONRY CEMENT**



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**PAKISTAN STANDARDS AND QUALITY CONTROL AUTHORITY**

**STANDARDS DEVELOPMENT CENTRE**

**(STANDARDIZATION WING),**

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**GULISTAN-E-JAUHAR**

**Karachi**

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**PAKISTAN STANDARDS SPECIFICATION**  
**FOR**  
**"MASONRY CEMENT"**

**FOREWORD:**

0.1 This Standard was adopted by Pakistan Standard & Quality Control Authority after recommendations of the Technical Committee for “Cement and Lime” (**BDC-05**) on **21<sup>st</sup> April 2014**. The same had been approved and endorsed by the Civil Engineering National Standards Committee (CENSC) on 8<sup>th</sup> May 2014.

0.2 This Standard has been prepared after taking into consideration the views and suggestions of the manufacturers, technologists, suppliers and utilizing agencies.

0.3 In preparation of this Standard the Technical Committee acknowledges with thanks the assistance drawn from the standard **BS-5224/95**

0.4 This Standard is subject to periodical review in order to keep pace with development in industry. Any suggestions for improvement will be recorded and placed before the committee in due course.

## **1. Scope**

This Pakistan standard for masonry cements specifies the requirements for composition and manufacture, for the strength, physical and chemical properties as characteristic values and for marking.

Recommendations for a manufacturer's autocontrol system for conformity, sampling plans, sampling and testing for acceptance at delivery, provision of information, workability and product guidance are given in annexes A to F.

## **2. References**

### **2.1 Normative references**

This Pakistan Standard incorporates, by dated or undated reference, provisions from other publications. The 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 Pakistan Standard only when incorporated in the reference by updating or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

### **2.2 Informative references**

This Pakistan 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 purpose of this Pakistan Standard the definitions given in BS 6110: (PS...) Section 6.1 apply; together with the following.

### **3.1 Inspection**

Process of testing samples of masonry cement in order to compare them with the specification.

### **3.2 statistical quality control**

Quality control using statistical methods (such as control charts and sampling plans).

### **3.3 autocontrol**

Continuous statistical quality control of the masonry cement, carried out by the manufacturer.

### **3.4 Lot**

Definite quantity of masonry cement produced during the inspection period. After specified tests, this quantity is regarded as a whole 'conforming' or 'not conforming' to the autocontrol requirements.

### **3.5 spot sample**

Sample taken at the same time and from one and the same place relating to the intended test (see BS EN 196-7)/(PS...).

### **3.6 consumer's risk**

Risk to the consumer that a lot will be declared as conforming to the standard when in reality the percentage of non-conformities will be higher than the acceptable percentage of non-conformities, *pa*. It is characterized as that point on the operating characteristic curve (OC curve) corresponding to a predetermined low probability of acceptance (in this standard 5 %).

### **3.7 characteristic value**

Value of a property corresponding to an acceptable percentage of non-conformities

NOTE. Numerical values are given in tables 3, 4 and 5.

**3.8 non-conformity**

The non-fulfilment of a specified requirement for a characteristic value in clause 6

**3.9 probability of acceptance**

Probability that a lot with a given percentage of non-conformities will result in acceptance under a given sampling plan.

**3.10 inspection by attributes**

Comparison between the counted number of non-conformities and an estimated number of non-conformities, calculated from the number of tests and the specified acceptable overall percentage of non-conformities.

**3.11 Inspection by variables**

Estimation from the test results of the overall percentage of non-conformities in the lot from which the samples are taken.

**3.12 limit value**

Maximum and/or minimum value of a property required for conformity to the standard.

NOTE. Numerical values are given in table B.1.

**4. Masonry cement**

Masonry cement is a dry, finely powdered hydraulic binder which shall contain Portland cement clinker as the primary strength developing constituent. When mixed with sand and water only and without the addition of further materials it shall produce a workable mortar suitable for use in masonry construction, rendering and plastering.

Masonry cement conforming to this standard consists individual small grains of different material, but shall be statistically homogenous in composition.

**5. Composition and manufacture**

Masonry cements shall consists of Portland cement clinker, inorganic materials and, where appropriate, organic material, as given in table 1.

<b>Table 1. Composition of masonry cements</b>		
<b>Class</b>	<b>Content % (m/m)</b>	
	<b>Portland cement clinker</b>	<b>Organic material</b>
<b>MC 5</b>	≥ 25	≤ 1
<b>MC 12.5</b> <b>MC 12.5X</b> <b>MC 22.5X</b>	≥ 40	
NOTE. These masonry cement compositions permit less clinker than in the 1976 edition of this standard. The effect on strength is readily determined but the long term properties have not yet been established in the current absence of a test for durability.		

Constituents shall not promote corrosion of embedded metal such as reinforcement and wall ties or impair the properties, including behaviour in fire, of the mortar made from masonry cement.

## 6. Physical and chemical properties

### 6.1 General

The physical and chemical properties of masonry cements shall be measured by the test methods described in the relevant Part of BS EN 196 and in BS EN 413-2. These standards give alternative methods for some properties but in the event of a dispute, only the reference methods shall be used.

All requirements for physical and chemical properties are specified as characteristic values and shall define the quality and classification of the masonry cements, which are entitled to the designation 'MC' (masonry cement).

NOTE, Conformity to the requirements for physical and chemical properties may be ensured by the manufacturer by the operation of a statistical quality control scheme based on the conformity criteria described in annex A.

### 6.2 Classification and notation

Classes defined on the basis of the 28-day compressive strength determined in accordance with BS EN 196-1 shall be those in table 2.

Strength class	Strength range at 28 days N/mm <sup>2</sup>	Notation	
		With air-entraining agent	Without air-entraining agent
5	5 to 15	MC 5 <sup>1</sup>	Not permitted
12.5	12.5 to 32.5	MC 12.5	MC 12.5X <sup>2</sup>
22.5	22.5 to 42.5	Not permitted	MC 22.5X

1)MC denotes masonry cement  
2)X indicates non air-entraining.

### 6.3 Physical Properties

#### 6.3.1 Sieve residue

The residue on a test sieve of 90 µm mesh aperture conforming to BS 410 shall be not more than 15% when determined in accordance with BS EN 196-6 (PS...).

#### 6.3.2 Initial setting time

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

#### 6.3.2 Final setting time

The final setting time shall be not more than 15 h when determined in accordance with BS EN 196-3 (PS...).

#### 6.3.3 Soundness

The expansion shall be not more than 10 mm when determined in accordance with BS EN 196-3/(PS...).

#### 6.3.4 Fresh mortar properties

Properties of fresh mortar shall be measured on a mortar of standard consistence which shall have a penetration of (35 ± 3). mm using the plunger test (see 4.2 of BSEN 413-2 :1995)/(PS...)

The air content when determined in accordance with 6.2 or 6.3 of BS EN 413-2 : 1995, and the water retention with clause 5 of BS EN 413-2 : 1995 shall conform to the requirements in table 3.

NOTE. An air-entraining agent is incorporated into the masonry cements of lower strength classes to improve their workability and durability. An upper limit is set for air content to maintain good bond strength to masonry units. Water retention limits are specified for all classes of masonry cement to provide a balanced performance when used with both high and low suction masonry units.

Class	Air content % (V/V)	Water retention % (m/m)
MC 5	8 to 20	80 to 95
MC 12.5		
MC 12.5X MC 22.5X	≥ 6	

NOTE. The measurement of the cohesiveness, determined in accordance with clause 7 of BS EN 413-2 : 1995, (PS...) of a fresh mortar of standard consistence provides a useful indication of the workability (see annex E).

### 6.3.6 Compressive strength

The compressive strength when determined in accordance with BS EN 196-1 at the fixed water masonry cement ratio of 0.50 shall conform to the requirements in table 4.

Class	7-day strength N/(m/m) <sup>2</sup>	28-days strength N/(m/m) <sup>2</sup>	
MC 5	–	≥ 5	≤ 15
MC 12.5 MC 12.5X	≥ 7	≥ 12.5	≤ 32.5
MC 22.5X	≥ 10	≥ 22.5	≤ 42.5

NOTE 1. The criterion for assessing the acceptability of an alternative method of compaction (as permitted in BS EN 196-1) (PS...) shall be that the difference between the averages of the two sets of 20 test batches when tested at 28 days shall exceed 2.0 N/(m/m)<sup>2</sup> and not on the basis of the 'D' value of 5 % 11.7.2.5 of BS EN 196-1 : 1994 (PS...).

NOTE 2. A loading rate of (15 ± 1.5) N/s shall be used when testing specimens of classes MC 5, MC 12.5 and MC 12.5X.

Property	Reference test method	Class	Value % (m/m)
Sulfate content (as SO <sup>3</sup> )	BS EN 196-2	MC 5	≤ 2.0
		MC 12.5 MC 12.5X MC 22.5X	≤ 3.0 <sup>1)</sup>
		Chloride content (as Cl)	BS EN 196-21

<sup>1)</sup>If the Portland cement clinker content can be demonstrated to be not less than 55% of the final masonry cement then the sulfate content of masonry cements of these classes is permitted to be not more than 3.5% by mass.

## 7 Marking and Packaging

Masonry cement shall be marked on the each bag prominently and clearly that masonry cement is not used for structural concrete in English as well as in Urdu.

The colour of bag should be white and print should be red so it makes difference from the other cement bags.



## Annexes

### Annex A (informative) Conformity criteria (cement manufacturer's autocontrol)

#### A.1 General

Conformity of masonry cements with this standard should be continuously assessed. In consequence this clause recommends that the conformity of such masonry cements be verified by means of a statistical quality control scheme based upon continuous inspection of the manufactured masonry cement. This inspection can be operated by the masonry cement manufacturer (autocontrol).

A statistically formulated conformity criterion includes three elements:

- a) a definition of the requirement in terms of characteristic value as given in clause 6;
- b) the acceptable percentage  $P_a$  of non-conformities i.e the fractile of the normal (Gaussian) distribution to which the characteristic value corresponds. In this standard, this is the 10% fractile or, for the 28 days lower limits and the air content upper limit, the 5% fractile;
- c) the probability of acceptance of a lot of masonry cement which does not conform to the requirement.

A sampling inspection procedure can only produce an approximate value for the percentage of non-conformities in a lot. The bigger the sample, 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 in 5% for the continuous inspection which is the basis for assessment of conformity.

#### A.2 Procedure

**A.2.1** The assessment should be based upon continuous sampling inspection using spot samples taken in accordance with BS EN 196-7 (PS...) at the point where the masonry cement is ready for delivery from the place of manufacture.

**A.2.2** The continuous inspection should take place at the masonry cement plant and be operated by the manufacturer (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, except in the cases of a new factory or a new type or strength class of masonry cement at an existing factory.

Minimum testing frequencies should be as given in table A.1<sup>2)</sup>.

<sup>2)</sup>In these two cases the period for assessing the conformity should be declared by the manufacturer on the certificate, but should not be less than 2 weeks.

<b>Table A.1 Minimum testing frequencies</b>	
Property	Number of samples
Air content (classes MC 5 and MC 12.5 only)	1 per week
Compressive strength (7-day and 28-day) Sulfate content Setting times	1 per 2 week
Soundness Chloride content Water retention Sieve residue	1 per month

**A.2.3** In the case of assessment of conformity by attributes, the test value which does not conform to the appropriate values in clause 6 is a non-conformity. Assessment by variables is described in **B.2**

**A.3 Assessment of conformity**

**A.3.1** The 28-days strength lower limit and air content upper limit given in clause 6 should be assessed at the 5 % level of non-conformities and all other requirements at the 10 % level of non-conformities.

**A.3.2** In the case of all the specified requirements, the conformity procedure should be based upon inspection by attributes.

In order to improve inspection efficiency, the masonry cement manufacturer may employ inspection by variables for properties where 20 or more test results are available for the inspection period. For practical calculations the acceptability constant  $k_A$  is used for the evaluation of conformity (see **B.2**).

**A.3.3** The sampling plan (including the number of single spot samples to be taken) is established by means of the two parameters.

- acceptable overall percentage of non-conformities
- acceptable consumer’s risk.

NOTE 1 Some convenient sampling plans for inspection by attributes and for inspection by variables are given in annex B. Any other plans satisfying the values for percentage of non-conformities and for consumer’s risk are, in principle acceptable for the conformity procedure.

NOTE 2 In addition to the statistical conformity of test results to this standard, table C.1 gives limits values for each test result.

**Annex B (informative)**  
**Sampling plans for cement manufacturer’s autocontrol**

NOTE. The annex contains a number of sampling plans for the following two alternatives;

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

**B.1 Inspection by attributes**

In this case the number  $c_D$  of non-conformities (one result per sample) in the complete series of samples is counted.

The conformity is checked by the equation

$$c_D \leq c_A$$

Where the acceptable number of non-conformities depends on the parameters specified in **A.3.1** and on the number  $n$ , of test results. Values of  $c_A$  are listed in table B.1.

<b>Table B.1 Acceptable number of Non-conformities at 5 % consumer’s risk</b>		
<b>Acceptable percentage of Non-conformities <math>P_a = 10 \%</math></b>	$c_A$	<b>Acceptable percentage of Non-conformities <math>P_a = 10 \%</math></b>
<b>Number of test results <math>n</math></b>		<b>Number of test results <math>n</math></b>
Less than 40	0	Less than 80
40 to 54	1	80 to 109
55 to 69	2	110 to 139
70 to 84	3	140 to 169
85 to 99	4	170 to 199
100 to 109	5	200 to 219

## B.2 Inspection by variables

In this case the mean value,  $x$ , and the standard deviation,  $s$ , of the complete series of test results (one result per sample) are calculated.

The conformity criteria are:

$$x - k_{AS} \geq L$$

and

$$x + k_{AS} U \text{ where}$$

$k_A$  is the acceptability constant from table B.2;

$L$  is the specified lower

$U$  is the specified upper limit.

The acceptability constant  $k_A$  depends on the acceptable percentage of non-conformities,  $Pa$ , and on the number  $n$ , of test results. Values of  $k_A$  are listed in table B.2.

$N$	$Pa = 5 \%$	$Pa = 10 \%$
20 to 21	2.40	1.93
22 to 23	2.35	1.89
24 to 25	2.31	1.85
26 to 27	2.27	1.82
28 to 29	2.24	1.80
30 to 34	2.22	1.78
35 to 39	2.17	1.73
40 to 49	2.13	1.70
50 to 59	2.07	1.65
60 to 79	2.02	1.61
80 to 99	1.97	1.56
100 to 149	1.93	1.53
150 to 199	1.87	1.48
$\geq 200$	1.84	1.45

## Annex C (informative)

### Sampling and testing for acceptance inspection at delivery

**C.1** For assessing compliance at delivery, when requested a spot sample of the masonry cement should be taken in accordance with **3.6** and **6.2, 6.3, 6.4** or **6.5** of BS EN 196-7 : 1992 (PS...) either before, or at the time of, delivery. A laboratory sample should be prepared and packed in accordance with clause **8** and **9** of BSEN 196-7 : 1992/(PS...). A sampling report should be completed at the time of sampling and should be attached to the laboratory sample in accordance with clause 10 of BS EN 196-7 : 1992

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 contentiously as described in **9.2** of BS EN 196-7 : 1992/PS....

**C.2** When the masonry cement is tested for strength (see **6.3.6**), unless otherwise agreed between the purchaser and manufacturer, the pit or quarry from which the CEN standard sand (as specified in BS EN 196-1) is obtained and the compaction procedure to be used should be those in use by the manufacturer at the time when the cement was originally tested.

**C.3** When the masonry cement is tested for chemical properties (see **6.4**) the sample should be prepared by the method described in clause **6** of BS EN 196-2 : 1995(PS...).

**C.4** The tests should be made in accordance with the relevant procedures in BS EN 413-2 or BS EN 196. The limit values applicable to this subclause should be those given in table C.1.

<b>Table C.1 Acceptance inspection limit values</b>				
<b>Property</b>	<b>Limit values</b>			
	<b>Class</b>			
	<b>MC 5</b>	<b>MC 12.5</b>	<b>Mc 12.5X</b>	<b>MC 22.5X</b>
Compressive strength Lower limit (N/mm <sup>2</sup> )				
7-days	-	6.0	6.0	9.0
28-days	4.0	10.5	10.5	20.5
Compressive strength Upper limit (N/mm <sup>2</sup> )				
28-days	17.5	37.0	37.5	47.5
Sieve residue Maximum (% <i>m/m</i> )	20	20	20	20
Setting times				
Initial – lower limit (min)	45	45	45	45
final – upper limit (h)	17	17	17	17
Soundness Maximum (% <i>m/m</i> )	11	11	11	11
Sulfate content Maximum (% <i>m/m</i> )	2.1	3.1 <sup>1)</sup>	3.1 <sup>1)</sup>	3.1 <sup>1)</sup>
Chloride content Maximum (% <i>m/m</i> )	-	0.11	0.11	0.11
Water retention				
upper limit (%)	97	97	97	97
lower limit (%)	75	75	75	75
Air content				
upper (% <i>V/V</i> )	20	20	6	6
lower limit (% <i>V/V</i> )	6	6	0	0
<sup>1)</sup> 3.6 % if the Portland clinker content can be shown to be not less than 55 %				

### **Annex D (informative)** **Information to be provided**

#### **D.1 Test certificate**

If a test certificate is requested, it should include results of the following tests on the samples of masonry cement relating to the material delivered:

- a) compressive strength at 7 days if appropriate, and also at 28 days, obtained from tests on mortar prisms in accordance with BS EN 196-1 (PS...) (see **6.3.6**);
- b) initial setting time (see **6.3.2**);
- c) soundness (see **6.3.4**);
- d) sulfate content (see **6.4**);
- e) chloride content (see **6.4**);
- f) air content (see table 3);
- g) water retention (see table 3);

NOTE. The certificate should be available from the manufacturer.

## **Annex E (informative)**

### **Workability**

The workability of mortar is a complex property involving consistence (wetness) and cohesiveness. A good mortar should spread easily whilst clinging well to the trowel and masonry unit. This has been addressed in annex A of DD ENV 413-1.

Workability is defined as cohesiveness at a standard consistence measured by means of flow time using a workability meter as described in BS EN 413-2(PS...). On the basis of workability meter values obtained from a European masonry cement test programme during the development of DD ENV 413-1 a flow time between 5 s and 30 s was found to correspond to a suitable workability for masonry cement.

Apart from UK work in the test programme there is no other UK experience of the workability meter described in BS EN 413-2.

However, the concept of cohesiveness at standard consistence is not new to the UK and a flow table test was included in BS 5224: 1976. Flow table spread at standard consistence as a measure of cohesiveness as an alternative to the flow time in the workability meter in BS EN 413-2 (PS...) is currently being investigated.

## **Annex F (informative)**

### **Product guidance**

#### **F.1 General**

Guidance on the use of masonry cement in mortar can be found in BS 5628 (PS...): BS 5628 Part 3, BS 8000 : Part 3 and BRE Digest 362{1}.

#### **F.2 Safety warning**

Dry cement in normal use has no harmful effect on dry skin. When cement is mixed with water, alkali is released. Precautions should therefore be taken to avoid dry cement entering the eyes, mouth and nose and to prevent skin contact with wet cement. Repeated skin contact with wet cement or mortar over a period can cause irritant dermatitis. The abrasiveness of the particles of cement and sand in mortar can contribute to this effect. Continued contact during a working day can lead to cement burns with ulceration, but this is not common. Some people are sensitive to the small amounts of chromate which can be present in cements and can develop allergic contact dermatitis, but this is rare.

When working in places where dry cement becomes airborne, protection for the eyes, mouth and nose should be worn.

When working with wet mortar, waterproof or other suitable protective clothing should be worn, such as long sleeved shirts and water gloves. Clothing contaminated with wet cement or mortar should be removed and washed before further use. If cement enters the eye it should immediately be washed out thoroughly with clean water and medical treatment should be sought without delay. Wet mortar on the skin should be washed off immediately.

#### **F.3 Storage**

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

Paper bags should be stored clear of the ground, not more than 8 bags high and protected by a waterproof structure. As significant strength losses begin after 4 weeks to 6 week of storage in bags in normal conditions, and considerably sooner under adverse weather conditions or high humidity, deliveries should be controlled and used in order of receipt. Manufacturers normally provide a system of marking a high proportion of the bags in each delivery to indicate when they were filled.

#### **F.4 Test temperature**

BS EN 196-1 (PS...) and BS EN 196-3 (PS...) require that the strength and setting time tests are carried out at a temperature of  $(20 \pm 1)$  °C. When cement is tested at a different temperature the results are likely to be affected. Appropriate advice may be obtained from the manufacturer.

#### **F.5 Rendering and grouting**

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

#### **F.6 Use of masonry cement in mortar**

The only class of masonry cement equivalent to cements previously specified in BS 5224:1976 (PS...) is MC 12.5 but it should be noted that this revision permits a wider range of compositions than the 1976 edition. In particular; Portland clinker contents as low as 40 % are permitted. There is no experience in the UK of classes MC 5, MC 12.5X and MC 22.5X.

The mix proportions (by volume) required to produce any given designation of prescribed mortar will vary depending on the composition and bulk density of the masonry cement. Manufacturers' advice should be followed to achieve the required designation.

The compositional changes introduced in this edition permit the use of masonry cements with lower clinker contents than established materials. Although the working properties and strength may be determined, there is no information yet available on durability when these new masonry cements are subjected to country's climatic conditions.

## List of references (see clause 2)

### Normative reference

#### BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 410: 1986 (PS...)	<i>Specification for test sieves.</i>
BS 6100/(PS...):	<i>Glossary of building and civil engineering terms</i>
BS 6100: Part 6/(PS...):	<i>Concrete and plaster</i>
BS 6100: Section 6.1:1984(PS...)	<i>Blinders</i>
BS EN 196(PS...):	<i>Methods of testing cement</i>
BS EN 196-1 : 1995(PS...)	<i>Determination of strength</i>
BS EN 196-2 : 1995(PS...)	<i>Chemical analysis of cement</i>
BS EN 196-3 : 1995(PS...)	<i>Determination of setting time and soundness</i>
BS EN 196-6 : 1992 (PS...)	<i>Determination of fineness</i>
BS EN 196-7 : 1995 (PS...)	<i>Methods of taking and preparing samples of cement</i>
BS EN 196-21 : 1992 (PS...)	<i>Determination of the chloride, carbon dioxide and Alkali content of cement</i>
BS EN 413/(PS...):	<i>Masonry cement</i>
BS EN 413-2 : 1995/(PS...)	<i>Test methods</i>

### Information reference

#### BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 12: 1991 (PS...)	<i>Specification for Portland cement</i>
BS 5262: 1991(PS...)	<i>Code of practice external renderings</i>
BS 5628 (PS...)	<i>Code of practice for use of masonry</i>
BS 5628: Part 3 :1985 (PS...)	<i>Materials and components, design and workmanship</i>
BS 8000/ (PS...):	<i>Workmanship building sites</i>
BS 8000: Part 3 :1989(PS...)	<i>Code of practice for masonry</i>
DD ENV 197 (PS...)	<i>Cement-composition, specifications and conformity criteria</i>
DD ENV 197-1 : 1995(PS...)	<i>Common cements</i>
DD ENV 413: (PS...)	<i>Masonry cement</i>
DD ENV 413-1 : 1995(PS...)	<i>Specification</i>
BS EN ISO 9000: (PS...)	<i>Quality management and quality assurances standards</i>

### Other references

[1] BRE Digest 362 *Building mortar*: Watford Building Research Establishment, 1991.