BS EN 197-1:2011
Incorporating corrigenda November 2011, October 2015 and February 2019

BSI Standards Publication

Cement

Part 1: Composition, specifications and conformity criteria for common cements

National foreword

This British Standard is the UK implementation of EN 197-1:2011. It supersedes BS EN 197-1:2000, BS EN 197-4:2004 and BS 1370:1979 which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/516, Cement and lime.

A list of organizations represented on this committee can be obtained on request to its secretary.

When reference to this Standard has been published in the Official Journal of the European Union (OJEU), compliance with it will confer a presumption of conformity with the Construction Products Directive.

The detailed requirements for evaluating the conformity of common cements with this standard are given in BS EN 197-2, *Cement — Part 2: Conformity evaluation*. In addition, these same provisions describe all the tasks that are required for demonstrating legal attestation of conformity to a system 1+ for CE marking purposes.

This British Standard does not include in its scope the additional special properties of pozzolanic pulverized-fuel ash cement, conforming to BS 6610, or other types of cement where hardening is not primarily due to the hydration of calcium silicates.

National annex NA (informative) details the exchange of additional information between the cement manufacturer and user, including the provision of information for alkali contents.

National annex NB (informative) gives recommendations for sampling and testing for acceptance inspection at delivery.

National annex NC (informative) gives a national recommendation for the loss on ignition property of a siliceous fly ash constituent.

National annex ND (informative) provides guidance on the general use of common cements, including health and safety aspects.

National annex NE (informative) lists publications referred to in national annexes NA – ND.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2019

ISBN 978 0 539 03842 2

ICS 91.100.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 September 2011.

Amendments/corrigenda issued since publication

Date	Text affected
30 November 2011	National foreword revised and addition of National Annexes NA, NB, NC, ND and NE
31 October 2015	Correction to supersession details in National foreword
28 February 2019	Update to subclause NA.4.3.2 and Table NA.1 in National Annex NA

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 197-1

September 2011

ICS 91.100.10

Supersedes EN 197-1:2000, EN 197-4:2004

English Version

Cement - Part 1: Composition, specifications and conformity criteria for common cements

Ciment - Partie 1 : Composition, spécifications et critères des conformité des ciments courants

Zement - Teil 1: Zusammensetzung, Anforderungen und Konformitätskriterien von Normalzement

This European Standard was approved by CEN on 6 August 2011.

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Ref. No. EN 197-1:2011: E

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Foreword

This document (EN 197-1:2011) has been prepared by Technical Committee CEN/TC 51 “Cement and building limes”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2012, and conflicting national standards shall be withdrawn at the latest by June 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 197-1:2000, EN 197-4:2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of EN 197-1.

Annexes A and ZA are informative.

In addition to consolidating EN 197-1:2000/A1:2004, EN 197-1:2000/prA2, EN 197-1:2000/A3:2007, EN 197-4:2004 and EN 197-4:2004/prA1 into a single standard, the principal changes from EN 197-1:2000 are the introduction of additional requirements for common cements with a low heat of hydration and common cements with sulfate resisting properties.

The preparation of a standard for cement was initiated by the European Economic Community (EEC) in 1969 and, at the request of a member state later in 1973, the work was given to the European Committee for Standardization (CEN). The Technical Committee CEN/TC 51 was entrusted with the task of preparing a cement standard for the countries of Western Europe, comprising the EEC and EFTA members.

In the early eighties, CEN/TC 51 decided to include in the standard for cement only those cements which are intended for use in any plain and reinforced concrete and which are familiar in most countries in Western Europe because they have been produced and used in these countries for many years. The EU Construction Products Directive (89/106/EEC) requires the incorporation of all traditional and well-tried cements in order to remove technical barriers to trade in the construction field. There are currently no criteria for the descriptions "traditional" and "well tried" and it was considered necessary to separate the “common cements” from special cements, i.e. those with additional or special properties.

The requirements in this standard are based on the results of tests on cement in accordance with EN 196-1, EN 196-2, EN 196-3, EN 196-5, EN 196-6, EN 196-7, EN 196-8, and EN 196-9. The scheme for the evaluation of conformity of common cements including common cements with low heat of hydration and common cements generally accepted as being sulfate resisting are specified in EN 197-2.

In order to find out which common cements are generally accepted as being sulfate resisting and should be included in EN 197-1, there was an investigation within CEN/TC 51 comprising all national specifications and recommendations in the European Union. The review of these investigations led to the following results:

— a wide variety of cements has been classified in the EU Member States as sulfate resisting. This is due to the different geographical and climatic conditions under which sulfate attacks on mortar and concrete occur at the place of use and the traditionally different rules governing the production and use of sulfate resistant mortars and concretes;

— sulfate resistance is an additional property and therefore sulfate resisting cements have first to conform to the requirements of the standards which define the product, e.g. EN 197-1 for common cements;

— the additional requirements to be met by the nationally specified sulfate resisting cements refer to selected characteristics for which the required limit values are more stringent than those for common cements;

— having satisfied the local requirements for various cement types many countries apply further restrictions to the production of concrete to be used in a sulfate environment, such as minimum cement contents and/or maximum water/cement ratio that vary depending on the cement type and the type and intensity of the sulfate conditions.

Based on the above results common cement types to be harmonized at the European level have been chosen. The predominant part of the common cements considered to be sulfate resisting in the market is covered by this selection. It was not possible to take into account national particularities the use of which is laid down within national standards, national application rules and regulations/provisions.

The strength attained at 28 days is the important criterion in classifying cement for most uses. In order to achieve a specific strength class at 28 days the early strength, at 2 days or at 7 days, can vary and some types of cement may not attain the minimum early strengths specified in EN 197-1 for common cements.

The heat of hydration is linked to the early reactivity and lower early strengths indicate lower heat evolution and lower temperatures in concrete. For these cements additional precautions in use can be necessary to ensure adequate curing and safety in construction.

The purpose of this standard is to specify the composition requirements and conformity requirements for common cements, including common cements with low heat of hydration and common cements with adequate sulfate resistance as well as low early strength blast furnace cements and low early strength blast furnace cements with low heat of hydration.

Cement types and strength classes defined in this European Standard allow the specifier and/or the user to fulfil objectives of sustainability for cement based constructions. Cement types produced by using constituents listed and defined in Clause 5 allow the manufacturer to minimize the use of natural resources in accordance with local conditions of production.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

It is recognised that different cements have different properties and performance. Those performance tests now available (i.e. setting time, strength, soundness and heat of hydration), have been included in this standard. In addition, work is being carried out by CEN/TC 51 to identify any additional tests which are needed to specify further performance characteristics of cement. Until further performance tests are available it is necessary that the choice of cement, especially the type and/or strength class in relation to the requirements for durability depending on exposure class and type of construction in which it is incorporated, follows the appropriate standards and/or regulations for concrete or mortar valid in the place of use.

1 Scope

This European Standard defines and gives the specifications of 27 distinct common cements, 7 sulfate resisting common cements as well as 3 distinct low early strength blast furnace cements and 2 sulfate resisting low early strength blast furnace cements and their constituents. The definition of each cement includes the proportions in which the constituents are to be combined to produce these distinct products in a range of nine strength classes. The definition also includes requirements which the constituents have to meet. It also includes mechanical, physical, and chemical requirements. Furthermore, this standard states the conformity criteria and the related rules. Necessary durability requirements are also given.

In addition to those sulfate resisting cements defined in the present document, other cements conforming either to this standard or to other standards, European or national, have been nationally demonstrated to have sulfate resisting properties. These cements which are listed in Annex A, are considered by different CEN Member countries as sulfate resisting within the limits of their territory.

NOTE 1 In addition to the specified requirements, an exchange of additional information between the cement manufacturer and user can be helpful. The procedures for such an exchange are not within the scope of this standard but should be dealt with in accordance with national standards or regulations or can be agreed between the parties concerned.

NOTE 2 The word “cement” in EN 197-1 is used to refer only to common cements unless otherwise specified.

This European Standard does not cover:

— very low heat special cement covered by EN 14216;

— supersulfated cement covered by EN 15743;

— calcium aluminate cement covered by EN 14647;

— masonry cement covered by EN 413-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 196-1, *Methods of testing cement — Part 1: Determination of strength*

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

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

EN 196-5, *Methods of testing cement — Part 5: Pozzolanicity test for pozzolanic cement*

EN 196-6, *Methods of testing cement — Part 6: Determination of fineness*

EN 196-7, *Methods of testing cement — Part 7: Methods of taking and preparing samples of cement*

EN 196-8, *Methods of testing cement — Part 8: Heat of hydration — Solution method*

EN 196-9, *Methods of testing cement — Part 9: Heat of hydration — Semi-adiabatic method*

EN 197-2:2000, *Cement — Part 2: Conformity evaluation*

EN 451-1, *Method of testing fly ash — Part 1: Determination of free calcium oxide content*

EN 933-9, *Tests for geometrical properties of aggregates — Part 9: Assessment of fines - Methylene blue test*

EN 13639, *Determination of total organic carbon in limestone*

ISO 9277, *Determination of the specific surface area of solids by gas adsorption — BET method*

ISO 9286, *Abrasive grains and crude — Chemical analysis of silicon carbide*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
reactive calcium oxide (CaO)
fraction of the calcium oxide which, under normal hardening conditions, can form calcium silicate hydrates or calcium aluminate hydrates

NOTE To evaluate this fraction, the total calcium oxide content (see EN 196-2) is reduced by the fraction corresponding to calcium carbonate ($CaCO_3$), based on the measured carbon dioxide (CO_2) content (see EN 196-2), and the fraction corresponding to calcium sulfate ($CaSO_4$), based on the measured sulfate (SO_3) content (see EN 196-2) after subtraction of the SO_3 taken up by alkalis.

3.2
reactive silicon dioxide (SiO_2)
fraction of the silicon dioxide which is soluble after treatment with hydrochloric acid (HCl) and with boiling potassium hydroxide (KOH) solution

NOTE The quantity of reactive silicon dioxide is determined by subtracting from the total silicon dioxide content (see EN 196-2) the fraction contained in the residue insoluble in hydrochloric acid and potassium hydroxide (see EN 196-2), both on a dry basis.

3.3
main constituent
specially selected inorganic material in a proportion exceeding 5 % by mass related to the sum of all main and minor additional constituents

3.4
minor additional constituent
specially selected inorganic material used in a proportion not exceeding a total of 5 % by mass related to the sum of all main and minor additional constituents

3.5
type of common cement
one of the 27 products (see Table 1) in the family of common cements

3.6
strength class of cement
class of compressive strength

3.7
autocontrol testing
continual testing by the manufacturer of cement spot samples taken at the point(s) of release from the factory/depot

3.8
control period
period of production and dispatch identified for the evaluation of the autocontrol test results

3.9
characteristic value
value of a required property outside of which lies a specified percentage, the percentile P_k, of all the values of the population

3.10
specified characteristic value
characteristic value of a mechanical, physical or chemical property which in the case of an upper limit is not to be exceeded or in the case of a lower limit is, as a minimum, to be reached

3.11
single result limit value
value of a mechanical, physical or chemical property which – for any single test result – in the case of an upper limit is not to be exceeded or in the case of a lower limit is, as a minimum, to be reached

3.12
allowable probability of acceptance CR
for a given sampling plan, allowed probability of acceptance of cement with a characteristic value outside the specified characteristic value

3.13
sampling plan
specific plan which states the (statistical) sample size(s) to be used, the percentile P_k and the allowable probability of acceptance CR

3.14
spot sample
sample which is taken at the same time and from one and the same place, relating to the intended tests, and which can be obtained by combining one or more immediately consecutive increments

NOTE See EN 196-7.

3.15
heat of hydration
quantity of heat developed by the hydration of a cement within a given period of time

3.16
low heat common cement
common cement with a limited heat of hydration

3.17
sulfate resisting common cement
common cement which fulfils the requirements for sulfate resisting properties

3.18
low heat low early strength blast furnace cement
low early strength blast furnace cement with a limited heat of hydration

3.19
sulfate resisting low early strength blast furnace cement
low early strength blast furnace cement which fulfils the requirements for sulfate resisting properties

4 Cement

Cement is a hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water.

Cement conforming to this standard, termed CEM cement, shall, when appropriately batched and mixed with aggregate and water, be capable of producing concrete or mortar which retains its workability for a sufficient time and shall after defined periods attain specified strength levels and also possess long-term volume stability.

Hydraulic hardening of CEM cement is primarily due to the hydration of calcium silicates but other chemical compounds may also participate in the hardening process, e.g. aluminates. The sum of the proportions of reactive calcium oxide (CaO) and reactive silicon dioxide (SiO_2) in CEM cement shall be at least 50 % by mass when the proportions are determined in accordance with EN 196-2.

CEM cements consist of different materials and are statistically homogeneous in composition resulting from quality assured production and material handling processes. The link between these production and material handling processes and the conformity of cement to this standard is elaborated in EN 197-2.

NOTE There are also cements whose hardening is mainly due to other compounds, e.g. calcium aluminate in calcium aluminate cement.

5 Constituents

5.1 General

The requirements for the constituents specified in 5.2 to 5.5 shall be determined in principle in accordance with the test methods described in EN 196 unless otherwise specified.

5.2 Main constituents

5.2.1 Portland cement clinker (K)

Portland cement clinker is made by sintering a precisely specified mixture of raw materials (raw meal, paste or slurry) containing elements, usually expressed as oxides, CaO, SiO_2, Al_2O_3, Fe_2O_3 and small quantities of other materials. The raw meal, paste or slurry is finely divided, intimately mixed and therefore homogeneous.

Portland cement clinker is a hydraulic material which shall consist of at least two-thirds by mass of calcium silicates ($3CaO \cdot SiO_2$ and $2CaO \cdot SiO_2$), the remainder consisting of aluminium and iron containing clinker phases and other compounds. The ratio by mass $(CaO)/(SiO_2)$ shall be not less than 2,0. The content of magnesium oxide (MgO) shall not exceed 5,0 % by mass.

Portland cement clinker incorporated in sulfate resisting Portland cement (CEM I) and sulfate resisting pozzolanic cements (CEM IV) shall fulfil additional requirements for tricalcium aluminate content (C_3A). The tricalcium aluminate content of the clinker shall be calculated by Equation (1) as follows:

$$C_3A = 2{,}65\ A - 1{,}69\ F \quad (1)$$

where

A is the percentage of aluminium oxide (Al_2O_3) by mass of the clinker as determined in accordance with EN 196-2

F is the percentage of iron (III) oxide (Fe_2O_3) by mass of the clinker as determined in accordance with EN 196-2.

NOTE It may happen that a negative C_3A value is obtained from the calculation. In this case, the value 0 % should be recorded. A test method to determine the C_3A content of clinker from the analysis of a spot sample of cement is currently under development by CEN/TC 51. Until this method is available, the C_3A content should be directly measured on the clinker. In the specific case of CEM I, it is permissible to calculate the C_3A content of clinker from the chemical analysis of the cement. The minimum frequency of testing and the use of alternative methods for the direct or indirect evaluation of C_3A should be included in the factory production control (see EN 197-2). A typical frequency of testing is two per month in routine situations.

Sulfate resisting Portland cements and sulfate resisting pozzolanic cements are made with Portland cement clinker in which the C_3A content does not exceed:

— For CEM I: 0 %, 3 % or 5 % as appropriate (see 6.2)

— For CEM IV/A and CEM IV/B: 9 %.

5.2.2 Granulated blast furnace slag (S)

Granulated blast furnace slag is made by rapid cooling of a slag melt of suitable composition, as obtained by smelting iron ore in a blast furnace and contains at least two-thirds by mass of glassy slag and possesses hydraulic properties when suitably activated.

Granulated blast furnace slag shall consist of at least two-thirds by mass of the sum of calcium oxide (CaO), magnesium oxide (MgO) and silicon dioxide (SiO_2). The remainder contains aluminium oxide (Al_2O_3) together with small amounts of other compounds. The ratio by mass (CaO + MgO)/(SiO_2) shall exceed 1,0.

5.2.3 Pozzolanic materials (P, Q)

5.2.3.1 General

Pozzolanic materials are natural substances of siliceous or silico-aluminous composition or a combination thereof. Although fly ash and silica fume have pozzolanic properties, they are specified in separate subclauses (see 5.2.4 and 5.2.7).

Pozzolanic materials do not harden in themselves when mixed with water but, when finely ground and in the presence of water, they react at normal ambient temperature with dissolved calcium hydroxide ($Ca(OH)_2$) to form strength-developing calcium silicate and calcium aluminate compounds. These compounds are similar to those which are formed in the hardening of hydraulic materials. Pozzolanas consist essentially of reactive silicon dioxide (SiO_2) and aluminium oxide (Al_2O_3). The remainder contains iron oxide (Fe_2O_3) and other oxides. The proportion of reactive calcium oxide for hardening is negligible. The reactive silicon dioxide content shall be not less than 25,0 % by mass.

Pozzolanic materials shall be correctly prepared, i.e. selected, homogenised, dried, or heat-treated and comminuted, depending on their state of production or delivery.

5.2.3.2 Natural pozzolana (P)

Natural pozzolanas are usually materials of volcanic origin or sedimentary rocks with suitable chemical and mineralogical composition and shall conform to 5.2.3.1.

5.2.3.3 Natural calcined pozzolana (Q)

Natural calcined pozzolanas are materials of volcanic origin, clays, shales or sedimentary rocks, activated by thermal treatment and shall conform to 5.2.3.1.

5.2.4 Fly ashes (V, W)

5.2.4.1 General

Fly ash is obtained by electrostatic or mechanical precipitation of dust-like particles from the flue gases from furnaces fired with pulverised coal.

NOTE 1 For definition of fly ash see EN 450-1.

Ash obtained by other methods shall not be used in cement that conforms to this standard.

Fly ash may be siliceous or calcareous in nature. The former has pozzolanic properties; the latter may have, in addition, hydraulic properties. The loss on ignition of fly ash determined in accordance with EN 196-2, but using an ignition time of 1 h, shall be within one of the following limits:

a) 0 % to 5,0 % by mass

b) 2,0 % to 7,0 % by mass

c) 4,0 % to 9,0 % by mass

The upper limit of loss on ignition of the fly ash used as a main constituent for the production of a cement shall be stated on its packaging and/or delivery note.

NOTE 2 The purpose of the requirement for the loss on ignition is to limit the residue of unburnt carbon in the fly ash. It is therefore sufficient to show, through direct measurement of unburnt carbon residue, that the content of unburnt carbon falls within the limits of the categories specified above. The content of unburnt carbon is determined in accordance with ISO 10694.

5.2.4.2 Siliceous fly ash (V)

Siliceous fly ash is a fine powder of mostly spherical particles having pozzolanic properties. It consists essentially of reactive silicon dioxide (SiO_2) and aluminium oxide (Al_2O_3). The remainder contains iron oxide (Fe_2O_3) and other compounds.

The proportion of reactive calcium oxide (CaO) shall be less than 10,0 % by mass, the content of free calcium oxide, as determined by the method described in EN 451-1 shall not exceed 1,0 % by mass. Fly ash having a free calcium oxide content higher than 1,0 % by mass but less than 2,5 % by mass is also acceptable, provided that the requirement on expansion (soundness) does not exceed 10 mm when tested in accordance with EN 196-3 using a mixture of 30 % by mass of siliceous fly ash and 70 % by mass of a CEM I cement conforming to EN 197-1.

The reactive silicon dioxide content shall not be less than 25,0 % by mass.

5.2.4.3 Calcareous fly ash (W)

Calcareous fly ash is a fine powder, having hydraulic and/or pozzolanic properties. It consists essentially of reactive calcium oxide (CaO), reactive silicon dioxide (SiO_2) and aluminium oxide (Al_2O_3). The remainder contains iron oxide (Fe_2O_3) and other compounds. The proportion of reactive calcium oxide shall not be less than 10,0 % by mass. Calcareous fly ash containing between 10,0 % and 15,0 % by mass of reactive calcium oxide shall contain not less than 25,0 % by mass of reactive silicon dioxide.

Adequately ground calcareous fly ash containing more than 15,0 % by mass of reactive calcium oxide shall have a compressive strength of at least 10,0 MPa at 28 days when tested in accordance with EN 196-1. Before testing, the fly ash shall be ground and the fineness, expressed as the proportion by mass of the ash retained when wet sieved on a 40 µm mesh sieve, shall be between 10 % and 30 % by mass. The test mortar shall be prepared with ground calcareous fly ash only instead of cement. The mortar specimens shall be demoulded 48 h after preparation and then cured in a moist atmosphere of relative humidity of at least 90 % until tested.

The expansion (soundness) of calcareous fly ash shall not exceed 10 mm when tested in accordance with EN 196-3 using a mixture of 30 % by mass of calcareous fly ash ground as described above and 70 % by mass of a CEM I cement conforming to EN 197-1.

NOTE If the sulfate (SO_3) content of the fly ash exceeds the permissible upper limit for the sulfate content of the cement then this has to be taken into account for the manufacture of the cement by appropriately reducing the calcium sulfate-containing constituents.

5.2.5 Burnt shale (T)

Burnt shale, specifically burnt oil shale, is produced in a special kiln at temperatures of approximately 800 °C. Owing to the composition of the natural material and the production process, burnt shale contains clinker phases, mainly

dicalcium silicate and monocalcium aluminate. It also contains, besides small amounts of free calcium oxide and calcium sulfate, larger proportions of pozzolanically reacting oxides, especially silicon dioxide. Consequently, in a finely ground state burnt shale shows pronounced hydraulic properties like Portland cement and in addition pozzolanic properties.

Adequately ground burnt shale shall have a compressive strength of at least 25,0 MPa at 28 days when tested in accordance with EN 196-1. The test mortar shall be prepared with finely ground burnt shale only instead of cement. The mortar specimens shall be demoulded 48 h after preparation and cured in a moist atmosphere of relative humidity of at least 90 % until tested.

The expansion (soundness) of burnt shale shall not exceed 10 mm when tested in accordance with EN 196-3 using a mixture of 30 % by mass of ground burnt shale and 70 % by mass of a CEM I cement conforming to EN 197-1.

NOTE If the sulfate (SO_3) content of the burnt shale exceeds the permissible upper limit for the sulfate content of the cement then this has to be taken into account for the manufacture of the cement by appropriately reducing the calcium sulfate-containing constituents.

5.2.6 Limestone (L, LL)

Limestone shall meet the following requirements:

a) The calcium carbonate ($CaCO_3$) content calculated from the calcium oxide content shall be at least 75 % by mass.

b) The clay content, determined by the methylene blue test in accordance with EN 933-9, shall not exceed 1,20 g/100 g. For this test the limestone shall be ground to a fineness of approximately 5 000 cm^2/g determined as specific surface in accordance with EN 196-6.

c) The total organic carbon (TOC) content, when tested in accordance with EN 13639, shall conform to one of the following criteria:

   1) LL:shall not exceed 0,20 % by mass;

   2) L: shall not exceed 0,50 % by mass.

5.2.7 Silica fume (D)

Silica fume originates from the reduction of high purity quartz with coal in electric arc furnaces in the production of silicon and ferrosilicon alloys and consists of very fine spherical particles containing at least 85 % by mass of amorphous silicon dioxide. The content of elemental silicon (Si) determined according to ISO 9286, shall not be greater than 0,4 % by mass.

Silica fume shall meet the following requirements:

a) The loss on ignition shall not exceed 4,0 % by mass determined in accordance with EN 196-2 but using an ignition time of 1 h.

b) The specific surface (BET) of the untreated silica fume shall be at least 15,0 m^2/g when tested in accordance with ISO 9277.

For intergrinding with clinker and calcium sulfate the silica fume may be in its original state or compacted or pelletised (with water) or equivalently processed.

5.3 Minor additional constituents

Minor additional constituents are specially selected, inorganic natural mineral materials, inorganic mineral materials derived from the clinker production process or constituents as specified in 5.2 unless they are included as main constituents in the cement.

Minor additional constituents, after appropriate preparation and on account of their particle size distribution, improve the physical properties of the cement (such as workability or water retention). They can be inert or have slightly hydraulic, latent hydraulic or pozzolanic properties. However, no requirements are set for them in this respect.

Minor additional constituents shall be correctly prepared, i.e. selected, homogenised, dried and comminuted depending on their state of production or delivery. They shall not increase the water demand of the cement appreciably, impair the resistance of the concrete or mortar to deterioration in any way or reduce the corrosion protection of the reinforcement.

NOTE Information on the minor additional constituents in the cement should be available from the manufacturer on request.

5.4 Calcium sulfate

Calcium sulfate is added to the other constituents of cement during its manufacture to control setting.

Calcium sulfate can be gypsum (calcium sulfate dihydrate, $CaSO_4 \cdot 2H_2O$), hemihydrate ($CaSO_4 \cdot ½H_2O$), or anhydrite (anhydrous calcium sulfate, $CaSO_4$) or any mixture of them. Gypsum and anhydrite are found naturally. Calcium sulfate is also available as a by-product of certain industrial processes.

5.5 Additives

Additives for the purpose of EN 197-1 are constituents not covered in 5.2 to 5.4 which are added to improve the manufacture or the properties of the cement.

The total quantity of additives shall not exceed 1,0 % by mass of the cement (except for pigments). The quantity of organic additives on a dry basis shall not exceed 0,2 % by mass of the cement. A higher quantity may be incorporated in cements provided that the maximum quantity, in %, is declared on the packaging and/or the delivery note.

These additives shall not promote corrosion of the reinforcement or impair the properties of the cement or of the concrete or mortar made from the cement.

When admixtures for concrete, mortar or grouts conforming to the EN 934 series are used in cement the standard notation of the admixture shall be declared on bags or delivery documents.

6 Composition and notation

6.1 Composition and notation of common cements

The products in the family of common cements, covered by EN 197-1, and their notation are given in Table 1. They are grouped into five main cement types as follows:

— CEM I Portland cement,

— CEM II Portland-composite cement,

— CEM III Blast furnace cement,

— CEM IV Pozzolanic cement,

— CEM V Composite cement.

The composition of each of the products in the family of common cements shall be in accordance with Table 1.

NOTE For clarity in definition, the requirements for the composition refer to the sum of all main and minor additional constituents. The final cement is to be understood as the main and minor additional constituents plus the necessary calcium sulfate (see 5.4) and any additives (see 5.5).

Table 1 — The 27 products in the family of common cements

Main types	Notation of the 27 products (types of common cement)		Composition (percentage by mass[a])										
			Main constituents										Minor additional constituents
			Clinker	Blast-furnace slag	Silica fume	Pozzolana		Fly ash		Burnt shale	Limestone		
						natural	natural calcined	siliceous	calca-reous				
			K	S	D[b]	P	Q	V	W	T	L	LL	
CEM I	Portland cement	CEM I	95-100	–	–	–	–	–	–	–	–	–	0-5
CEM II	Portland-slag cement	CEM II/A-S	80-94	6-20	–	–	–	–	–	–	–	–	0-5
		CEM II/B-S	65-79	21-35	–	–	–	–	–	–	–	–	0-5
	Portland-silica fume cement	CEM II/A-D	90-94	–	6-10	–	–	–	–	–	–	–	0-5
	Portland-pozzolana cement	CEM II/A-P	80-94	–	–	6-20	–	–	–	–	–	–	0-5
		CEM II/B-P	65-79	–	–	21-35	–	–	–	–	–	–	0-5
		CEM II/A-Q	80-94	–	–	–	6-20	–	–	–	–	–	0-5
		CEM II/B-Q	65-79	–	–	–	21-35	–	–	–	–	–	0-5
	Portland-fly ash cement	CEM II/A-V	80-94	–	–	–	–	6-20	–	–	–	–	0-5
		CEM II/B-V	65-79	–	–	–	–	21-35	–	–	–	–	0-5
		CEM II/A-W	80-94	–	–	–	–	–	6-20	–	–	–	0-5
		CEM II/B-W	65-79	–	–	–	–	–	21-35	–	–	–	0-5
	Portland-burnt shale cement	CEM II/A-T	80-94	–	–	–	–	–	–	6-20	–	–	0-5
		CEM II/B-T	65-79	–	–	–	–	–	–	21-35	–	–	0-5
	Portland-limestone cement	CEM II/A-L	80-94	–	–	–	–	–	–	–	6-20	–	0-5
		CEM II/B-L	65-79	–	–	–	–	–	–	–	21-35	–	0-5
		CEM II/A-LL	80-94	–	–	–	–	–	–	–	–	6-20	0-5
		CEM II/B-LL	65-79	–	–	–	–	–	–	–	–	21-35	0-5
	Portland-composite cement[c]	CEM II/A-M	80-88	‹---------- 12-20 ----------›									0-5
		CEM II/B-M	65-79	‹---------- 21-35 ----------›									
CEM III	Blast furnace cement	CEM III/A	35-64	36-65	–	–	–	–	–	–	–	–	0-5
		CEM III/B	20-34	66-80	–	–	–	–	–	–	–	–	0-5
		CEM III/C	5-19	81-95	–	–	–	–	–	–	–	–	0-5
CEM IV	Pozzolanic cement[c]	CEM IV/A	65-89	–	<---------- 11-35 ---------->					–	–	–	0-5
		CEM IV/B	45-64	–	<---------- 36-55 ---------->					–	–	–	0-5
CEM V	Composite cement[c]	CEM V/A	40-64	18-30	–	<-------- 18-30 -------->			–	–	–	–	0-5
		CEM V/B	20-38	31-49	–	<-------- 31-49 -------->			–	–	–	–	0-5

a The values in the table refer to the sum of the main and minor additional constituents.

b The proportion of silica fume is limited to 10 %.

c In Portland-composite cements CEM II/A-M and CEM II/B-M, in pozzolanic cements CEM IV/A and CEM IV/B and in composite cements CEM V/A and CEM V/B the main constituents other than clinker shall be declared by designation of the cement (for examples, see Clause 8).

6.2 Composition and notation of sulfate resisting common cements (SR-Cements)

The seven products in the family of the sulfate resisting common cements, covered by this standard are given in Table 2.

They are grouped into three main cement types as follows:

Sulfate resisting Portland cement:

— CEM I-SR 0 Sulfate resisting Portland cement (C_3A content of the clinker = 0 %),

— CEM I-SR 3 Sulfate resisting Portland cement (C_3A content of the clinker ≤ 3 %),

— CEM I-SR 5 Sulfate resisting Portland cement (C_3A content of the clinker ≤ 5 %),

Sulfate resisting blast furnace cement:

— CEM III/B-SR Sulfate resisting blast furnace cement (no requirement on C_3A content of the clinker),

— CEM III/C-SR Sulfate resisting blast furnace cement (no requirement on C_3A content of the clinker),

Sulfate resisting pozzolanic cement:

— CEM IV/A-SR Sulfate resisting pozzolanic cement (C_3A content of the clinker ≤ 9 %),

— CEM IV/B-SR Sulfate resisting pozzolanic cement (C_3A content of the clinker ≤ 9 %).

The composition of each of the seven products in the family of the sulfate resisting common cements shall be in accordance with Table 2. The cement type notation shall be in accordance with the requirements of this standard with additional notation by SR 0, SR 3, SR 5 for CEM I cements and only "SR" for CEM III and IV cements.

Table 2 — The seven products in the family of sulfate resisting common cements

Main types	Notation of the seven products (types of sulfate resisting common cement)		Composition (percentage by mass[a])				
			Main constituents				Minor additional constituents
			Clinker K	Blast furnace slag S	Pozzolana natural P	Siliceous fly ash V	
CEM I	Sulfate resisting Portland cement	CEM I-SR 0 CEM I-SR 3 CEM I-SR 5	95 – 100				0 – 5
CEM III	Sulfate resisting blast furnace cement	CEM III/B-SR	20 – 34	66 – 80	-	-	0 – 5
		CEM III/C-SR	5 – 19	81 – 95	-	-	0 – 5
CEM IV	Sulfate[b] resisting pozzolanic cement	CEM IV/A-SR	65 – 79		⇐ --- 21 – 35 --- ⇒		0 – 5
		CEM IV/B-SR	45 – 64		⇐ --- 36 – 55 --- ⇒		0 – 5

[a] The values in the table refer to the sum of the main and minor additional constituents.

[b] In sulfate resisting pozzolanic cements, types CEM IV/A-SR and CEM IV/B-SR, the main constituents other than clinker shall be declared by designation of the cement (for examples, see Clause 8).

6.3 Composition and notation of low early strength common cements

Low early strength common cements are CEM III blast furnace cements as specified in Table 1. They differ from other common cements regarding the early strength requirements (see 7.1.2). Low early strength CEM III cements conforming to the requirements in Table 2 can also be declared as sulfate resisting common cements.

7 Mechanical, physical, chemical and durability requirements

7.1 Mechanical requirements

7.1.1 Standard strength

The standard strength of a cement is the compressive strength determined in accordance with EN 196-1 at 28 days and shall conform to the requirements in Table 3.

Three classes of standard strength are included: class 32,5, class 42,5 and class 52,5 (see Table 3).

7.1.2 Early strength

The early strength of a cement is the compressive strength determined in accordance with EN 196-1 at either 2 days or 7 days and shall conform to the requirements in Table 3.

Three classes of early strength are included for each class of standard strength, a class with ordinary early strength, indicated by N, a class with high early strength, indicated by R and a class with low early strength, indicated by L (see Table 3). Class L is only applicable for CEM III cements. These are the distinct low early strength blast furnace cements.

Table 3 — Mechanical and physical requirements given as characteristic values

Strength class	Compressive strength MPa				Initial setting time	Sound-ness (expan-sion)
	Early strength		Standard strength			
	2 days	7 days	28 days		min	mm
32,5 L[a]	-	≥ 12,0	≥ 32,5	≤ 52,5	≥ 75	≤ 10
32,5 N	-	≥ 16,0				
32,5 R	≥ 10,0	-				
42,5 L[a]	-	≥16,0	≥ 42,5	≤ 62,5	≥ 60	
42,5 N	≥ 10,0	-				
42,5 R	≥ 20,0	-				
52,5 L[a]	≥ 10,0	-	≥ 52,5	-	≥ 45	
52,5 N	≥ 20,0	-				
52,5 R	≥ 30,0	-				

a Strength class only defined for CEM III cements.

7.2 Physical requirements

7.2.1 Initial setting time

The initial setting time, determined in accordance with EN 196-3, shall conform to the requirements in Table 3.

7.2.2 Soundness

The expansion, determined in accordance with EN 196-3, shall conform to the requirement in Table 3.

7.2.3 Heat of hydration

The heat of hydration of low heat common cements shall not exceed the characteristic value of 270 J/g, determined in accordance with either EN 196-8 at 7 days or in accordance with EN 196-9 at 41 h.

Low heat common cements shall be identified by the notation "LH".

NOTE 1 Pre-normative research has demonstrated the equivalence of test results for EN 196-8 at 7 days and EN 196-9 at 41 h. Nevertheless, in case of dispute between laboratories, the method to be applied should be agreed.

NOTE 2 Cement with a higher hydration heat value is appropriate for some applications. It is necessary that this value should be agreed upon between manufacturer and user, and that this cement should not be identified as low heat cement (LH).

7.3 Chemical requirements

The properties of the cements of the cement type and strength class shown in columns 3 and 4 respectively of Table 4 shall conform to the requirements listed in column 5 of this table when tested in accordance with the standard referred to in column 2.

Table 4 — Chemical requirements given as characteristic values

1	2	3	4	5
Property	**Test reference**	**Cement type**	**Strength class**	**Requirements[a]**
Loss on ignition	EN 196-2	CEM I CEM III	All	≤ 5,0 %
Insoluble residue	EN 196-2 [b]	CEM I CEM III	All	≤ 5,0 %
Sulfate content (as SO_3)	EN 196-2	CEM I CEM II[c] CEM IV CEM V	32,5 N 32,5 R 42,5 N	≤ 3,5 %
			42,5 R 52,5 N 52,5 R	≤ 4,0 %
		CEM III[d]	All	
Chloride content	EN 196-2	all [e]	All	≤ 0,10 %[f]
Pozzolanicity	EN 196-5	CEM IV	All	Satisfies the test

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

[b] Determination of residue insoluble in hydrochloric acid and sodium carbonate.

[c] Cement types CEM II/B-T and CEM II/B-M with a T content > 20 % may contain up to 4,5 % sulfate (as SO_3) for all strength classes.

[d] Cement type CEM III/C may contain up to 4,5 % sulfate.

[e] Cement type CEM III may contain more than 0,10 % chloride but in that case the maximum chloride content shall be stated on the packaging and/or the delivery note.

[f] For pre-stressing applications cements may be produced according to a lower requirement. If so, the value of 0,10 % shall be replaced by this lower value which shall be stated in the delivery note.

7.4 Durability requirements

7.4.1 General

In many applications, particularly in severe environmental conditions, the choice of cement has an influence on the durability of concrete, mortar and grouts, e.g. frost resistance, chemical resistance and protection of reinforcement. Alkalis from cement or other concrete constituents may react chemically with certain aggregates. Adequate requirements are given in EN 206-1.

The choice of cement, from this standard, particularly as regards type and strength class for different applications and exposure classes shall follow the appropriate standards and/or regulations for concrete or mortar valid in the place of use.

Low early strength common cements will have lower early strength compared to other common cement of the same standard strength class and may require additional precautions in their use such as extension of formwork stripping times and protection during adverse weather. In all other respects, their performance and suitability of application will be similar to the other common cements, conforming to this standard, of the same type and standard strength class.

7.4.2 Sulfate resistance

Sulfate resisting common cement shall fulfil the additional chemical requirements specified in Table 5. Sulfate resisting common cements shall be identified by the notation SR.

Table 5 — Additional requirements for sulfate resisting common cements given as characteristic values

1	2	3	4	5
Property	**Test reference**	**Cement type**	**Strength class**	**Requirements[a]**
Sulfate content (as SO_3)	EN 196-2	CEM I-SR 0 CEM I-SR 3 CEM I-SR 5[b] CEM IV/A-SR CEM IV/B-SR	32,5 N 32,5 R 42,5 N	≤ 3,0 %
			42,5 R 52,5 N 52,5 R	≤ 3,5 %
C_3A in clinker[c]	EN 196-2[d]	CEM I-SR 0	All	= 0%
		CEM I-SR 3		≤ 3 %
		CEM I-SR 5		≤ 5 %
	- [e]	CEM IV/A-SR CEM IV/B-SR		≤ 9 %
Pozzolanicity	EN 196-5	CEM IV/A-SR CEM IV/B-SR	All	Satisfies the test at 8 days

[a] Requirements are given as percentage by mass of the final cement or clinker as defined in the table.

[b] For specific applications cements CEM I-SR 5 may be produced according to a higher sulfate content. If so the numerical value of this requirement for higher sulfate content shall be declared on the delivery note.

[c] The test method for the determination of C_3A content of clinker from an analysis of the final cement is under development in CEN/TC51.

[d] In the specific case of CEM I, it is permissible to calculate the C_3A content of clinker from the chemical analysis of the cement. The C_3A content shall be calculated by the formula: $C_3A = 2,65\ A – 1,69\ F$ (see 5.2.1).

[e] Until the test method is finalised the C_3A content of clinker (see 5.2.1) shall be determined on the basis of the analysis of clinker as part of the manufacturer's Factory Production Control (EN 197-2:2000, 4.2.1.2).

8 Standard designation

CEM cements shall be designated by at least the notation of the cement type as specified in Table 1 and the figures 32,5, 42,5 or 52,5 indicating the strength class (see 7.1). In order to indicate the early strength class the letter N, R or L shall be added as appropriate (see 7.1).

When in the same factory a manufacturer produces different cements complying with the same standard designation, these cements receive an additional identification in the form of a number or of two lower case letters, between brackets, in order to distinguish these cements from each other. For the numbering system, this number should be 1 for the second certified cement, 2 for the next, and so on. For the lettering system, the letters shall be chosen in such a way as to avoid confusion.

Sulfate resisting cement shall be designated additionally by the notation SR.

Cements not covered by this European Standard for their sulfate resisting property but considered sulfate resisting according to National Standards listed in Annex A shall not be identified by the notation SR.

NOTE The CE marking may be affixed for those products as common cements.

Low heat common cement shall be additionally designated by the notation LH.

EXAMPLE 1

Portland cement, conforming to EN 197-1, of strength class 42,5 with high early strength is designated by:

Portland cement EN 197-1 – CEM I 42,5 R

EXAMPLE 2

Portland-limestone cement, conforming to EN 197-1, containing between 6 % and 20 % by mass of limestone (L) with a TOC content not exceeding 0,50 % by mass of strength class 32,5 with an ordinary early strength is designated by:

Portland-limestone cement EN 197-1 – CEM II/A-L 32,5 N

EXAMPLE 3

Portland-composite cement, conforming to EN 197-1, containing in total a quantity of granulated blast furnace slag (S), siliceous fly ash (V) and limestone (L) of between 12 % and 20 % by mass and of strength class 32,5 with high early strength is designated by:

Portland-composite cement EN 197-1 – CEM II/A-M (S-V-L) 32,5 R

EXAMPLE 4

Composite cement, conforming to EN 197-1, containing between 18 % and 30 % by mass of granulated blast furnace slag (S) and between 18 % and 30 % by mass of siliceous fly ash (V) of strength class 32,5 with an ordinary early strength is designated by:

Composite cement EN 197-1 – CEM V/A (S-V) 32,5 N

EXAMPLE 5

Blast furnace cement, conforming to EN 197-1, containing between 66 % and 80 % by mass of granulated blast furnace slag (S), of strength class 32,5 with an ordinary early strength and a low heat of hydration and sulfate resisting is designated by:

Blast furnace cement EN 197-1 – CEM III/B 32,5 N – LH/SR

EXAMPLE 6

Portland cement, conforming to EN 197-1, of strength class 42,5 with high early strength and sulfate resisting with C_3A content of the clinker ≤ 3 % by mass is designated by:

Portland cement EN 197-1 – CEM I 42,5 R – SR 3

EXAMPLE 7

Pozzolanic cement, conforming to EN 197-1, containing between 21 % and 35 % by mass of natural pozzolana (P), of strength class 32,5 with an ordinary early strength and sulfate resisting with C_3A content of the clinker ≤ 9 % by mass and meeting the requirement for pozzolanicity is designated by:

Pozzolanic cement EN 197-1 – CEM IV/A (P) 32,5 N – SR

EXAMPLE 8

Blast furnace cement, conforming to EN 197-1, containing between 81 % and 95 % by mass granulated blast furnace slag (S) of strength class 32,5 with low early strength and low heat of hydration and sulfate resisting is designated by:

Blast furnace cement EN 197-1 – CEM III/C 32,5 L – LH/SR

EXAMPLE 9

Portland cement, conforming to EN 197-1, of strength class 42,5 with high early strength and where the factory produces different cements complying with the same standard designation, is designated by:

Portland cement EN 197-1 – CEM I 42,5 R (1)

9 Conformity criteria

9.1 General requirements

Conformity of the products to this standard shall be continually evaluated on the basis of testing of spot samples. The properties, test methods and the minimum testing frequencies for the autocontrol testing by the manufacturer are specified in Table 6. Concerning testing frequencies for cement not being dispatched continuously and other details, see EN 197-2. Alternative test methods could be used provided that they have been validated in accordance with the appropriate provisions in the cited standards of the reference test methods. In the event of a dispute, only the reference methods are used.

NOTE 1 This standard does not deal with acceptance inspection at delivery.

NOTE 2 For certification of conformity by a notified body, conformity of cement with this standard is evaluated in accordance with EN 197-2.

The compliance of the common cements with the requirements of this standard and with the stated values (including classes) shall be demonstrated by:

— initial type testing,

— factory production control by the manufacturer, including product assessment.

Table 6 — Properties, test methods and minimum testing frequencies for the autocontrol testing by the manufacturer, and the statistical assessment procedure

			Autocontrol testing			
Property	Cements to be tested	Test method [a] [b]	Minimum testing frequency		Statistical assessment procedure	
					Inspection by	
			Routine situation	Initial period for a new type of cement	Variables [c]	Attributes
1	2	3	4	5	6	7
Early strength Standard strength	All	EN 196-1	2/week	4/week	x	
Initial setting time	All	EN 196-3	2/week	4/week		x [d]
Soundness (Expansion)	All	EN 196-3	1/week	4/week		x
Loss on ignition	CEM I, CEM III	EN 196-2	2/month [e]	1/week		x [d]
Insoluble residue	CEM I, CEM III	EN 196-2	2/month [e]	1/week		x [d]
Sulfate content	All	EN 196-2	2/week	4/week		x [d]
Chloride content	All	EN 196-2	2/month [e]	1/week		x [d]
C_3A in clinker [f]	CEM I-SR 0 CEM I-SR 3 CEM I-SR 5	EN 196-2 [g]	2/month	1/week		x [d]
	CEM IV/A-SR CEM IV/B-SR	- [h]				
Pozzolanicity	CEM IV	EN 196-5	2/month	1/week		x
Heat of hydration	Low heat common cements	EN 196-8 or EN 196-9	1/month	1/week		x [d]
Composition	All	- [i]	1/month	1/week		

[a] Where allowed in the relevant part of EN 196, other methods than those indicated may be used provided they give results correlated and equivalent to those obtained with the reference method.

[b] The methods used to take and prepare samples shall be in accordance with EN 196-7.

[c] If the data are not normally distributed then the method of assessment may be decided on a case-by-case basis.

[d] If the number of samples is at least one per week during the control period, the assessment may be made by variables.

[e] When none of the test results within a period of 12 months exceeds 50 % of the characteristic value the frequency may be reduced to one per month.

[f] The test method for the determination of C_3A content of clinker from an analysis of the final cement is under development in CEN/TC51.

[g] In the specific case of CEM I, it is permissible to calculate the C_3A content of clinker from the chemical analysis of the cement. The C_3A content shall be calculated by the formula: $C_3A = 2{,}65\ A - 1{,}69\ F$ (see 5.2.1).

[h] Until the test method is finalised the C_3A content of clinker (see 5.2.1) shall be determined on the basis of the analysis of clinker as part of the manufacturer's Factory Production Control (EN 197-2:2000, 4.2.1.2).

[i] Appropriate test method chosen by the manufacturer.

9.2 Conformity criteria for mechanical, physical and chemical properties and evaluation procedure

9.2.1 General

Conformity of cement with the requirements for mechanical, physical and chemical properties of this standard is assumed if the conformity criteria specified in 9.2.2 and 9.2.3 are met. Conformity shall be evaluated on the basis of continual sampling using spot samples taken at the point of release and on the basis of the test results obtained on all autocontrol samples taken during the control period.

9.2.2 Statistical conformity criteria

9.2.2.1 General

Conformity shall be formulated in terms of a statistical criterion based on:

— the specified characteristic values for mechanical, physical and chemical properties as given in 7.1, 7.2, and 7.3;

— the percentile P_k, on which the specified characteristic value is based, as given in Table 7;

— the allowable probability of acceptance CR, as given in Table 7.

Table 7 — Required values P_k and CR

	Mechanical requirements		**Physical and chemical requirements**
	Early and standard strength (Lower limit)	**Standard strength (Upper limit)**	
The percentile P_k on which the characteristic value is based	5 %	10 %	
Allowable probability of acceptance CR	5 %		

NOTE Conformity evaluation by a procedure based on a finite number of test results can only produce an approximate value for the proportion of results outside the specified characteristic value in a population. The larger the sample size (number of test results), the better the approximation. The selected probability of acceptance CR controls the degree of approximation by the sampling plan.

Conformity with the requirements of this standard shall be verified either by variables or by attributes, as described in 9.2.2.2 and 9.2.2.3 and as specified in Table 6.

The control period shall be 12 months.

9.2.2.2 Inspection by variables

For this inspection the test results are assumed to be normally distributed.

Conformity is verified when Equation(s) (2) and (3), as relevant, are satisfied:

$$\bar{x} - k_A \cdot s \geq L \tag{2}$$

and

$$\bar{x} + k_A \cdot s \leq U \tag{3}$$

where

$\bar{x}$ is the arithmetic mean of the totality of the autocontrol test results in the control period;

s is the standard deviation of the totality of the autocontrol test results in the control period;

k_A is the acceptability constant;

L is the specified lower limit given in Table 3 referred to in 7.1;

U is the specified upper limit given in Tables 3, 4 and 5 referred to in Clause 7.

The acceptability constant k_A depends on the percentile P_k on which the characteristic value is based, on the allowable probability of acceptance CR and on the number n of the test results. Values of k_A are listed in Table 8.

Table 8 — Acceptability constant k_A

Number of test results n	k_A [a]	
	for P_k = 5 %	for P_k = 10 %
	Early and standard strength (lower limit)	Other properties
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 44	2,13	1,70
45 to 49	2,09	1,67
50 to 59	2,07	1,65
60 to 69	2,02	1,61
70 to 79	1,99	1,58
80 to 89	1,97	1,56
90 to 99	1,94	1,54
100 to 149	1,93	1,53
150 to 199	1,87	1,48
200 to 299	1,84	1,45
300 to 399	1,80	1,42
> 400	1,78	1,40
NOTE Values given in this table are valid for CR = 5 %.		
[a] Values of k_A valid for intermediate values of n may also be used.		

9.2.2.3 Inspection by attributes

The number c_D of test results outside the characteristic value shall be counted and compared with an acceptable number c_A, calculated from the number n of autocontrol test results and the percentile P_k as specified in Table 9.

Conformity is verified when Equation (4) is satisfied:

$$c_D \leq c_A \quad (4)$$

The value of c_A depends on the percentile P_k on which the characteristic value is based, on the allowable probability of acceptance CR and on a number n of the test results. Values of c_A are listed in Table 9.

Table 9 — Values of c_A

Number of test results n[a]	c_A for P_K = 10 %
20 to 39	0
40 to 54	1
55 to 69	2
70 to 84	3
85 to 99	4
100 to 109	5
110 to 123	6
124 to 136	7
NOTE Values given in this table are valid for CR = 5 %.	
[a] If the number of test results is n < 20 (for P_k = 10 %) a statistically based conformity criterion is not possible. Despite this, a criterion of c_A = 0 shall be used in cases where n < 20. If the number of test results is n > 136, C_A can be calculated as follows: C_A = 0,075 (n – 30).	

9.2.3 Single result conformity criteria

In addition to the statistical conformity criteria, conformity of test results to the requirements of this standard requires that it shall be verified that each test result remains within the single result limit values specified in Table 10.

Table 10 — Limit values for single results

Property		Limit values for single results								
		Strength class								
		32,5 L	32,5 N	32,5 R	42,5 L	42,5 N	42,5 R	52,5 L	52,5 N	52,5 R
Early strength (MPa), lower limit value	2 days	-	-	8,0	-	8,0	18,0	8,0	18,0	28,0
	7 days	10,0	14,0	-	14,0	-	-	-	-	-
Standard strength (MPa), lower limit value	28 days	30,0			40,0			50,0		
Initial setting time (min), lower limit value		60			50			40		
Soundness (expansion, mm), upper limit value		10								
Sulfate content (as % SO_3), upper limit value	CEM I CEM II[a] CEM IV CEM V	-	4,0		-	4,0	4,5	-	4,5	
	CEM I-SR 0 CEM I-SR 3 CEM I-SR 5[b] CEM IV/A-SR CEM IV/B-SR	-	3,5		-	3,5	4,0	-	4,0	
	CEM III/A CEM III/B	4,5								
	CEM III/C	5,0								
C_3A (%), upper limit value	CEM I-SR 0 CEM I-SR 3 CEM I-SR 5 CEM IV/A-SR CEM IV/B-SR	1 4 6 10 10								
Chloride content (%)[c], upper limit value		0,10[d]								
Pozzolanicity		-	Satisfies the test at 15 days		-	Satisfies the test at 15 days		-	Satisfies the test at 15 days	
Heat of hydration (J/g), upper limit value	LH	300								

[a] Cement types CEM II/B-T and CEM II/B-M with a T content > 20 % may contain up to 5,0 % SO_3 for all strength classes.

[b] For specific applications CEM I-SR 5 may be produced according to a higher maximum sulfate content (see Table 5). If so, the upper limit value is 0,5 % above the declared value.

[c] Cement type CEM III may contain more than 0,10 % chloride but in that case the maximum chloride content shall be declared.

[d] For pre-stressing applications cements may be produced according to a lower requirement. If so, the value of 0,10 % shall be replaced by this lower value which shall be stated in the delivery note.

9.3 Conformity criteria for cement composition

The composition of the cement shall be checked by the manufacturer at least once per month using, as a rule, a spot sample taken at the point of release of the cement. The cement composition shall meet the requirements specified in Table 1 and Table 2. The limiting quantities of the main constituents specified in Table 1 and Table 2 are reference values to be met by the average composition calculated from the spot samples taken in the control period. For single results, maximum deviations of -2 at the lower and +2 at the higher reference value are allowed. Suitable procedures

during production and appropriate verification methods to ensure conformity to this requirement shall be applied and documented.

9.4 Conformity criteria for properties of the cement constituents

The cement constituents shall meet the requirements specified in Clause 5. Suitable procedures during production to ensure conformity with this requirement shall be applied and documented.

Annex A
(informative)

List of common cements considered as sulfate resisting by National Standards in different CEN member countries but not included in Table 2 or not fulfilling the requirements given in Table 5

Table A.1 — List of common cements considered as sulfate resisting by National Standards in different CEN member countries but not included in Table 2 or not fulfilling the requirements given in Table 5

CEN member countries	National standard	CEM Cement types
Austria	ÖNORM B 3327-1 ÖNORM B 4710-1	II/A-S, II/B-S, II/A-V, II/B-V, II/A-M, II/B-M, II/A-D, III/A
Belgium	NBN B12-108	V/A (S-V)
Denmark	DS/INF 135	I
		II/A-V, II/B-V
France	NF P 15-319	II/A-S, II/B-S, II/A-V, II/A-P, II/A-M (S-V)
		III/A
		V/A, V/B
Hungary	MSZ 4737-1	II/A-V
Italy	UNI 9156	II/A-S, II/B-S, II/A-D, II/A-P, II/A-V, II/A-L, II/A-LL, II/B-L, II/B-LL, II/A-M, II/A-W, II/A-T, II/B-P, II/B-V, II/B-W, II/B-T, II/B-M
		III/A
		IV/A, IV/B
		V/A, V/B
Poland	PN-B-19707	II/B-V
		III/A
		V/A, V/B
Portugal	NP EN 206-1	II/A-L, II/A-LL, II/A-M, II/A-S, II/B-S, II/A-D, II/A-P, II/B-P, II/A-V, II/B-V
		III/A
		IV/A, IV/B
		V/A, V/B
Spain	UNE 80303-1	II/A-S, II/B-S, II/A-D, II/A-P, II/B-P, II/A-V, II/B-V
		III/A
		V/A
Switzerland	SN EN 206-1	II/A-D, II/B-M (D, V, S, T, LL)
United Kingdom	BS 8500	II/B-V
		III/A
		IV/A (V), IV/B (V)

Annex ZA
(informative)

Clauses of this European standard addressing the provisions of the EU Construction Products Directive

ZA.1 Scope and relevant characteristics

This European standard and this Annex ZA have been prepared under a Mandate M114 “Cement, building limes and other hydraulic binders” given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European standard, shown in this Annex, meet the requirements of the mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of common cements, covered by this standard for their intended use(s) indicated herein; reference shall be made to the information accompanying the CE marking.

> **WARNING:** Other requirements and other EU Directives, not affecting the fitness for intended use, may be applicable to the construction products falling within the scope of this standard.

NOTE 1 In addition to any specific clauses relating to dangerous substances contained in this standard, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

NOTE 2 An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA (accessed through http://ec.europa.eu/enterprise/construction/cpd-ds/).

This annex establishes the conditions for the CE marking of the common cement intended for the uses indicated in Table ZA 1.1 and shows the relevant clauses applicable.

This annex has the same scope as Clause 1 of this standard and is defined by Table ZA. 1.

Table ZA.1 Relevant clauses

Construction Products:	27 distinct common cements, 7 sulfate resisting common cements as well as 3 distinct low early strength blast furnace cements and 2 sulfate resisting low early strength blast furnace cements (see Tables 1 and 2)
Intended use(s):	Preparation of concrete, mortar, grout and other mixes for construction and for the manufacture of construction products (see Notes in this table)

Requirement/Characteristic from the Mandate	**Requirement clauses[a] in this European Standard**		**Mandated classes or levels**	**Notes**
	Clauses[a]	**Outline of the requirements**		
Common cements (Subfamilies) constituents and composition	3, 4, 5, 6, 8, 9	Constitutions of the different products (Table 1) in the product family “Common cements”, defined on the basis of constituent materials and composition	None	Selection of cements by the Member States in technical regulations for particular intended uses shall be possible, based on the different cement products and on strength classes
Compressive strength (early and standard)	7.1, 8, 9	Compressive strength requirements expressed in terms of strength classes and limits[b]	None	
Setting time	7.2 9	Requirements expressed in terms of lower limits[b]	None	
Insoluble residue	7.3 9	Requirements expressed in terms of upper limits[b]	None	Only for CEM I and CEM III
Loss on ignition	7.3 9	Requirements expressed in terms of upper limits[b]	None	Only for CEM I and CEM III
Soundness - Expansion - SO_3 content	7.2 9 7.3 9	Requirements expressed in terms of upper limits[b]	None	
Heat of hydration	7.2.3 9	Requirements expressed in terms of upper limits[b]	None	Only for low heat common cements
Chloride content	7.3 9	Requirements expressed in terms of upper limits[b]	None	
Pozzolanicity (for pozzolanic cement only)	7.3 9	Requirements expressed in terms of limits[b]	None	Only for CEM IV
Durability	4 5 7.4			Durability relates to the concrete, mortar, grout and other mixes made from cement according to the application rules valid in the place of use
C_3A in clinker	7.4.2 9	Requirements expressed in terms of upper limits[b]	None	Only for sulfate resisting common cements
Release of dangerous substances	See Notes 1 and 2			See Notes 1 and 2

[a] The requirements in these clauses, including the entire contents and tables of the clauses listed, are fully integrated parts of this harmonised European Standard for cement.

[b] These limits are part of the definition of the products covered by this harmonised European Standard for cement.

The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturers placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option "No performance determined" (NPD) in the information accompanying the CE marking (see Clause ZA.3) may be used.

The NPD option may not be used, however, where the characteristic is subject to a threshold level.

ZA.2 Procedure for the attestation of conformity of products

ZA.2.1 System of attestation of conformity

The system of attestation of conformity for the 27 distinct common cements, 7 sulfate resisting common cements as well as 3 distinct low early strength blast furnace cements and 2 sulfate resisting low early strength blast furnace cements or low heat common cements indicated in Table ZA.1 is shown in Table ZA.2 for the indicated intended use(s), in accordance with the Commission Decision of 14 July 1997 (97/555/EC) published in the Official Journal of the European Communities and given in annex 3 of the Mandate for the product family “Cements”.

Table ZA.2 System of attestation of conformity

<table>
<tr><th>Product(s)</th><th>Intended use(s)</th><th>Level(s) or class(es)</th><th>Attestation of conformity system(s)</th></tr>
<tr><td>Common cements, including common cements with low heat of hydration and sulfate resisting common cements as well as low early strength blast furnace cements and low early strength blast furnace cements with low heat of hydration</td><td rowspan="9">Preparation of concrete, mortar, grout and other mixes for construction and for the manufacture of construction products</td><td rowspan="9">……</td><td rowspan="9">1+</td></tr>
<tr><td>- Portland cements</td></tr>
<tr><td>- Portland composite cements
Portland-slag cement
Portland-silica fume cement
Portland-pozzolana cement
Portland-fly ash cement
Portland-burnt shale cement
Portland-limestone cement
Portland composite cement</td></tr>
<tr><td>- Blast furnace cements</td></tr>
<tr><td>- Pozzolanic cements</td></tr>
<tr><td>- Composite cements</td></tr>
<tr><td colspan="4">System 1+: See annex III Section 2 point (i) of Directive 89/106/EEC, with audit-testing of samples taken at the factory</td></tr>
</table>

The attestation of conformity to common cements, including common cements with low heat of hydration and common cements generally accepted as being sulfate resisting as well as low early strength blast furnace cements and low early strength blast furnace cements with low heat of hydration in Table ZA.1 shall be based on the evaluation of conformity procedures indicated in Table ZA.3 resulting from application of the clauses of this European Standard indicated therein. Clause 6 of EN 197-2:2000 gives rules relating to actions in the event of non-conformity.

Clause 9 of EN 197-2:2000, giving rules relating to Dispatching Centres, is not part of the procedure of attestation of conformity for the affixing of the CE marking under the CPD.

Table ZA.3 — Assignment of evaluation of conformity tasks for cement under system 1+

Tasks		Content of the tasks	Evaluation of conformity clauses to apply
Tasks under the responsibility of the manufacturer	Factory production control (FPC)	Parameters related to all characteristics of Table ZA.1[a] relevant for the intended use	Clause 9 of this standard and EN 197-2:2000, Clause 4
	Further testing of samples taken at factory	All characteristics of Table ZA.1[a] relevant for the intended use	Clause 9 of this standard and EN 197-2:2000, Clause 4
Tasks under the responsibility of the product certification body	Initial type testing	Those characteristics of Table ZA.1[a] relevant for the intended use	Clause 9 of this standard and EN 197-2:2000, Clauses 5 and 7
	Initial inspection of factory and of FPC	Parameters related to all characteristics of Table ZA.1[a], relevant for the intended use	Clause 9 of this standard and EN 197-2:2000, Clauses 5 and 7
	Continuous surveillance, assessment and approval of FPC	Parameters related to all characteristics of Table ZA.1[a], relevant for the intended use	Clause 9 of this standard and EN 197-2:2000, Clauses 5 and 7
	Audit testing of samples taken at factory	Those characteristics of Table ZA.1[a] relevant for the intended use	Clause 9 of this standard and EN 197-2:2000, Clauses 5 and 7

a Except durability.

ZA.2.2 EC certificate of conformity

When compliance with the conditions of this annex is achieved, the certification body shall draw up a certificate of conformity (EC Certificate of conformity), which entitles the manufacturer to affix the CE marking. The certificate shall include:

— name, address and identification number of the certification body,

— name and address of the manufacturer, or his authorised representative established in the EEA, and place of production,

NOTE The manufacturer may also be the person responsible for placing the product onto the EEA market if he takes responsibility for CE marking.

— description of the product (type, identification, use,...),

— provisions to which the product conforms (i.e. Annex ZA of this EN),

— particular conditions applicable to the use of the product (e. g. provisions for use under certain conditions),

— the number of the certificate,

— conditions of validity of the certificate, where applicable,

— name of, and position held by, the person empowered to sign the certificate.

The above mentioned certificate shall be presented in the language or languages accepted in the Member State in which the product is to be used.

ZA.3 CE marking and labelling

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EEC and shall be shown on the bag or for bulk deliveries, on the accompanying commercial documents e.g. a delivery note. The following information shall accompany the CE marking symbol:

a) identification number of the notified body,

b) name or identifying mark and registered address of the manufacturer,

c) the last two digits of the year in which the marking is affixed,

d) number of the EC Certificate of conformity or factory production control certificate (if relevant),

e) reference to this European Standard,

f) description of the product: generic name,… and intended use,

g) information on those relevant essential characteristics listed in Table ZA.1 which are to be declared presented as:

   1) declared values and, where relevant, level or class (including “pass” for pass/fail requirements, where necessary) to declare for each essential characteristic as indicated in "Notes" in Table ZA.1;

   2) as an alternative, standard designation(s) alone or in combination with declared values as above, and

   3) “No performance determined” for characteristics where this is relevant.

The “No performance determined” (NPD) option may not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State of destination.

Figure ZA.1 gives an example of the information to be given on the product, label, packaging and/or commercial documents.

In the case of bagged cement, the CE conformity marking, the identification number of the certification body and the accompanying information as given below shall be affixed either on the bag or on the accompanying commercial documents or on a combination of these. If all the information is not placed on the bag, but only part, then the full information shall be given on the accompanying commercial documents. In all cases, the CE marking on bags shall be accompanied at least by the name or identifying mark of the manufacturer, the last two digits of the year in which the marking was affixed, and the number of the EC certificate of conformity and indications to identify the characteristics of the product i.e. the standard designation.

CE 0123	*CE conformity marking, consisting of the "CE"-symbol given in Directive 93/68/EEC.*
AnyCo Ltd, PO Box 21, B-1050	*Identification number of the certification body*
The registered address	*Name or identifying mark of the manufacturer*
Any Factory	*Registered address of the manufacturer*
10	*Name or identifying mark of the factory where the cement was produced*[1)]
0123-CPD-0234	*Last two digits of the year in which the marking was affixed*[2)] *Certificate number*
EN 197-1:2011	*No. of European Standard with the date of version*
CEM I 42,5 R - SR 3	*Example of standard designation, indicating the cement product and the strength class, (and, where applicable, the notation for low heat of hydration and/or sulfate resistance) as specified in Clause 8 of EN 197-1:2011*
	Limit for chloride, in %[3)]
	Upper limit for loss on ignition of fly ash, in %[4)]
Additional information	*Standard notation of admixture* [5)]
	Limit for sulfate, in %[6)]
	Limit for organic additives exceeding 0,2 %[7)]

Figure ZA.1 — Example CE marking information

1) Considered necessary for the requirements of EN 197-2 but not compulsory.

2) The year of marking should relate to either the time of packing into bags or the time of dispatch from the factory or depot. The two digits of affixing could be the last two digits of the production year of the CE marked product.

3) Only where the common cement or sulfate resisting common cement is produced to meet a different chloride content limit to the value specified in Table 4 of EN 197-1:2011.

4) Only where, in accordance with 5.2.4.1 of EN 197-1:2011, a fly ash is used as main constituent.

5) Only where, in accordance with 5.5 of EN 197-1:2011, an admixture conforming to the EN 934 series is used.

6) Only where CEM I-SR 5 is produced with a different limit of the sulfate content compared to the specifications given in Table 5 of EN 197-1:2011.

7) Only where, in accordance with 5.5 of EN 197-1:2011, the quantity of organic additives on a dry basis exceeds 0,2 % by mass of the final cement.

For reasons of practicability, selections from the following alternative arrangements for bagged cement concerning the presentation of the accompanying information may be used.

h) When the CE marking is given on the bag (this is the normal situation and is preferred) the elements shown on the Figure ZA.1 shall be given.

i) Where the last two digits of the year in which the CE marking is affixed is pre-printed on the bag, the year so printed should relate to the date of affixing with an accuracy of within plus or minus three months.

j) Where the last two digits of the year in which the marking is affixed is to be presented but not pre-printed on the bag it may be applied by means of date-stamping of the bag in any easily visible position. This position should be indicated in the information accompanying the CE marking.

In the case of bulk cement, the CE conformity marking, the identification number of the certification body and the accompanying information as listed before for bagged cement should be affixed in some suitable practical form on the accompanying commercial documents.

In addition to any specific information relating to dangerous substances shown above, the product should be accompanied, when and where required and in the appropriate form, by documentation listing any legislation on dangerous substances for which compliance is claimed, together with any information required by that legislation.

NOTE 1 European legislation without national derogations need not be mentioned.

NOTE 2 Affixing the CE marking symbol means, if a product is subject to more than one directive, that it complies with all applicable directives.

Bibliography

[1] EN 206-1, *Concrete — Part 1: Specification, performance, production and conformity*

[2] EN 413-1, *Masonry cement — Part 1: Composition, specifications and conformity criteria*

[3] EN 450-1, *Fly ash for concrete — Part 1: Definition, specifications and conformity criteria*

[4] EN 934 (all parts), *Admixtures for concrete, mortar and grout*

[5] EN 14216, *Cement — Composition, specifications and conformity criteria for very low heat special cements*

[6] EN 14647, *Calcium aluminate cement — Composition, specifications and conformity criteria*

[7] EN 15743, *Supersulfated cement — Composition, specifications and conformity criteria*

[8] ISO 10694, *Soil quality —Determination of organic and total carbon after dry combustion (elementary analysis)*

[9] Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) establishing a European Chemicals Agency amending Directive 1999/45/EC and repealing Council Regulation (EEC) No. 793/93 and Commission Regulation (EC) No. 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

National annex NA
(informative)

Information to be provided

NA.1 General

In accordance with Note 1 to Clause 1, the provisions for the exchange of additional information between the manufacturer and the user should be made in accordance with, but not limited to, this annex.

NA.2 Conditions of supply – packed/bagged cement

Where cement is supplied in a bag for manual handling, the nominal quantity should be marked on the bag. The nominal quantity should be 25 kg, or less, within permitted tolerances.

NA.3 Test report

NA.3.1 General

The information in NA.3.2 – NA.3.5, concerning test results on samples of the cement, should be included in a test report, if requested from the manufacturer, relating to the material delivered.

NA.3.2 All CEM cements

a) compressive strength at either 2 days or 7 days, as appropriate, and also at 28 days (see 7.1);

b) initial setting time (see 7.2.1.);

c) soundness (see 7.2.2);

d) chloride content (see 7.3).

NA.3.3 Portland-slag (CEM II/A-S and II/B-S) and blastfurnace cements (CEM III/A, CEM III/B and CEM III/C)

The proportion of blastfurnace slag, as a target mean, reported to the nearest 1 % by mass.

NA.3.4 Portland-fly ash cements (CEM II/A-V and II/B-V)

a) the proportion of siliceous fly ash, as a target mean, reported to the nearest 1 % by mass;

b) the loss on ignition of the siliceous fly ash if greater than 7.0% by mass (see Annex NC).

NA.3.5 Portland-limestone cements (CEM II/A-L, CEM II/A-LL, CEM II/B-L and CEM II/B-LL)

The proportion of limestone, as a target mean, reported to the nearest 1 % by mass.

NOTE The notation, CEM II/A-LL, indicates that the total organic carbon (TOC) content of the limestone constituent does not exceed 0,20 % by mass, whereas the notation, CEM II/A-L, indicates that the TOC of the limestone does not exceed 0,50 % by mass (see 5.2.6).

NA.4 Additional information

NA.4.1 General

The information in NA.4.2 and in NA.4.3, appropriate to the type of cement, should be made available, if requested at the time of ordering, relating to the material delivered.

NA.4.2 All CEM cements

a) the type and quantity of any minor additional constituent;

b) the fineness as determined by specific surface or sieve residue;

c) the silicon dioxide, aluminium oxide, iron(III) oxide, calcium oxide and magnesium oxide contents of the clinker;

d) the sulfate content expressed as SO_3 (see 7.3).

NA.4.3 Alkali information

NA.4.3.1 Declared mean alkali content

Alkali information is given as the declared mean alkali content of the cement.

NOTE 1 No provision is made in this British Standard for standardizing low alkali CEM cements to a guaranteed alkali limit. Availability and supply of such CEM cements is agreed between purchaser and manufacturer.

a) The declared mean alkali content, is an alkali content expressed as the sodium oxide equivalent, which is not exceeded without prior notice from the manufacturer. It is a certified average alkali content plus a margin that reflects the manufacturer's variability of production.

   NOTE 2 It is the declared mean alkali content, rather than the certified average alkali content, which is used for purposes of classification and calculation of contributions of alkali from CEM cements to the alkali content of concrete.

b) A certified average alkali content, expressed as the sodium oxide equivalent, is an average of the manufacturer's latest 25 consecutive determinations on spot samples, taken in accordance with a statistically based sampling plan e.g. autocontrol.

c) The variability of a certified average alkali content is represented by the standard deviation of the manufacturer's latest 25 consecutive determinations.

NA.4.3.2 Alkali contributions from main constituents other than clinker

The alkali contributions, from main constituents in CEM cements other than clinker, which are taken into account by the manufacturer when calculating the declared mean alkali content of the cement, are given in Table NA.1.

Table NA.1 - Alkali contributions

Main type (see Clause 6)	Notation		Proportion by mass [1] of blastfurnace slag or siliceous fly ash (%)	Proportion of declared mean alkali content of the blastfurnace slag or siliceous fly ash taken into account (%)
CEM I	Portland cement	CEM I	0	N/A
CEM II	Portland-limestone cement	CEM II/A-L	6 to 20	100
		CEM II/A-LL	6 to 20	100
	Portland-slag cement	CEM II/A-S	6 to 20	100
		CEM II/B-S	21 to 25	100
		CEM II/B-S	26 to 35	50
	Portland-silica fume cement	CEM II/A-D	6 to 10	100
	Portland-fly ash cement	CEM II/A-V	6 to 20	100
		CEM II/B-V	21 to 25	20
		CEM II/B-V	26 to 35	0
	Portland-pozzolana cement [2]	CEM II/A-P	6 to 20	100
		CEM II/A-Q	6 to 20	100
		CEM II/A-P	21 to 25	20
		CEM II/A-Q	21 to 25	20
		CEM II/B-P	26 to 35	0
		CEM II/B-Q	26 to 35	0
	Portland-pozzolana cement [3]	CEM II/A-Q	6 to 10	100
		CEM II/A-Q	11 to 20	100
	Portland-composite cement	CEM II/A-M (S,L)	12 to 20	The alkali contribution is determined on the basis of the slag or fly ash content using the guidance in this table
		CEM II/A-M (S,LL)	12 to 20	
		CEM II/A-M (V,L)	12 to 20	
		CEM II/A-M (V,LL)	12 to 20	
		CEM II/B-M (S,L)	21 to 35	
		CEM II/B-M (S,LL)	21 to 35	
		CEM II/B-M (V,L)	21 to 35	
		CEM II/B-M (V,LL)	21 to 35	
CEM III	Blastfurnace cement	CEM III A	36 to 41	50
		CEM III A	42 to 65	0
		CEM III B	66 to 80	0
		CEM III C	81 to 95	0

Main type (see Clause 6)	Notation		Proportion by mass [1] of blastfurnace slag or siliceous fly ash (%)	Proportion of declared mean alkali content of the blastfurnace slag or siliceous fly ash taken into account (%)
CEM IV	Pozzolanic cement	CEM IV/A-V	6 to 20	100
		CEM IV/A-V	21 to 25	20
		CEM IV/A-V	26 to 35	0
		CEM IV/B-V	36 to 55	0
		CEM IV/A-P [2]	6 to 20	100
		CEM IV/A-P [2]	21 to 25	20
		CEM IV/A-P [2]	26 to 35	0
		CEM IV/A-P [2]	36 to 55	0
		CEM IV/A-Q [2]	6 to 20	100
		CEM IV/A-Q [2]	21 to 25	20
		CEM IV/A-Q [2]	26 to 35	0
		CEM IV/B-Q [2]	36 to 55	0
		CEM IV/A-Q [3]	6 to 10	100
		CEM IV/A-Q [3]	11 to 20	100

NOTE Where a CEM I cement contains a minor additional constituent (mac), 100% of the alkali content of the mac is taken into account

1) The proportions in the table are based on the sum of the main constituents and the minor additional constituents (formerly called the 'cement nucleus')

2) Containing natural pozzolana (P) and natural calcined pozzolana (Q) conforming to BS 8615-1 only

3) Containing natural calcined pozzolana (Q) conforming to BS 8615-2 only

NA.4.4 Chloride information

The manufacturer might declare a chloride content that should not be exceeded without prior notification. If such a declaration is made, then the basis on which it is derived should also be stated.

National annex NB
(informative)

Sampling and testing for acceptance inspection at delivery

NB.1 For acceptance at delivery, when requested, a spot sample of the cement should be taken in accordance with 3.6 and 6.2, 6.3, 6.4 or 6.5 of BS EN 196-7:2007 either before or at the time of delivery. A laboratory sample should be prepared and packed in accordance with Clauses 8 and 9 of BS EN 196-7:2007. 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 196-7:2007.

NOTE Testing may be delayed for up to three months from the time of sampling provided that there is confirmation that the sample has been stored continuously in the manner described in 9.2 of BS EN 196-7:2007.

NB.2 When the cement is tested for strength (see 7.1), it is recommended that the pit/quarry from which the CEN Standard sand (see BS EN 196-1) is obtained and the compaction procedure to be used should be those in use by the manufacturer at the time the cement was originally tested.

NOTE It should be noted that the source of CEN Standard sand and the compaction procedure can, within permitted limits (see BS EN 196-1), influence the strength achieved.

NB.3 When the cement is tested for chemical properties (see 7.3) the test sample should be prepared by the method described in Clause 6 of BS EN 196-2:2005.

NB.4 Testing should be carried out in accordance with the relevant methods in the BS EN 196 series of standards.

NB.5 The limiting values applicable to acceptance inspection of cement should be those given in Table NB.1.

NOTE The acceptance inspection limits are in general those given as limit values for single results in Table 10 of this standard. However, Table 10 does not give values for loss on ignition or insoluble residue.

Table NB.1 - Acceptance inspection limits

Property		Strength class					
		32,5 N	**32,5 R**	**42,5 N**	**42,5 R**	**52,5 N**	**52,5 R**
Early strength (MPa) lower limit value	2 day	—	8.0	8.0	18.0	18.0	28.0
	7 day	14.0	—	—	—	—	—
Standard strength (MPa) lower limit value	28 day	30.0	30.0	40.0	40.0	50.0	50.0
Initial setting time (min) lower limit value		60		50		40	
Soundness (mm) upper limit value		10					
Sulfate content (as % SO3 by mass) upper limit value	CEM I	4.0		4.5			
	CEM II						
	CEM IV						
	CEM V						
	CEM III/A CEM III/B	4.5					
	CEM III/C	5.0					
Chloride content (% by mass) upper limit value		0.10[1)]					
Loss on ignition (% by mass) upper limit value		5.1					
Insoluble residue (% by mass) upper limit value		5.1					
Pozzolanicity		positive at 15 days					

1) Where a CEM III cement has been declared by the manufacturer to contain more than 0,10% chloride, the acceptance inspection limit in this table does not apply

National annex NC
(informative)

National recommendation for the loss on ignition of a siliceous fly ash constituent

In the UK, the loss on ignition of a siliceous fly ash constituent should not exceed 7,0 % by mass, as a characteristic value.

NOTE In the case of a fly ash with a loss on ignition between 5,0% and 7,0% by mass, the maximum limit 7,0% is stated on the packaging and/or the delivery note of the cement.

National annex ND
(informative)

Product guidance

ND.1 General

Guidance on the use of cements in concrete can be found in BS EN 206-1, BS 8500-1, BS 8500-2, BS 8000-2-1 and BS 8000-2.2.

Guidance on the use of cements in building mortars can be found in the National Annex to BS EN 1996-1-1, as well as BS EN 998-1, BS EN 998-2, PD 6678, BS 8000-3, BS EN 13914-1, BS EN 13914-2, BS EN 13813, BS 8204-1 and BS 8204-2.

ND.2 Safety warning

ND.2.1 Manual handling of bags

Manual handling activities are subject to the Manual Handling Operations Regulations 1992 (as amended) [1]. Where manual handling operations cannot be avoided, the Regulations require that the risks be assessed and reduced so far as is reasonably practicable. Guidance on how to assess and reduce risk, is given by the Health and Safety Executive (HSE), the UK's regulatory authority, in its booklet, Manual Handling (Manual Handling Operations Regulations 1992 (as amended)) [2], Guidance and Regulations L23 (HMSO). In addition, the HSE in its Construction Information Sheet No. 26 (revision 2) [3], recommends that cement should be supplied in 25 kg bags or ordered in bulk supply, in order to reduce the risk of injury.

ND.2.2 Safety in use

ND.2.2.1 Regulations

Work with cement is subject to the Control of Substances Hazardous to Health Regulations (COSHH) 2002 (as amended) [4]. Furthermore, Portland cement has been classified as an irritant under The Chemicals [Hazard Information & Packaging for Supply] Regulations (CHIP 4) 2009 [5]. In addition, requirements to limit the water-soluble chromium (VI) content to no more than 2ppm (0,0002%) by total dry weight of cement and the provision of Safety Data Sheets (SDS), are both covered by the REACH Regulation [6].

ND.2.2.2 Hazards

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

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

In addition, cementitious grouts, cement-mortar and concrete mixes can, until they have set, cause both irritant and allergic contact dermatitis:

a) Irritant contact dermatitis results from a combination of the moisture content, alkalinity and abrasiveness of the construction materials.

b) Allergic contact dermatitis is mainly a consequence of the sensitivity of an individual's skin to hexavalent chromium salts in solution.

Frequently repeated exposures to airborne cement in excess of the Occupational Exposure Standard (OES) [7] have been linked with rhinitis and coughing.

ND.2.2.3 First aid measures

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

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

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

Clothing or footwear contaminated by wet cement, cementitious grout, cement-mortar or concrete should be removed and washed immediately and thoroughly before being re-used.

ND.2.2.4 Use of personal protective equipment (PPE)

a) Where the risk of cement becoming airborne can neither be prevented nor completely controlled, appropriate respiratory protective equipment should be worn to ensure that exposure is less than the regulatory limit [Occupational Exposure Standard (OES)]; and, in addition, dust-proof goggles should be worn in order to protect the eyes;

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

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

   2) Where this takes the form of eye protection, wherever there is a risk of cement, or any wet cement mixture entering the eye, dust-proof goggles should be worn.

ND.3 Storage

To protect cement from premature hydration after delivery and to optimize the activity of any reducing agent added to the cement to reduce the water-soluble chromium (VI) content to no more than 2ppm (0,0002%), bulk silos should be waterproof and internal condensation should be minimized. Where reducing agents are used, manufacturers are required, under Annex 17 of the REACH Regulation [6] to mark delivery documents with the despatch date and the storage period appropriate to maintaining the activity of the reducing agent required to keep the content of soluble chromium (VI) below the regulatory limit.

Cement in paper bags should be stored unopened, clear of the ground, not more than eight bags high, in cool dry conditions protected from excessive draught and additionally protected by a waterproof structure where storage is external to buildings. As significant strength losses begin after four weeks to six weeks of storage in paper bags in normal conditions, and considerably sooner under adverse weather conditions or high humidity, deliveries should be controlled and bags used in order of receipt. Where reducing agents are used, manufacturers are required, under the REACH Regulation to legibly and indelibly mark bags with information on the packing date and the storage period appropriate to

maintaining the activity of the reducing agent required to keep the content of soluble chromium (VI) below the regulatory limit.

National annex NE
(informative)

Publications referred to in national annexes

NE.1 Standards publications

BS 8000-2.1, *Workmanship on building sites – Part 2: Code of practice for concrete work – Section 2.1: Mixing and transporting concrete*

BS 8000-2.2, *Workmanship on building sites – Part 2: Code of practice for concrete work – Section 2.2: Sitework with in situ and precast work*

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

BS 8204-1, *Screeds, bases and in situ floorings – Part 1: Concrete bases and cementitious levelling screeds to receive floorings. Code of practice*

BS 8204-2, *Screeds, bases and in situ floorings – Part 2: Concrete wearing surfaces. Code of practice*

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

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

PD 6678, *Guide to the specification of masonry mortar*

BS EN 196-1:2005, *Methods of testing cement – Part 1: Determination of strength*

BS EN 196-2:2005, *Methods of testing cement – Part 2: Chemical analysis of cement*

BS EN 196-7:2007, *Methods of testing cement – Part 7: Methods of taking and preparing samples of cement*

BS EN 206-1, *Concrete – Part 1: Specification, performance, production and conformity*

BS EN 998-1, *Specification for mortar for masonry Part 1: Rendering and plastering mortar*

BS EN 998-2, *Specification for mortar for masonry Part 2: Masonry mortar*

NA to BS EN 1996-1-1, *UK National Annex to Eurocode 6. Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures*

BS EN 13813, *Screed material and floor screeds. Screed material. Properties and requirements*

BS EN 13914-1, *Design, preparation and application of external rendering and internal plastering – Part 1: External rendering*

BS EN 13914-2, *Design, preparation and application of external rendering and internal plastering – Part 2: Design considerations and essential principles for internal plastering*

NE.2 Other publications

[1] GREAT BRITAIN. Manual Handling Operations Regulations 1992 (as amended). London: The Stationery Office.

[2] GREAT BRITAIN. Manual Handling Operations Regulations 1992 (as amended), Guidance and Regulations booklet L23. London: The Stationery Office.

[3] Health and Safety Executive (HSE) – *Health and Safety Executive. Construction information sheet No. 26,* (revision 2), London: HSE books, 2002

[4] GREAT BRITAIN. Control of Substances Hazardous to Health Regulations (COSHH) 2002 (as amended). London: The Stationery Office.

[5] GREAT BRITAIN. The Chemicals [Hazard Information and Packaging for Supply] Regulations (CHIP 4) 2009. London: The Stationery Office.

[6] EUROPE. Regulation (EC) No. 1907/2006 of the European Parliament and Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No. 793/93 and Commission Regulation (EC) No. 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. Brussels: OJEU L 136

[7] FAIRHURST, S., et al. – *Portland Cement Dust Criteria document, for an occupational exposure limit,* (HSE EH65/12), London: HS

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