BRITISH STANDARD

BS EN
197-1:2000
Incorporating
Amendment No. 1

Cement —

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

The European Standard EN 197-1:2000, with the incorporation of amendment A1:2004, has the status of a British Standard

ICS 91.100.10

National foreword

This British Standard is the official English language version of the harmonized European Standard EN 197-1:2000, Cement Part 1: Composition, specifications and conformity criteria for common cements, including amendment A1:2004, prepared by Technical Committee CEN/TC 51, Cement and building limes. This British Standard includes national annexes that provide additional information and guidance to complement EN 197-1. It converts and supersedes DD ENV 197-1:1995 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

The UK participation in its preparation was entrusted by Technical Committee B/516, Cements and lime, to Subcommittee B/516/6, Cement specifications, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

This European Standard is subject to transitional arrangements agreed under a Commission mandate which is intended to lead to CE marking in support of the Construction Products Directive. In order to allow for any changes in national regulations, the Member States have agreed a transition period of 21 months for the co-existence of the British Standards listed below and EN 197-1. At the end of this period, the British Standards listed below will be withdrawn, notification of which will be made in *Update Standards*.

BS 12: 1996 *Specification for Portland cement*;
BS 4246:1996 *Specification for high slag blastfurnace cement*;
BS 6588:1996 *Specification for Portland pulverized-fuel ash cements*;
BS 7583:1996 *Specification for Portland limestone cement*.

Common cements conforming to this standard, where the intended use is for the preparation of concrete, mortar, grout, other mixes for construction and for the manufacture of construction products, have been mandated by the European Commission to be specified under a system of attestation of conformity (see annex ZA). Attestation of conformity is a legal means for demonstrating that a product meets the requirements of a harmonized European technical specification, as defined in the Construction Products Directive (89/106/EEC). In the case of a system 1+, it is supported by an EC certificate of conformity, issued by an EU notified body, enabling the manufacturer to issue an EC declaration of conformity and to affix the minimum legal health, safety and environmental requirements in the EU Member States, it is not a quality mark.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 9 July 2004

Amendments issued since publication

Amd. No.	Date	Comments
15209	9 July 2004	See national foreword

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The detailed requirements for evaluating the conformity of common cements with this standard, including certification of conformity by a third party, are given in BS EN 197-2:2000, *Cement — Part 2: Conformity evaluation*. In addition, these same provisions describe all the tasks that will be required of the manufacturer and notified body for demonstrating legal attestation of conformity to a system 1+.

This British Standard forms a part of a group of related construction standards, which will include design and construction in concrete, standardized within the countries of the CEN members. The standards will include Part 1 of Eurocode 2 (EN 1992-1) for the design of concrete structures, EN 206-1, and its associated UK complementary British Standard (BS 8500), for the specifications and associated test methods for the constituent materials of concrete, including the BS EN 196 series of test methods for cement.

This British Standard does not include in its scope: the additional special properties of low heat Portland cement, conforming to BS 1370 or of sulfate-resisting Portland cement, conforming to BS 4027; or high slag blastfurnace cement, previously specified in BS 4246 or the low early strength classes of Portland blastfurnace cements, specified in BS 146, or pozzolanic pulverized-fuel ash cement, conforming to BS 6610; or other types of cement whose hardening is not primarily due to the hydration of calcium silicates, i.e. high alumina cement, conforming to BS 915-1, and supersulfated cement, conforming to BS 4248. It is intended that cements from within this range will be specified in further parts of BS EN 197 or in other standards.

National annex NA (informative) compares the notation for common cements given in Table 1 of this British Standard, with the notation in those British Standard specifications listed previously and which are to be withdrawn after the period of co-existence, and those still current. Table NA.1 in the national annex provides a means by which users of related construction standards that contain lists of permitted cements conforming to British Standards which are to be withdrawn can select common cements (by name and notation) that are their equivalent. This assessment of equivalence will only be necessary for a limited period. It arises because the British Standards Institution has agreed with industry that amendments to cement-related construction standards will not be issued to reflect the notation in use for common cements. When, however, the majority of such British Standards have themselves been replaced by European Standards the need to assess equivalence will cease.

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

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

This British Standard does not give fineness limits. National annex ND (informative) describes how specialist users in the UK can order a controlled fineness CEM I cement having a small agreed range of fineness. It also includes provisions for pigmented cement.

National annex NE (normative) gives a requirement, which is permitted to be standardized on a national basis, for the loss on ignition property of a siliceous fly ash constituent.

National annex NF (informative) gives guidance on the general use of common cements including health and safety aspects.

National annex NG (informative) lists publications referred to in the national annexes.

UK purchasers are recommended to specify common cement which has been manufactured and supplied to a nationally recognized third party product quality certification scheme.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Electronic Catalogue* under the section entitled International Standards Correspondence Index, or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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

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Summary of pages

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 197-1

June 2000

+A1

April 2004

ICS 91.100.10

Supersedes ENV 197-1:1992

English version

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

(includes amendment A1:2004)

Ciment - Partie 1: Compostition, spécifications et critères de conformité des ciments courants
(inclut l'amendement A1:2004)

Zement - Teil 1: Zusammensetzung, Anforderungen, und Konformitätskriterien von Normalzement
(enthält Änderung A1:2004)

This European Standard was approved by CEN on 21 May 2000, and amendment A1 was approved by CEN on 16 January 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 197-1:2000 + A1:2004 E

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 51, Cement and building limes, the Secretariat of which is held by IBN.

This European Standard replaces ENV 197-1:1992

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 December 2000, and conflicting national standards shall be withdrawn at the latest by December 2000.

The 1992 version was modified by application of PNE rules, introduction of a revised clause 9, prepared by CEN/TC 51/WG 13, and by taking into account the results of a CEN/TC 51 enquiry in 1995 and a CEN enquiry in 1998. [A1] The amendment A1:2004 contained the low heat common cements. [A1]

EN 197-1 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.

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 TC 51 was entrusted with the task of preparing a cement standard for the countries of Western Europe, comprising the EEC and EFTA members.

A first enquiry initiated by CEN/TC 51 in the mid-seventies identified at that time nearly 20 different kinds of cement, which had all been standardized on a national basis and which had proved satisfactory in common or special fields of application under local conditions. The evaluation of the enquiry showed that different sources of raw materials, different climatic conditions and different social/cultural attitudes have established a typical architecture with different building techniques in the different regions of Western Europe which led to the great variety of kinds of cement. The same or similar cement may be used in very different structures with different types of application and with substantially different requirements regarding its performance under the respective climatic conditions.

When CEN/TC 51 became aware of this situation, it decided in the early eighties 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 view of CEN/TC 51 was then that the more regional cements should continue to be standardized at the national level. The 1989 draft for the standard for cement followed this approach, but did not achieve the majority necessary for acceptance because a few countries wanted to incorporate all their nationally standardized cements and because 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 as yet no criteria for the descriptions "traditional" and "well tried". A second enquiry initiated by CEN/TC 51 in 1990 revealed a further 50 cements standardized nationally. It became obvious that some of the cements described as traditional by the respective national standardization bodies have been produced and used for decades so that their durability performance has been proved in practice. In contrast, there are some cements, also regarded as traditional and well tried which have been produced only for a few years and have been standardized nationally for only one or two years.

In view of the large number of different cements involved, it was considered necessary to separate the "common cements" from special cements i.e. those with additional or special properties. The purpose of EN 197-1 is to specify the composition, requirements and conformity criteria for the common cements. This includes all common cements [A1] and common cements with low heat of hydration [A1] which are described by the respective national standardization bodies within CEN as traditional and well tried. Types based on composition and a classification based on strength have been introduced in order to take into account the different cements included. The hardening of these cements mainly depends on the hydration of calcium silicates. Common cements with special properties as well as cements with different hardening processes will be included in further parts of this European Standard or in further European Standards respectively.

The requirements in EN 197-1 are based on the results of tests on cement in accordance with EN 196-1, -2, -3, -5, -6, -7 [A1] -8, -9 [A1] and -21. The scheme for the evaluation of conformity of common cements [A1] and common cements with low heat of hydration [A1] is specified in EN 197-2.

Annex A is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A1

This document EN (197-1:2000/A1:2004) has been prepared by Technical Committee CEN/TC 51, Cement and building lime, the Secretariat of which is held by IBN.

This Amendment to the European Standard EN 197-1:2000 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2004, and conflicting national standards shall be withdrawn at the latest by October 2004.

This Amendment extends the European Standard EN 197-1:2000 to cover the optional property of low heat of hydration for common cement. The technical content of EN 197-1:2000 has not been changed.

Very low heat special cements are dealt with in EN 14216.

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 Directives, see informative annex ZA, which is an integral part of this document.

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

Introduction

It is recognized that different cements have different properties and performance. Those performance tests now available (i.e. setting time, strength, [A1] soundness and heat of hydration) [A1], have been included in EN 197-1. 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

EN 197-1 defines and gives the specifications of 27 distinct common cement products 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 six strength classes. The definition also includes requirements the constituents have to meet and the mechanical, physical and chemical [A1] including, where appropriate, heat of hydration requirements [A1] of the 27 products and strength classes. EN 197-1 also states the conformity criteria and the related rules. Necessary durability requirements are also given.

NOTE 1: In addition to the specified requirements, an exchange of additional information between the cement manufacturer and user may be helpful. The procedures for such an exchange are not within the scope of EN 197-1 but should be dealt with in accordance with national standards or regulations or may 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.

2 Normative references

EN 197-1 incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to EN 197-1 only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to 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 time and soundness.*

EN 196-5, *Methods of testing cement – Part 5: Pozzolanicity test for Pozzolanic cements.*

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.*

[A1] 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.* [A1]

EN 196-21 [1], *Methods of testing cement – Part 21: Determination of the chloride, carbon dioxide and alkali content of cement.*

EN 197-2, *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 934-2, *Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – Definitions and requirements.*

〈A1〉 EN 13639:1999, *Determination of total organic carbon content in limestone.* 〈A1〉

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

3 Definitions

For the purposes of EN 197-1, the following definitions apply:

3.1
reactive calcium oxide (CaO)
that 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 196-21), and the fraction corresponding to calcium sulfate ($CaSO_4$), based on the measured sulfate (SO_3) content (see EN 196-2) after substraction of the SO_3 taken up by alkalis.

3.2
reactive silicon dioxide (SiO_2)
that 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) that 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

[1] EN 196-21 is currently being incorporated into EN 196-2.

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, the 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 taken at the same time and from one and the same place, relating to the intended tests. It can be obtained by combining one or more immediately consecutive increments (see EN 196-7)

〈A1〉
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 〈A1〉

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 EN 197-1, 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 EN 197-1 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.

5.2.2 Granulated blastfurnace slag (S)

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

Granulated blastfurnace 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 clauses (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, homogenized, 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 pulverized coal. Ash obtained by other methods shall not be used in cement that conforms to EN 197-1.

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 not exceed 5,0 % by mass.

Fly ash with loss on ignition of 5,0 % to 7,0 % by mass may also be accepted, provided that particular requirements for durability, especially frost resistance, and for compatibility with admixtures are met according to the appropriate standards and/or regulations for concrete or mortar in the place of use. In the case of fly ash with a loss on ignition between 5,0 % and 7,0 % by mass the maximum limit, 7,0 %, shall be stated on the packaging and/or the delivery note of the cement.

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 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 prEN 13639:1999, shall conform to one of the following criteria:

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

- 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.

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 pelletized (with water).

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, homogenized, 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 ($CaSO_4$ 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 0,5 % by mass of the cement.

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

The 27 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 Blastfurnace cement;
- CEM IV Pozzolanic cement;
- CEM V Composite cement.

The composition of each of the 27 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 to 5
CEM II	Portland-slag cement	CEM II/A-S	80 to 94	6 to 20	–	–	–	–	–	–	–	–	0 to 5
		CEM II/B-S	65 to 79	21 to 35	–	–	–	–	–	–	–	–	0 to 5
	Portland-silica fume cement	CEM II/A-D	90 to 94	–	6 to 10	–	–	–	–	–	–	–	0 to 5
	Portland-pozzolana cement	CEM II/A-P	80 to 94	–	–	6 to 20	–	–	–	–	–	–	0 to 5
		CEM II/B-P	65 to 79	–	–	21 to 35	–	–	–	–	–	–	0 to 5
		CEM II/A-Q	80 to 94	–	–	–	6 to 20	–	–	–	–	–	0 to 5
		CEM II/B-Q	65 to 79	–	–	–	21 to 35	–	–	–	–	–	0 to 5
	Portland-fly ash cement	CEM II/A-V	80 to 94	–	–	–	–	6 to 20	–	–	–	–	0 to 5
		CEM II/B-V	65 to 79	–	–	–	–	21 to 35	–	–	–	–	0 to 5
		CEM II/A-W	80 to 94	–	–	–	–	–	6 to 20	–	–	–	0 to 5
		CEM II/B-W	65 to 79	–	–	–	–	–	21 to 35	–	–	–	0 to 5
	Portland-burnt shale cement	CEM II/A-T	80 to 94	–	–	–	–	–	–	6 to 20	–	–	0 to 5
		CEM II/B-T	65 to 79	–	–	–	–	–	–	21 to 35	–	–	0 to 5
	Portland-limestone cement	CEM II/A-L	80 to 94	–	–	–	–	–	–	–	6 to 20	–	0 to 5
		CEM II/B-L	65 to 79	–	–	–	–	–	–	–	21 to 35	–	0 to 5
		CEM II/A-LL	80 to 94	–	–	–	–	–	–	–	–	6 to 20	0 to 5
		CEM II/B-LL	65 to 79	–	–	–	–	–	–	–	–	21 to 35	0 to 5
	Portland-composite cement [c)]	CEM II/A-M	80 to 94	<---------- 6 to 20 ---------->									0 to 5
		CEM II/B-M	65 to 79	<---------- 21 to 35 ---------->									0 to 5
CEM III	Blastfurnace cement	CEM III/A	35 to 64	36 to 65	–	–	–	–	–	–	–	–	0 to 5
		CEM III/B	20 to 34	66 to 80	–	–	–	–	–	–	–	–	0 to 5
		CEM III/C	5 to 19	81 to 95	–	–	–	–	–	–	–	–	0 to 5
CEM IV	Pozzolanic cement [c)]	CEM IV/A	65 to 89	–	<---------- 11 to 35 ---------->					–	–	–	0 to 5
		CEM IV/B	45 to 64	–	<---------- 36 to 55 ---------->					–	–	–	0 to 5
CEM V	Composite cement [c)]	CEM V/A	40 to 64	18 to 30	–	<-------- 18 to 30 ------>			–	–	–	–	0 to 5
		CEM V/B	20 to 38	31 to 50	–	<-------- 31 to 50 ------>			–	–	–	–	0 to 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 example see clause 8).

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 2.

Three classes of standard strength are included: class 32,5 class 42,5 and class 52,5 (see Table 2).

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 2.

Two classes of early strength are included for each class of standard strength, a class with ordinary early strength, indicated by N, and a class with high early strength, indicated by R (see Table 2).

Table 2 — Mechanical and physical requirements given as characteristic values

Strength class	Compressive strength MPa				Initial setting time	Soundness (expansion)
	Early strength		Standard strength			
	2 days	7 days	28 days		min	mm
32,5 N	–	≥ 16,0	≥ 32,5	≤ 52,5	≥ 75	≤ 10
32,5 R	≥ 10,0	–				
42,5 N	≥ 10,0	–	≥ 42,5	≤ 62,5	≥ 60	
42,5 R	≥ 20,0	–				
52,5 N	≥ 20,0	–	≥ 52,5	–	≥ 45	
52,5 R	≥ 30,0	–				

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 2.

7.2.2 Soundness

The expansion, determined in accordance with EN 196-3, shall conform to the requirement in Table 2.

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 are indicated by LH.

NOTE: 1 A pre-normative research project 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 producer 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 3 shall conform to the requirements listed in column 5 of this table when tested in accordance with the standard referred to in column 2.

NOTE: Some European countries have additional requirements for the content of water-soluble hexavalent chromium (see informative annex A).

7.4 Durability requirements

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.

The choice of cement, from EN 197-1, 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.

Table 3 — 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 196-21	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 type CEM II/B-T may contain up to 4,5 % sulfate 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.

8 Standard designation

CEM cements shall be identified 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 or the letter R shall be added as appropriate (see 7.1). ▌A1⟩ Low heat common cement shall be identified additionally by the notation LH. ⟨A1▌

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

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

EXAMPLE 2:
Portland-limestone cement containing between 6 % and 20 % by mass of limestone with a TOC content not exceeding 0,50 % by mass (L) of strength class 32,5 with an ordinary early strength is identified by:

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

EXAMPLE 3:
Portland-composite cement containing in total a quantity of granulated blastfurnace slag (S), siliceous fly ash (V) and limestone (L) of between 6 % and 20 % by mass and of strength class 32,5 with a high early strength is identified by:

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

EXAMPLE 4:
Composite cement containing between 18 % and 30 % by mass of granulated blastfurnace 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 identified by:

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

▌A1⟩ And for low heat common cements:

EXAMPLE 5:

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

Blastfurnace cement EN 197-1 – CEM III/B 32,5 N – LH ⟨A1▌

9 Conformity criteria

9.1 General requirements

Conformity of the 27 products to EN 197-1 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 4. Concerning testing frequencies for cement not being dispatched continuously and other details, see EN 197-2.

For certification of conformity by an approved certification body, conformity of cement with EN 197-1 shall be evaluated in accordance with EN 197-2.

NOTE: EN 197-1 does not deal with acceptance inspection at delivery.

Table 4 — 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** [e)]	**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 [f)]
Soundness (Expansion)	All	EN 196-3	1/week	4/week	–	x
Loss on ignition	CEM I, CEM III	EN 196-2	2/month [c)]	1/week	–	x [f)]
Insoluble residue	CEM I, CEM III	EN 196-2	2/month [c)]	1/week	–	x [f)]
Sulfate content	All	EN 196-2	2/week	4/week	–	x [f)]
Chloride content	All	EN 196-21	2/month [c)]	1/week	–	x [f)]
Pozzolanicity	CEM IV	EN 196-5	2/month	1/week	–	x
Composition	All	- [d)]	1/month	1/week	–	
▌A1⟩ Heat of hydration	Low heat common cements	EN 196-8 or EN 196-9	1/month	1/week	–	x [f)] ⟨A1▐

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) 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.
d) Appropriate test method chosen by the manufacturer.
e) If the data are not normally distributed then the method of assessment may be decided on a case by case basis.
f) If the number of samples is at least one per week during the control period, the assessment may be made by variables.

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 in EN 197-1 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 of EN 197-1;
- the percentile P_k, on which the specified characteristic value is based, as given in Table 5;
- the allowable probability of acceptance CR, as given in Table 5.

Table 5 — 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 EN 197-1 shall be verified either by variables or by attributes, as described in 9.2.2.2 and 9.2.2.3 as specified in Table 4.

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) (1) and (2), as relevant, are satisfied:

$$\bar{x} - k_A \times s \geq L \quad (1)$$

and;

$$\bar{x} + k_A \times s \leq U \quad (2)$$

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 2 referred to in 7.1;

U is the specified upper limit given in Tables 2 and 3 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 6.

Table 6 — 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 7.

Conformity is verified when equation (3) is satisfied:

$$c_D \leq c_A \qquad (3)$$

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 7.

Table 7 — 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.	

9.2.3 Single result conformity criteria

In addition to the statistical conformity criteria, conformity of test results to the requirements of EN 197-1 requires that it shall be verified that each test result remains within the single result limit values specified in Table 8.

Table 8 — Limit values for single results

Property			Limit values for single results					
			Strength class					
			32,5N	32,5R	42,5N	42,5R	52,5N	52,5R
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 (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			4,5		
	CEM III/A CEM III/B		4,5					
	CEM III/C		5,0					
Chloride content (%) [b] upper limit value			0,10 [c]					
Pozzolanicity			positive at 15 days					
⟨A1⟩ Heat of hydration (J/g) upper limit value	LH		300 ⟨A1⟩					

[a] Cement type CEM II/B-T may contain up to 5,0 % SO_3 for all strength classes.
[b] Cement type CEM III may contain more than 0,10 % chloride but in that case the maximum chloride content shall be declared.
[c] 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

At least once per month the composition of the cement shall be checked by the manufacturer, 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. The limiting quantities of the main constituents specified in Table 1 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)

A1 Water-soluble hexavalent chromium

Some CEN member countries have regulations for the content of water-soluble hexavalent chromium.

Alteration of these national regulations is, for the time being, outside the competence of CEN/CENELEC members. In these countries these regulations are valid in addition to the relevant requirements of this European Standard until they have been removed.

For this European Standard the following national regulations have been applied according to EC-Directive 90/531 by Denmark, Finland, Germany, Iceland, Norway and Sweden.

Denmark: Arbejdstilsynets bekendtgørelse nr. 661 af 28. November 1983 om vandopløseligt chromat i cement.

Finland: Decision of the Council of State concerning the content of chromate in cement for concrete and masonry cement, No. 593, July 24, 1986.

Germany: Gefahrstoffverordnung (GefStoffV) together with TRGS 613 “Ersatzstoffe, Ersatzverfahren und Verwendungsbeschränkungen für chromathaltige Zemente und chromathaltige zementhaltige Zubereitungen, April 1993 (BArbBI Nr. 4.1993)”.

Iceland: Reglur nr. 330/1989 um króm i sementi, Order No. 330 of 19 June 1989.

Norway: Directorate of Labour Inspection: Regulations relating to the Working Environment, laid down on 23 October 1987.

Sweden: Kamikalieinspektionens föreskrifter om kemiska produkter och biotekniska organismer, KIFS 1998:8, 9 kapitlet 10-13, Kemikalieinspektionens allmänna råd till föreskrifterna om krom i cement, 1989:1. A1

Annex ZA (informative)

Provisions for the CE marking of common cements under the EU Construction Products Directive

ZA.1 Clauses of EN 197-1 addressing the provisions of EU Construction Products Directive

EN 197-1 and this annex ZA have been prepared under a Mandate [2)] given to CEN by the European Commission and the European Free Trade Association.

The clauses of EN 197-1, shown in table ZA.1, meet the requirements of this Mandate given under the EU Construction Products Directive (89/106/EEC).

[A1] Compliance with these clauses confers a presumption of fitness of common cements and low heat common cements covered by EN 197-1 for the intended uses(s) under consideration in Table ZA.2. [A1]

WARNING: Other requirements and other EU Directives, not affecting the fitness for intended use(s), can be applicable to a construction product falling within the scope of EN 197-1.

There may be requirements on dangerous substances applicable to the products falling within the scope of EN 197-1 (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: an informative database of European and national provisions on dangerous substances is available at the Construction website on EUROPA (CREATE, accessed through http://europa.eu.int).

2) M114 “Cement, building limes and other hydraulic binders”.

Table ZA.1 — Harmonized clauses

Construction Products: 27 different common cement products (see Table 1) Preparation of concrete, mortar, grout and other mixes for construction and for the manufacture of construction products (see notes in this table)				
Requirements/ performance characteristics	**Harmonized clauses [a] in EN 197-1**		**CPD Article 3.2 level(s) and/or class(es)**	**Notes**
	Clauses [a]	**Outline of the requirements**		
Common cements (Subfamilies) constituents and composition	3, 4, 5, 6, 8 9	Constitutions of the 27 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	
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.
⟨A1⟩ Heat of hydration	7.2.3, 9	Requirements expressed in terms of upper limits [b].	None	Only for low heat common cements ⟨A1⟩

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

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

ZA.2 Procedure for the attestation of conformity of products

A1 The system of attestation of conformity for the 27 common cement or low heat common cement products 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.2A — System of attestation of conformity

Product(s)	Intended use(s)	Level(s) or class(es)	Attestation of conformity system(s)
Common cements or low heat common cements, including: - Portland cements - 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 - Blastfurnace cements - Pozzolanic cements - Composite cements	Preparation of concrete, mortar, grout and other mixes for construction and for the manufacture of construction products	……	1+
System 1+: See annex III Section 2 point (i) of Directive 89/106/EEC, with audit-testing of samples taken at the factory			

A1

The attestation of conformity to the specifications in EN 197-1 shall be based on clause 9 of EN 197-1 and on evaluation of conformity [3)] which shall be in accordance with EN 197-2. Clause 8 of EN 197-2 does not apply since it is superseded for CE marking purposes by the rules given in clauses ZA.3 and ZA.4. Clause 9 of EN 197-2, 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. However, Member States, within their market surveillance obligations, must ensure that CE marking is correctly used (Article 15.1 of the CPD). Clause 9 of EN 197-2 should be used for the corresponding national provisions concerning Dispatching Centres.

3) This term corresponds to the establishment of conformity that is mentioned in article 13.2 of the CPD.

ZA.3 EC certificate of conformity and EC declaration of conformity

When compliance with the system of attestation of conformity is achieved in accordance with clause 7 of EN 197-2, the certification body shall draw up a certificate of conformity (EC certificate of conformity) with the information indicated below. This EC certificate of conformity entitles the manufacturer to affix the CE marking, as described in ZA.4.

The EC certificate of conformity shall include the following information:

- Name and address of the certification body.
- Name and address of the manufacturer, or his authorized representative established in the EEA, and place of production.
- Description of the product (the standard designation of the cement according to EN 197-1 and any additional identification required).
- Provisions to which the product conforms (annex ZA of EN 197-1, with conformity established according to EN 197-2 as given in annex ZA of EN 197-1).
- Particular conditions applicable to the use of the product (none as regards conformity),
- The certificate's number.
- Conditions and period of validity of the certificate, where applicable.
- Name of, and position held by, the person empowered to sign the certificate.

In addition, for each product covered by an EC certificate of conformity, the manufacturer shall draw up a declaration of conformity (EC declaration of conformity) including the following information:

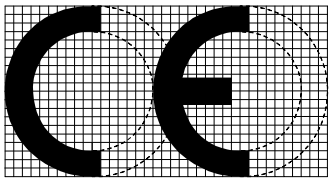
- Name and address of the manufacturer, or his authorized representative established in the EEA.
- Number of the attached EC certificate of conformity.
- Name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or of his authorized representative.

Both documents must be presented in the official language or languages of the Member State of the EU in which the product is to be used.

ZA.4 CE conformity marking

ZA.4.1 Bagged cement

In the case of bagged cement, the CE conformity marking, the identification number of the certification body and the accompanying information as given below should 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 should be given on the accompanying commercial documents.



0123

Any Company

The registered address

Any Factory [4)]

Year 01
(or position of date stamping)

0123-CPD-0456

EN 197-1

CEM I 42,5R

Additional information

CE conformity marking, consisting of the “CE”-symbol given in Directive 93/68/EEC.

Identification number of the certification body.

Name or identifying mark of the producer.

Registered address of the producer.

Name or identifying mark of the factory where the cement was produced [4)].

The last two digits of the year in which the marking was affixed [5)].

Number of the EC certificate of conformity.

Number of European standard.

Example of standard designation, indicating the cement product and the strength class ⟨A1⟩ (and, where applicable, the notation for low heat of hydration) ⟨A1⟩, as specified in clause 8 of EN 197-1.

Limit for chloride, in % [6)]
Limit for loss on ignition of fly ash, in % [7)] Standard notation of admixture [8)].

⟨A1⟩ Figure ZA.1 – Example of CE marking information ⟨A1⟩

4) Considered necessary for the requirements of EN 197-2 but not compulsory.
5) The year of marking should relate to either the time of packing into bags or the time of dispatch from the factory or depot.
6) Only where the common cement is produced to meet a different chloride content limit to the value specified in Table 3 of EN 197-1.
7) Only where, in accordance with 5.2.4.1 of EN 197-1, a fly ash loss on ignition limit of 5,0% to 7,0% is used.
8) Only where, in accordance with 5.5 of EN 197-1, an admixture conforming to the EN 934 series is used.

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

a) When the CE marking is given on the bag (this is the normal situation and is preferred) the following elements of the accompanying information may be given on the accompanying commercial documents instead of on the bag:

   - the name or identifying mark of the factory;
   - the year of affixing the CE marking;
   - the number of the EC certificate of conformity;
   - additional information.

b) 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.

c) 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.

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: European legislation without national derogations need not be mentioned.

ZA.4.2 Bulk cement

In the case of bulk cement, the CE conformity marking, the identification number of the certification body and the accompanying information as listed for bagged cement in ZA.4.1 should be affixed in some suitable practical form on the accompanying commercial documents.

National annex NA (informative)

Comparison between cements specified in British Standards which are still current or are to be withdrawn, and common cements specified in this British Standard

Table NA.1 Comparison between British Standards current or to be withdrawn and notation for common cements in Table 1

British Standard		Main type	Notation		Clinker content (%)	Content of other main constituents (%)
To be withdrawn	Current					
BS 12:1996	BS 4027:1996[1)]	CEM 1	Portland cement	CEM I	95 to 100	—
—	BS 146:1996[2)]	CEM II	Portland-slag cement	CEM II/A-S	80 to 94	6 to 20
				CEM II/B-S	65 to 79	21 to 35
—	—		Portland-silica fume cement	CEM II/A-D	90 to 94	6 to 10
—			Portland-Pozzolanic cement	CEM II/A-P	80 to 94	6 to 20
				CEM II/B-P	65 to 79	21 to 35
				CEM II/A-Q	80 to 94	6 to 20
				CEM II/B-Q	65 to 79	21 to 35
BS 6588:1996			Portland-fly ash cement	CEM II/A-V	80 to 94	6 to 20
				CEM II/B-V	65 to 79	21 to 35
—				CEM II/A-W	80 to 94	6 to 20
				CEM II/B-W	65 to 79	21 to 35
—			Portland-burnt shale cement	CEM II/A-T	80 to 94	6 to 20
				CEM II/B-T	65 to 79	21 to 35
—			Portland-limestone cement	CEM II/A-L	80 to 94	6 to 20
BS 7583:1996				CEM II/A-LL	80 to 94	6 to 20
—				CEM II/B-L	65 to 79	21 to 35
				CEM II/B-LL	65 to 79	21 to 35
—			Portland-composite cement	CEM II/A-M	80 to 94	6 to 20
				CEM II/B-M	65 to 79	21 to 35
	BS 146:1996[2)]	CEM III	Blastfurnace cement	CEM III/A	35 to 64	36 to 65
BS 4246:1996[3)]				CEM III/B	20 to 34	66 to 80
				CEM III/C	5 to 19	81 to 95
—	—	CEM IV	Pozzolanic cement	CEM IV/A	65 to 89	11 to 35
—	BS 6610:1996[4)]			CEM IV/B	45 to 64	36 to 55
—	—	CEM V	Composite cement	CEM V/A	40 to 64	36 to 60
				CEM V/B	20 to 38	62 to 80

NOTE: In addition to the cement types in this table, BS 1370:1979 for low heat Portland cement, is current.

1) BS 4027:1996 is the British Standard for a CEM I cement with special sulfate-resisting properties.

2) BS 146:1996 is to be revised to cover only low early strength classes for blastfurnace slag cements outside the scope of this British Standard with granulated blastfurnace slag content greater than 35 %.

3) BS 4246:1996 is to be incorporated into the revised BS 146. Following this revision 'High slag blastfurnace slag cement' conforming to BS 146 will be equivalent to cement previously conforming to BS 4246:1996.

4) BS 6610:1996 covers a strength class of 22,5N which is outside the scope of this British Standard.

Table NA.2 Maximum values of sulfate (as SO_3) in Table 3 compared with maxima in British Standards which are to be withdrawn

Main type	Notation		Maximum sulfate content allowed in Table 3 (% by mass)		British Standard to be withdrawn	Maximum sulfate content allowed in British Standard withdrawn (% by mass)
CEM I	Portland cement	CEM I	Lower strength classes	3,5	BS 12:1996	3,5
			Strength subclass of 42,5R and higher	4,0		
CEM II	Portland-fly ash cement	CEM II/A-V and CEM II/B-V	Lower strength classes	3,5	BS 6588:1996	3,5
			Strength subclass of 42,5R and higher	4,0		
	Portland-limestone cement	CEM II/A-L and CEM II/A-LL	Lower strength classes	3,5	BS 7583:1996	3,5
			Strength subclass of 42,5R and higher	4,0		
CEM III	Blastfurnace cement	CEM III/A, III/B and III/C	All strength classes	4,0	BS 4246:1996	3,5

National annex NB (informative)

Information to be provided

NB.1 General

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

NB.2 Conditions of supply

NB.2.1 Identification

Cement should be identified on the bag or the delivery note, and on any test report, with the following particulars:

a) the name, trade mark or other means of identification of the manufacturer to facilitate traceability to the factory in which the cement was manufactured;

b) the designation/name, the notation/type and strength class of the cement; e.g.

Portland cement CEM I 42,5N;

Portland-fly ash cement CEM II/B-V 32,5R;

Portland-limestone cement CEM II/A-LL 42,5N;

Blastfurnace cement CEM III/A 42,5N;

c) the number and date of this British Standard i.e. BS EN 197-1:2000;

d) the standard notation of any admixture, where applicable;

e) the CE marking plus associated information;

and in the case of bagged supply only:

f) the weight of a bag packed with cement.

NB.2.2 Packed/bagged cement

Where cement is supplied in a bag for manual handling, the weight should be 25 kg, or less, within permitted tolerances.

NB.3 Test report

NB.3.1 General

If a test report is requested from the manufacturer, it should include results of the following tests on samples of the cement, and the information, where indicated, relating to the material delivered.

NB.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).

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

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

NB.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.

NOTE: See 5.2.4.1 and National annex NE for the loss on ignition requirement standardized in the UK.

NB.3.5 Portland-limestone cements (CEM II/A-L and CEM II/A-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).

NB.4 Additional information

NB.4.1 General

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

NB.4.2 All CEM cements

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

b) the fineness;

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);

e) an indication of the variability of the chloride content when its mean level exceeds 0,05 % by mass.

NB.4.3 Alkali information for individual CEM cements

The alkali information, relevant to cement type, which should be made available is given in Table NB.1.

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 should be agreed between purchaser and manufacturer.

NOTE 2: A limit of 0,60 % by mass, expressed as the sodium oxide equivalent, which the manufacturer guarantees will not be exceeded by any test result on any spot sample, has been defined (see BS 5328-1) as the guaranteed alkali limit for a cement. Low alkali sulfate-resisting Portland cement, conforming to BS 4027, is a cement standardized to a guaranteed alkali limit.

The terms used in Table NB. 1 can be described as follows:

a) A ‘CEM I type’ component, of a cement which contains blastfurnace slag or siliceous fly ash as a second main constituent, is the cement excluding the proportion of the second main constituent.

b) A declared mean alkali content, is an alkali content expressed as the sodium oxide equivalent, which will not be 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 1: It is the declared mean alkali content, rather than the certified average alkali content, which is to be used for purposes of classification and calculation of contributions of alkali from CEM cements to the alkali content of concrete.

NOTE 2: Where a cement contains blastfurnace slag or siliceous fly ash as a second main constituent, it is the declared mean alkali content of the ‘CEM I type’ component which is used for purposes of classification of the alkali content of the cement.

c) 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.

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

e) An alkali guarantee, for a blastfurnace slag or siliceous fly ash constituent, is a guarantee by the manufacturer that no test result on any spot sample of the constituent will exceed a limit, expressed as the sodium oxide equivalent, of 1,0 % by mass for blastfurnace slag or 5,0 % by mass for siliceous fly ash.

f) The declared mean alkali content of a blastfurnace slag or siliceous fly ash constituent is the value used by the manufacturer for the purpose of calculating the contribution of alkali from the constituent to the alkali content of the cement, where the proportion of the blastfurnace slag constituent is less than 42 % by mass of the sum of the main and minor additional constituents (formerly called cement nucleus) or where the proportion of the siliceous fly ash constituent is less than 26 % by mass of the sum of the main and minor additional constituents (formerly called cement nucleus).

Table NB. 1 Alkali information for individual CEM cements

Main type	Notation		Information (and its basis)		
			Cement	'CEM I type' component	Blastfurnace slag/siliceous fly ash constituent
CEM I	Portland cement	CEM I	Declared mean Certified average Variability	—	—
CEM II	Portland-limestone cement	CEM II/A-L CEM II/A-LL	Declared mean Certified average Variability	—	—
	Portland-slag cement	CEM II/A-S CEM II/B-S	Declared mean [1)]	Declared mean Certified average Variability	Alkali guarantee Declared mean Certified average Variability
	Portland-fly ash cement	CEM II/A-V CEM II/B-V	Declared mean [1)]	Declared mean Certified average Variability	Alkali guarantee Declared mean [2)] Certified average[2)] Variability [2)]
CEM III	Blastfurnace cement	CEM III/A CEM III/B CEM III/C	Declared mean [1)]	Declared mean Certified average Variability	Alkali guarantee Declared mean [2)] Certified average [2)] Variability [2)]
CEM IV	Pozzolanic (siliceous fly ash) – cement	CEM IV/A CEM IV/B	Declared mean [1)]	Declared mean Certified average Variability	Alkali guarantee Declared mean [2)] Certified average[2)] Variability [2)]

NOTE 1: See NB.4.3 for a description of the terms used in this table.

NOTE 2: This table does not deal with the provision of alkali information for cements of type CEM V since they may contain both blastfurnace slag and siliceous fly ash as second/third main constituents.

[1)] See Table NB.2 for information on how declared mean alkali contents of cements which contain either blastfurnace slag or siliceous fly ash as a second main constituent are calculated.

[2)] Information on the declared mean, the certified average and the variability of the certified average is made available only where the proportions of a blastfurnace slag constituent is less than 42 % by mass of the sum of the main and minor additional constituents (formerly called cement nucleus), or where the proportion of a siliceous fly ash constituent is less than 26 % by mass of the sum of the main and minor additional constituents (formerly called cement nucleus).

Table NB.2 Alkali contributions, from blastfurnace slag or siliceous fly ash constituents of CEM cements, taken into account by the manufacturer when calculating the declared mean alkali content of the cement

Main type	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 II	Portland-slag cement	CEM II/A-S CEM II/B-S CEM II/B-S	6 to 20 21 to 25 26 to 35	100 100 50
	Portland-fly ash cement	CEM II/A-V CEM II/B-V CEM II/B-V	6 to 20 21 to 25 26 to 35	100 20 0
CEM III	Blastfurnace cement	CEM III A CEM III A CEM III B CEM III C	36 to 41 42 to 65 66 to 80 81 to 95	50 0 0 0
CEM IV	Pozzolanic (siliceous fly ash) cement	CEM IV A CEM IV A CEM IV A	11 to 20 21 to 25 26 to 35	100 20 0
		CEM IV B	36 to 55	0

NOTE: Where a CEM I cement contains blastfurnace slag or siliceous fly ash as a minor additional constituent, 100 % of the alkali content of the constituent is taken into account.

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

National annex NC (informative)

Sampling and testing for acceptance inspection at delivery

NC.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 196-7:1992 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 196-7:1992. A sampling report should be completed at the time of sampling and should be attached to the laboratory sample in accordance with clause 10 of BS EN 196-7:1992.

NOTE: Testing may be delayed for up to 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 196-7:1992.

NC.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.

NC.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 196-2:1995.

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

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

NOTE: The acceptance inspection limits are in general those given as limit values for single results in Table 8 of this standard. However, Table 8 does not give values for loss on ignition or insoluble residue.

Table NC.1 Acceptance inspection limits

Property		Strength class					
		32,5N	32,5R	42,5N	42,5R	52,5N	52,5R
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 % SO_3 by mass) upper limit value	CEM I CEM II CEM IV CEM V	4,0		4,5			
	CEM III/A CEM III/B	4,5					
	CEM III/C	5,0					
Chloride content (% by mass)[1] upper limit value		0,10					
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] Cement type CEM III may contain more than 0,10 % chloride but in such a case it is necessary to declare the actual chloride content.

National annex ND (informative)

Special Portland cements

ND.1 Controlled fineness Portland cement

Controlled fineness Portland cement should conform to the requirements for type CEM I of this British Standard and, in addition its fineness should lie within a range to be agreed between the purchaser and the manufacturer.

NOTE: For many years there has been a demand by specialist users for a cement which makes it easier to remove excess water from the concrete during compaction. In some applications the fineness of the cement is more critical than its compressive strength.

ND.2 Pigmented Portland cement

Pigmented Portland cement should be deemed to conform to the requirements for type CEM I of this British Standard provided that:

a) the pigments conform to BS EN 12878;

b) the chemical properties of the Portland cement constituent, excluding pigment conform to the requirements of clause 7.3 of this standard;

c) the final cement, including pigment, conforms to this British Standard with the exception of clause 6 and clause 7.3.

NOTE: The quantity of pigmented cement used in a concrete or mortar mix may need to be greater than that of an unpigmented cement in order to take account of the amount of pigment present.

National annex NE (normative)

Requirement, in the UK, for the loss on ignition of a siliceous fly ash constituent

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

NOTE 1: In 5.2.4.1 the requirement for the loss on ignition property of a siliceous fly ash constituent is permitted, within stated limits, to be standardized on a national basis.

NOTE 2: See 5.2.4.1 where the additional requirements for durability, compatibility with admixtures and the declaration to be made on the packaging or delivery note for the cement are given, where a requirement for the loss on ignition of a siliceous fly ash constituent has been standardized nationally.

National annex NF (informative)

Product guidance

NF.1 General

Guidance on the use of cements in concrete can be found in BS 5328-1 and in BS 8000-2.

Guidance on their use in mortar can be found in BS 5262, BS 5628-3 and BS 8000-3.

NF.2 Safety warning

NF.2.1 Manual handling of bags

Manual handling activities are subject to the Manual Handling Operations Regulations 1992 [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) [2], Guidance and Regulations L23 (HMSO). In addition, the HSE in its Construction Information Sheet No. 26 (Revised 10/96) [3], specifically encourages the use of 25 kg bags of cement whilst discouraging the use of 50 kg bags, in order to reduce the risk of injury.

NF.2.2 Safety in use

NF.2.2.1 Regulations

Work with cement is subject to the Control of Substances Hazardous to Health Regulations (COSHH) 1999 [4]. In addition, Portland cement has been classified as an irritant under The Chemicals [Hazard Information & Packaging] Regulations (CHIP)1994 [5].

These regulations variously require that:

a) the health risks of the cement in use be assessed and then prevented or controlled;

b) product health and safety information sheets be made available from the manufacturer/supplier;

c) bags containing common cement be labelled with a health and safety warning indicating that cement is an irritant.

NF.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 may 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 may, 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.

High repeated exposures to airborne cement in excess of the Occupational Exposure Standard (OES) [6]have been linked with rhinitis and coughing.

NF.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.

NF.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.

NF.3 Storage

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

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

NF.4 Test temperature

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

NF.5 Grouting and rendering

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

NF.6 Heat generation

The cement hydration process generates heat, particularly in the first few days. Cements with higher early strength usually have a higher initial rate of heat generation than those with lower early strength. A higher initial rate of heat generation may be an advantage for thinner concrete sections in cold weather because it reduces the need for extended striking times and the tendency for early-age frost damage. Conversely, it may be a disadvantage for larger concrete sections in either hot or cold weather on account of the temperature gradients which are set up.

NF.7 Alkali-silica reaction

Portland slag cements (CEM II/A-S and II/B-S), blastfurnace cements (CEM III/A, III/B and III/C), Portland fly ash cements (CEM II/A-V and II/B-V) and Pozzolanic (siliceous fly ash) cements (CEM IV/A and IV/B) may be beneficial in minimizing the risk of damage to concrete caused by the alkali-silica reaction.

NF.8 Sulfate resistance (including the thaumasite form)

Blastfurnace cements (CEM III/B and III/C), Portland fly ash cement (CEM II/B-V) and Pozzolanic (siliceous fly ash) cements (CEM IV/A and IV/B) can confer concrete with sulfate-resisting properties (see BS 5328-1).

Portland limestone cements, CEM II/A-L and CEM II/A-LL, for use in concrete exposed to a sulfate-bearing environment, are recommended in Class 1 sulfate conditions only, as defined in BS 5328-1.

National annex NG (informative)

Publications referred to in national annexes

NG.1 Standards publications

BS 12:1996, *Specification for Portland cement*

BS 146:1996, *Specification for Portland blastfurnace cements*

BS 915-2:1972, *Specification for high alumina cement – Part 2: Metric units*

BS 1370:1979, *Specification for low heat Portland cement*

BS 4027:1996, *Specification for sulfate-resisting Portland cement*

BS 4246:1996, *Specification for high slag blastfurnace cement*

BS 4248:1974, *Specification for supersulfated cement*

BS 5262:1991, *Code of practice for external renderings*

BS 5328-1:1997, *Concrete – Part 1: Guide to specifying concrete*

BS 5628-3:1985, *Code of practice for use of masonry – Part 3: Materials and components, design and workmanship*

BS 6588:1996, *Specification for Portland pulverized-fuel ash cements*

BS 6610:1996, *Specification for Pozzolanic pulverized-fuel ash cement*

BS 7583:1996, *Specification for Portland limestone cement*

BS 8000-2.1:1990, *Workmanship on building sites – Part 2: Code of practice for concrete work – Section 2.1: Mixing and transporting concrete*

BS 8000-2.2:1990, *Workmanship on building sites – Part 2: Code of practice for concrete work – Section 2.2: Sitework with in situ and precast work*

BS 8000-3:1989, *Workmanship on building sites – Part 3: Code of practice for masonry*

BS 8110-1:1997, *Structural use of concrete – Part 1: Code of practice for design and construction*

BS EN 196-1:1995, *Methods of testing cement – Part 1: Determination of strength*

BS EN 196-2:1995, *Methods of testing cement – Part 2: Chemical analysis of cement*

BS EN 196-3:1995, *Methods of testing cement – Part 3: Determination of setting time and soundness*

BS EN 196-7:1992, *Methods of testing cement – Part 7: Methods of taking and preparing samples of cement*

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

BS EN 12878:1999, *Pigments for colouring building materials based on cement and/or lime – Specifications and methods of test*

NG.2 Other publications

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

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

[3] GREAT BRITAIN. Health and Safety Executive. Construction information sheet No. 26, 1996. London: HSE books.

[4] GREAT BRITAIN. Control of Substances Hazardous to Health Regulations (COSHH) 1999. London: The Stationery Office.

[5] GREAT BRITAIN. The Chemicals [Hazard Information and Packaging] Regulations (CHIP) 1994. London: The Stationery Office.

[6] GREAT BRITAIN. Occupational Exposure Criteria Document, Portland Cement Dust. London: HSE books.

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