SLOVENSKI STANDARD

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Elektrofiltrski pepel – 1. del: Definicije, specifikacije in merila skladnosti

Fly ash for concrete - Part 1: Definition, specifications and conformity criteria

Flugasche für Beton - Teil 1: Definition, Anforderungen und Konformitätskriterien

Cendres volantes pour beton - Partie 1: Définition, spécifications et criteres de conformité

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Fly ash for concrete - Part 1: Definition, specifications and conformity criteria

Cendres volantes pour beton - Partie 1: Definition, spécification et critères de conformité

Flugasche für Beton - Teil 1: Definition, Anforderungen und Konformitätskriterien

This European Standard was approved by CEN on 22 December 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, 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.

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Foreword

This document (EN 450-1:2005) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by August 2005, and conflicting national standards shall be withdrawn at the latest by August 2006.

This document supersedes EN 450:1994.

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

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

It is supported by standards of the series EN 451 for test methods for determination of free calcium oxide content and of the fineness by sieve residue. No existing European Standard, apart from EN 450:1995, is superseded.

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

The use of coal for electricity production results in the generation of large quantities of fly ash.

Different types of coal and the type of boiler used in this process produce different fly ashes, such as siliceous, silico-calcareous, or calcareous fly ashes with pozzolanic and/or latent hydraulic properties. All these types of fly ash are used in concrete production in some European countries, based on national experiences and tradition.

Before its use fly ash maybe subject to processing, for example by classification, selection, sieving, drying, blending, grinding or carbon reduction, to optimize its fineness, reduce its water demand or to improve other properties. Such processed fly ashes may conform to this document to which reference is made in such case. When they are out of the scope of this document, their suitability for use as Type II additions in concrete according to EN 206-1 may also be established from National standards or provisions or European Technical Approvals valid in the place of use of the concrete and which refer specifically to the use of the addition in concrete conforming to EN 206-1.

When using fly ashes conforming to this document, it should be noted that, apart from the effect from the pozzolanicity of the fly ash, certain properties of fresh and hardened concrete may be affected. Where relevant, such effects have to be considered in concrete mix design (see EN 206-1).

1 Scope

This document specifies requirements for the chemical and physical properties as well as quality control procedures for siliceous fly ash, as defined in 3.2, for use as a type II addition for production of concrete, including in particular cast-in-situ or prefabricated structural concrete conforming to EN 206-1. Fly ash according to this document may also be used in mortars and grouts.

Fly ash produced with other types or higher percentages of co-combustion materials than those provided for in 4 is outside the scope of this document.

It is, however, beyond the scope of this document to specify provisions governing the practical application of fly ash in the production of concrete, i.e. requirements concerning composition, mixing, placing, curing etc. of concrete containing fly ash. As regards such provisions, reference should be made to other European or national standards for concrete, such as EN 206-1.

2 Normative references

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

EN 196-1:1994, *Methods of testing cement — Part 1: Determination of strength.*

EN 196-2:1994, *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 196-6, *Methods of testing cement — Determination of fineness.*

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

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

EN 197-1:2000, *Cement — Part 1: Composition, specification and conformity criteria for common cements.*

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

EN 450-2:2005, *Fly ash for concrete — Part 2: Conformity evaluation.*

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

EN 451-2, *Method of testing fly ash — Part 2: Determination of fineness by wet sieving.*

EN 1015-3:1999, *Methods of test for mortar for masonry — Part 3: Determination of consistence of fresh mortar (by flow table).*

EN ISO 11885, *Water quality - Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy (ISO 11885:1996).*

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

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. The values appearing in the definitions below shall not form part of the criteria for assessing conformity.

3.1
type II addition
finely divided inorganic, pozzolanic or latent hydraulic material that may be added to concrete in order to improve certain properties or to achieve special properties (see EN 206-1)

3.2
fly ash
fine powder of mainly spherical, glassy particles, derived from burning of pulverised coal, with or without co-combustion materials, which has pozzolanic properties and consists essentially of SiO_2 and Al_2O_3, the content of reactive SiO_2 as defined and described in EN 197-1 being at least 25 % by mass.

Fly ash is obtained by electrostatic or mechanical precipitation of dust-like particles from the flue gases of furnaces fired with pulverised coal, with or without co-combustion materials, see 4.

Fly ash may be processed, for example by classification, selection, sieving, drying, blending, grinding or carbon reduction, or by combination of these processes, in adequate production plants. Such processed fly ash may consist of fly ashes from different sources, each conforming to the definition given in this clause. If one or more of incoming fly ashes are obtained from co-combustion, then the processed fly ash shall be considered as fly ash from co-combustion

NOTE Municipal and industrial waste incineration ashes do not conform to the definition given in this clause.

3.3
test cement
selected brand of Portland cement of type CEM I, strength class 42,5 or higher, conforming to EN 197-1 to be used for carrying out the tests needed to evaluate conformity to the requirements of 5.3.2, 5.3.3, 5.3.5 and 5.3.6.

Test cement is selected by the fly ash producer and is further characterised by its fineness and contents of tricalcium aluminate and alkalis as follows:

Fineness (Blaine): At least 300 m^2/kg

Tricalcium aluminate: 6 % to 12 %

Alkalis (Na_2O eqv): 0,5 % to 1,2 %

3.4
particle density
average density of fly ash particles, including voids inside the particles

3.5
activity index
ratio (in percent) of the compressive strength of standard mortar bars, prepared with 75 % test cement plus 25 % fly ash by mass, to the compressive strength of standard mortar bars prepared with 100 % test cement, when tested at the same age

3.6
autocontrol
continuous statistical quality control of the fly ash based on the testing of samples taken by the producer or their agent at point(s) of release from the fly ash producing facility

3.7
control period
period of production and/or dispatch identified for the evaluation of the autocontrol test results

3.8
characteristic value
value of the required property outside of which lies a specified percentage, the percentile P_k, of all the values of the population

3.9
specified characteristic value
characteristic value of a chemical or physical 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

3.10
single result limit value
value of a chemical or physical 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

3.11
allowable probability of acceptance CR
for a given sampling plan, the allowed probability of acceptance of fly ash with a characteristic value outside the specified characteristic value

3.12
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

3.13
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)

4 Specific provisions for fly ash from co-combustion

4.1 Co-combustion materials

FIy ash from co-combustion as defined in 3.2 is obtained from pulverised coal fired simultaneously with co-combustion materials as listed in Table 1. The minimum percentage, by dry mass, of coal (K_c) shall not be less than 80 % and the maximum proportion of fly ash derived from co-combustion materials (M) shall not be greater than 10 % when calculated from the Formula (1):

$$M = 100\ (K_1 * A_1 + K_2 * A_2 \ldots K_n * A_n) / (K_c * A_c + (K_1 * A_1 + K_2 * A_2 \ldots K_n * A_n)) \quad (1)$$

where

M is the proportion of co-combustion ash in total fly ash in % by mass;

A_i is the ash content of co-combustion material No. i, in % by mass;

n is the number of co-combustion materials being used;

A_c is the ash content of coal in % by mass;

K_i and K_c are the proportions of co-combustion material(s) and coal being fired, respectively;

and where

$(K_c + K_1 + K_2 + \ldots K_n) = 1$ and $K_c \geq 0{,}80$.

Virtually ash free liquid and gaseous fuels can not be considered in accordance with Formula (1). For that reason the maximum percentage of such fuels shall be determined on the basis of their calorific contribution which shall not exceed 20 % of the total calorific energy.

Table 1 — Types of co-combustion materials

1	Vegetable material like wood chips, straw, olive shells and other vegetable fibres
2	Green wood and cultivated biomass
3	Animal meal
4	Municipal sewage sludge
5	Paper sludge
6	Petroleum coke
7	Virtually ash free liquid and gaseous fuels

4.2 Establishment of suitability of fly ash from co-combustion

The suitability of fly ash obtained from combustion of coal with co-combustion materials given in Table 1 shall be established and documented by the producer. An initial co-combustion in the furnace using the highest intended amount of co-combustion material shall be performed. A representative sample of fly ash taken from this co-combustion (see 7) shall be used to establish the suitability.

Suitability of fly ash obtained from co-combustion with one of the co-combustion materials in Table 1 is established if conformity to the requirements in 5.2, 5.3 and 5.4 has been proven.

Other co-combustion materials than those listed in Table 1 may be used if permitted by national laws, regulations or administrative provisions valid in the place of use of fly ash produced from such co-combustion materials and provided that such fly ash conforms to the requirements in 5.2, 5.3 and 5.4.

4.3 Environmental compatibility

Should there be any additional requirements resulting from national laws, regulations and administrative provisions in the place of use of the fly ash regarding e.g.

a) the fly ash,

b) the leachate of concrete produced with fly ash,

c) the co-combustion material,

these are to be considered with respect to environmental compatibility, and conformity to the relevant regulations has, where required, to be evaluated before production.

5 Specifications

5.1 General

The chemical and physical requirements in 5.2 and 5.3 are specified as characteristic values. Conformity to a characteristic value is assessed by means of a statistical quality control procedure as described in 8.

The test methods prescribed in this document are reference methods. In factory production control, cfr. EN 450-2, other methods may be used provided they give results equivalent to those obtained with the reference method. In case of a dispute, only the reference method shall be used.

NOTE Fly ash should be stored and delivered in a dry condition.

5.2 Chemical requirements

5.2.1 General

The chemical composition shall be expressed as proportions by mass of dry fly ash (see 7 for a method of obtaining a sample of dry fly ash).

In performing the test methods described in 13 of EN 196-2:1994 the following modifications shall be observed:

a) When heating the sample-peroxide mixture (13.2 of EN 196-2:1994) use a furnace temperature of 550 °C and maintain it for 60 min. Timing to start when temperature has recovered to 540 °C;

b) When dispersing the sintered mass from the furnace (13.2 of EN 196-2:1994), proceed with the test even though the melting may not be clear;

c) To decompose the evaporation residue (13.7 of EN 196-2:1994), add 2 g potassium bisulfate instead of the sodium carbonate/sodium chloride mixture.

5.2.2 Loss on ignition

The loss on ignition shall be determined in accordance with the principles of the method described in EN 196-2 but using an ignition time of 1 h, and shall fall within the limits of the categories specified below:

Category A: Not greater than 5,0 % by mass

Category B: Between 2,0 % and 7,0 % by mass

Category C: Between 4,0 % and 9,0 % by mass

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

NOTE As the magnitude of the loss on ignition may have an influence on the effect of air-entraining admixtures used for the manufacture of concrete resistant to freezing and thawing, the three loss on ignition categories defined in this document allow the user to take this into account by choosing the appropriate category for each particular application and exposure class, thus following the standards and/or regulations for concrete valid in the place of use.

5.2.3 Chloride

The content of chloride, expressed as Cl^-, shall be determined in accordance with EN 196-21 and shall not be greater than 0,10 % by mass.

5.2.4 Sulfuric anhydride

The content of sulfuric anhydride, SO_3, shall be determined in accordance with EN 196-2 and shall not be greater than 3,0 % by mass.