



SLOVENSKI STANDARD

SIST EN 450:1996

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Elektrofiltrski pepel - Definicije, zahteve in kontrola kakovosti

Fly ash for concrete - Definitions, requirements and quality control

Flugasche für Beton - Definitionen, Anforderungen und Güteüberwachung

Cendres volantes pour béton - Définitions, exigences et contrôle de qualité

Ta slovenski standard je istoveten z: **EN 450:1994**

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ICS:

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EUROPEAN STANDARD

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English version

Fly ash for concrete - Definitions, requirements and quality control

Cendres volantes pour béton - Définitions,
exigences et contrôle de qualitéFlugasche für Beton - Definitionen,
Anforderungen und Güteüberwachung

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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.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard was drawn up by the Technical Committee CEN/TC 104 "Concrete", the secretariat of which is held by DIN.

The preparatory work was carried out by WG 4 of CEN/TC 104 since June 1988 in which the following countries participated: Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Sweden and United Kingdom.

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

This European Standard shall be given the status of a National Standard, either by publication of an identical text or by endorsement, at the latest by March 1995, and conflicting national standards shall be withdrawn at the latest by March 1995.

It will be 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 No existing European Standard is superseded.

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

0 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 qualities of fly ash and some, especially those having pozzolanic properties, are used in concrete production.

This European standard gives requirements for the chemical and physical properties as well as quality control procedures for fly ashes which may be safely used as a pozzolanic addition for the production of cast-in-situ or prefabricated structural concrete. However, it is beyond the scope in this standard to specify provisions for the use of fly ash in concrete, for which reference should be made to ENV 206.

Fly ash may before its use be subject to processing by classification or selection to increase its fineness and to improve other properties. Such is the case for example in the UK and Ireland which, in order to limit variations of properties and to reduce water demand, have developed a low sieve residue fly ash for use as a special component of cementitious systems. The fineness of this fly ash is strictly controlled in order to maximise chemical activity and minimize the variability of properties not only within one source but also between different sources.

Although such processed fly ash may conform to this standard, the additional requirements for fineness and reduction of water demand which allow this processed fly ash to be used specifically as a special component of cementitious systems in concrete are not included in this standard.

When using fly ashes complying with this standard, it should be noted that, apart from pozzolanic properties, other properties of fresh and hardened concrete, in particular the water requirement (lower or higher), the setting time (normally increased) and the early age strength (relative reduction), may be affected. When relevant, such effects have to be considered in concrete mix design (see ENV 206).

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1 Scope

This European Standard specifies requirements for the properties of fly ash for use as a type II addition in cast-in-situ or prefabricated structural concrete conforming to ENV 206.

Fly ash for use in the manufacture of cements according to ENV 197-1 is outside the scope of this standard.

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 are not part of this standard. As regards such provisions, reference is made to ENV 206 or national standards for concrete.

2 Normative references

This European Standard 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 this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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|----------------|--|
| EN 196-1:1992 | Methods of testing cement - Determination of strength |
| EN 196-2:1992 | Methods of testing cement - Chemical analysis of cement |
| EN 196-3:1992 | Methods of testing cement - Determination of setting time and soundness |
| EN 196-6:1989 | Methods of testing cement - Determination of fineness |
| EN 196-7:1989 | Methods of testing cement - Methods of taking and preparing samples of cement |
| EN 196-21:1989 | Methods of testing cement - Determination of chloride, carbon dioxide and alkali content of cement |
| ENV 197-1:1992 | Cement - Composition, specifications and conformity criteria |
| ENV 206:1989 | Concrete - Performance, production, placing and compliance criteria |
| EN 451-1:1994 | Methods of testing fly ash - Part 1: Determination of free calcium oxide |
| EN 451-2:1994 | Methods of testing fly ash - Part 2: Determination of fineness by wet sieving |

3 Definitions

For the purpose of this standard the following 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, cf ENV 206.

3.2 Fly ash

Fine powder of mainly spherical, glassy particles, derived from burning of pulverized coal, which has pozzolanic properties and consists essentially of SiO_2 and Al_2O_3 , the content of reactive SiO_2 , defined and determined as described in ENV 197-1, being at least 25 % by mass.

Fly ash is obtained by electrostatic or mechanical precipitation of dust-like particles from the flue gasses of furnaces fired with pulverized anthracite or bituminous coal.

NOTE: Fly ash obtained from firing with sub-bituminous coals may be accepted on a national basis provided that its total content of CaO is less than 10 % by mass and that it complies with all other requirements of the present standard.

3.3 Reference cement

Selected brand of Portland cement of type CEM I, Strength Class 42,5, conforming to ENV 197-1 to be used for carrying out the tests needed to show compliance or non-compliance with the requirements of clauses 4.3.2 and 4.3.3 below.

Reference cement is selected and fixed on a national basis and is further characterized by its fineness and contents of tricalcium aluminate and alkalis.

3.4 Density

Average density of the 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 % reference cement plus 25 % fly ash by mass, to the compressive strength of standard mortar bars prepared with reference cement alone, 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 his agent at point(s) of release from the fly ash generation facility.

4 Requirements

4.1 General

The chemical and physical requirements in clauses 4.2 and 4.3 are specified as characteristic values. Compliance with a characteristic value is assessed by means of a statistical quality control procedure as described in clause 6.

NOTE: The test methods prescribed in this standard are reference methods. Other methods may be used if a relationship between the results obtained by means of the reference method and those of the alternative method has been established. In case of a dispute, only the reference method shall be used.

Fly ash shall be stored and transported to the purchaser in a dry condition, unless otherwise agreed.

4.2 Chemical requirements

4.2.1 General

The chemical composition shall be expressed as proportions by mass of dried ash (cf clause 6.2.2 for a method of obtaining a sample of dried fly ash).

In addition to the chemical requirements specified below a typical chemical composition of the dried fly ash comprising the contents of silica (SiO_2), aluminium oxide (Al_2O_3), iron oxide (Fe_2O_3), and calcium oxide (CaO) as determined by the methods described in EN 196-2, shall be supplied to the purchaser upon request. Also the total content of alkalis determined by the method described in EN 196-21 and calculated as Na_2O shall be supplied to the purchaser upon request.

NOTE: This standard has no requirement for magnesium oxide (MgO) because fly ash according to this standard does not contain free periclase which might cause uncontrolled expansion.

4.2.2 Loss on ignition

The loss on ignition, as determined in accordance with the principles of the method described in EN 196-2 but using an ignition time of 1 hour, shall not be greater than 5,0 % by mass.

NOTE 1: Fly ashes with losses on ignition up to 7,0 % by mass may also be accepted on a national basis.

NOTE 2: 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 this is less than the values specified above.

4.2.3 Chloride

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

4.2.4 Sulphuric anhydride

The content of sulphuric anhydride, SO_3 , as determined by the method described in EN 196-2, shall not be greater than 3,0 % by mass.

4.2.5 Free calcium oxide

The content of free calcium oxide, as determined by the method described in EN 451-1, shall not be greater than 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, however, also acceptable provided that it complies with the requirement for soundness in clause 4.3.3.

4.3 Physical requirements

4.3.1 Fineness

The fineness of fly ash shall be expressed as the mass proportion in % of the ash retained when wet sieved on a 0,045 mm mesh sieve and determined by the method described in EN 451-2.

The maximum value of the fineness shall not exceed 40 %. The fineness shall not vary by more than ± 10 percentage points from the average value which shall be calculated from the number of tests within a given production period as described in clause 6.2.

Upon request, the average value and the period over which it has been calculated shall be declared by the producer.

4.3.2 Activity index

Preparation of standard mortar bars and determination of the compressive strength shall be carried out in accordance with the method described in EN 196-1.

The activity index at 28 days and at 90 days shall be at least 75 % and 85 %, respectively.

NOTE: The result of the activity index tests gives no direct information on the strength contribution of fly ash in concrete, nor is the use of fly ash limited to the mixing ratio used in these tests.

4.3.3 Soundness

The expansion, as determined on a 50 % fly ash plus 50 % reference cement by mass reference cement paste by the method designated the Le Chatelier test and described in EN 196-3, shall not be greater than 10 mm.

NOTE: This test is required only if the free calcium oxide content of the fly ash exceeds 1,0 % by mass, cf clause 4.2.5.

4.3.4 Density

The density, determined by the method described in EN 196-6, shall not deviate by more than ± 150 kg/m³ from the average value as declared by the producer or his agent.

5 Packaging and marking

NOTE: Fly ash may be delivered in suitable packages, such as bags or drums, and in bulk-delivery vehicles or ships.

Packages shall be marked or labelled and delivery notes (or invoices) following bulk delivery shall be marked with the following particulars:

- the type of the material, i.e. fly ash;
- the name, trade mark or other means of identification of the supplier;
- the name and location of the facility from which the fly ash is dispatched;
- the number and year of this standard (or of national standards which implements this standard);
- certification mark.

6 Quality control

NOTE: This clause comprises general rules for conformity criteria and autocontrol. Rules for acceptance inspection at delivery and for certification are outside the scope of the standard.

6.1 Conformity criteria

The conformity criteria and conformity procedures specified in ENV 197-1 for the physical and the chemical properties of cement shall apply in this standard. The characteristic values specified in clause 4 shall correspond to the 10 %-fractile (upper or lower as appropriate) while the probability of acceptance (consumer's risk) shall be 5 % for all the properties dealt with in this standard. In addition, major defects, as defined in ENV 197-1, exceeding the values listed in table 1 shall not be accepted for any of the properties.

Table 1: Major defects

Property	Limit for major defect
Loss on ignition	+ 2,0 percentage points
Fineness	$\pm 5,0$ percentage points
Fineness variation	$\pm 5,0$ percentage points
Chloride	+ 0,01 percentage points
Free calcium oxide	+ 0,1 percentage points
Sulphuric anhydride	+ 0,5 percentage points
Soundness	+ 1,0 mm
Activity index	- 5,0 percentage points

6.2 Autocontrol

6.2.1 General

A system of autocontrol shall be operated by the producer or his agent at every single fly ash generating facility to ensure conformity to the requirements specified in clause 4. The continuous statistical quality control shall be based on inspection by attributes or by variables of the producer's or his agent's choice using single spot samples. A minimum of ten samples shall be used for assessing the conformity and shall represent a production period of not more than twelve months, not less than one month.

NOTE: Examples of some convenient sampling plans for inspection by variables and by attributes are shown in Annex A.

6.2.2 Sampling

Spot samples, equally distributed over the production period, shall be taken in connection with loading or discharging fly ash to or from a storage silo into packages or into a bulk-delivery vehicle or ship, or, alternatively, directly from packages or bulk-delivery vehicles or ships, using the equipment and principles described in EN 196-7.

For the purpose of carrying out all the analyses and tests needed to show compliance or non compliance with the requirements set out in clauses 4.2 and 4.3 a representative laboratory sample of dried fly ash of at least 1,000 g is required. This sample is obtained by subdividing, such as quartering, a spot or composite sample of at least 4,000 g. The laboratory sample shall be dried in a well-ventilated oven at 105 ± 5 °C to constant weight and then cooled in a dry atmosphere.

6.2.3 Frequency of sampling and testing

The properties of fly ash specified in clause 4 shall be tested at the following minimum frequencies:

Table 2: Sampling and Testing frequency

Property	Frequency
Loss on ignition	Daily
Fineness	Daily
Free calcium oxide	Once per week
Chlorides	Once per month
Sulphuric anhydride	Once per month
Particle density	Once per month
Activity index	Twice per month
Soundness	Once per week, if required

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