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Silica-calcium fume for concrete — Definitions, requirements and conformity criteria

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National foreword

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Fumées de silico-calcium pour béton - Définitions, exigences et critères de conformité

Siliko-Calciumstaub für Beton - Definitionen, Anforderungen und Konformitätskriterien

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European foreword

This document (EN 16622:2015) 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of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by August 2017.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

For relationship with Regulation (EU) No. 305/2011, 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, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Silica-calcium fume (SCF) according to this European Standard is a special type of silica fume containing some calcium. It is collected by filters as a by-product of the carbothermal process to produce silica-calcium alloys. It is only supplied as a densified product. SCF from more than one furnace, filter or intermediate storage silo will normally be blended in the production plant.

Many years of practical experience, especially in France, have demonstrated that SCF which satisfies the requirements in this European Standard has both hydraulic and pozzolanic properties, and may be used to produce concrete with improved properties in both the fresh and hardened states.

SCF is normally used in combination with a plasticizer and/or superplasticizer.

This European Standard is based on EN 13263-1 “Silica fume for concrete - Part 1: Definitions, requirements and conformity criteria”, with similar structure and requirements. The differences in the material properties is taken into account, for instance that silica-calcium fume is partly hydraulic unlike silica fume. When it comes to conformity, this European Standard refers to EN 13263-2 “Silica fume for concrete - Part 2: Conformity evaluation”.

1 Scope

This European Standard applies to the silica-calcium fume (SCF) which is a by-product of the carbothermal process used to produce silica-calcium alloys.

This European Standard gives requirements for chemical and physical properties for SCF to be used as a type II addition in concrete conforming to EN 206, or in mortars, grouts and other mixes. This European Standard also states conformity criteria and related rules.

This European Standard does not give rules for the use of SCF in concrete. Some general rules for the use of type II additions are given in EN 206.

NOTE Supplementary rules related to the use of SCF in concrete may be given in non-conflicting national standards for concrete.

2 Normative references

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

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

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

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

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

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

EN 413-2, *Masonry cement — Part 2: Test methods*

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

EN 934-2, *Admixtures for concrete, mortar and grout — Part 2: Concrete admixtures — Definitions, requirements, conformity, marking and labelling*

EN 1097-7, *Tests for mechanical and physical properties of aggregates — Part 7: Determination of the particle density of filler — Pyknometer method*

EN 13263-2, *Silica fume for concrete — Part 2: Conformity evaluation*

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

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

3 Terms and definitions

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

NOTE Some terms and definitions from EN 13263–2 to which this European Standard refers are included here for convenience. Where needed they are modified for the application to SCF.

3.1
activity index
ratio (in percent) of the compressive strength of standard mortar bars, prepared with 90 % test cement plus 10 % SCF by mass, to the compressive strength of standard mortar bars prepared with 100 % test cement, when tested at the same age

3.2
allowable probability of acceptance CR
for a given sampling plan, allowed probability of acceptance of SCF with a characteristic value outside the specified characteristic value

3.3
characteristic value
value having a prescribed probability of not being attained in a hypothetical unlimited test series

Note 1 to entry: Equivalent to “fractile” which is defined in ISO 3534-1.

[SOURCE: ISO 8930:1987]

3.4
control period
period of production and dispatch identified for the assessment of the test results

3.5
densified SCF
SCF that has been treated to increase the bulk density by particle agglomeration, the bulk density typically being above 500 kg/m^3

3.6
depot
bulk SCF handling facility – not located at the production plant – used for the dispatch of SCF– whether in bulk or bagged – after transfer or storage where the manufacturer has full responsibility for all aspects of the quality of the SCF

3.7
initial period
immediate period after the first issuing of the declaration of performance for a SCF

3.8
determination of product type
testing of the first audit sample

3.9
new production plant
production plant which is not already producing SCF

3.10
production plant
facility producing SCF:

a) silica-calcium alloy production plant;

b) processing plant, for example for the selection, blending or densifying of SCF

3.11
quality control
part of quality management focused on fulfilling quality requirements

[SOURCE: EN ISO 9000:2015, 3.3.7]

3.12
sampling plan
specific plan which states the (statistical) sample size(s) to be used, the percentage P_k on which the characteristic value is based, and the allowable probability of acceptance CR

[SOURCE: EN 13263-1:2005+A1:2009, 3.23]

3.13
silica-calcium fume (SCF)
very fine particles of amorphous silicon dioxide and dicalcium silicate collected as a by-product of the carbothermal process used to produce silica-calcium alloys

Note 1 to entry: SCF may be processed, for example by classification, selection, blending, densifying, or by a combination of these processes, in adequate production plants. Such processed SCF may consist of SCF from different sources, each conforming to the definition given in this subclause.

3.14
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

[SOURCE: EN 13263-1:2005+A1:2009, 3.26]

3.15
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

[SOURCE: EN 13263-1:2005+A1:2009, 3.27]

3.16
spot sample
sample taken within a short period of time and at a fixed point from within a larger quantity, relating to the intended tests. It can be obtained by combining one or more immediately consecutive increments

[SOURCE: EN 196-7:2007, 3.6]

3.17
test
technical operation that consists of the determination of a characteristic of a product according to a specified procedure

[SOURCE: EN 13263-1:2005+A1:2009, 3.29]

3.18
test cement
cement used for evaluation of the activity index of SCF

3.19
testing laboratory
laboratory which measures, examines, tests, calibrates or otherwise determines the characteristics or performance of materials or products

[SOURCE: EN 13263-1:2005+A1:2009, 3.31]

3.20
test method
specified technical procedure for performing a test

3.21
type II addition
pozzolanic or latent hydraulic addition

[SOURCE: EN 206:2013, 3.1.2.3]

3.22
works´ quality manual
document that provides information on the production control which is applied by a manufacturer at a particular production plant to ensure conformity of the SCF with the requirements of this European Standard

4 Health, hygiene and environment

4.1 Release of dangerous substances

National regulations on dangerous substances may require verification and declaration on release, and sometimes content, when construction products covered by this standard are placed on those markets. In the absence of European harmonized test methods, verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction website on EUROPA accessed through: http://ec.europa.eu/growth/tools-databases/cp-ds/index_en.htm.

4.2 Emission of radioactivity

SCF used in products shall not release any radioactivity in excess of the maximum permitted levels specified in a relevant European Standard for the material or permitted in the national regulations of the member state of destination".

NOTE See ZA.1 in Annex ZA.

5 Product characteristics

5.1 General

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

The test methods prescribed in this European Standard are reference methods. In factory production control other methods may be used provided they give results equivalent to those obtained with the reference method. In case of dispute, only the reference method shall be used.

5.2 Chemical requirements

5.2.1 Silicon dioxide

The content of silicon dioxide, SiO_2, as determined by the method described as reference method in EN 196-2 shall not be less than 70 % by mass and shall be declared.

NOTE In the 2013 edition of EN 196–2, the reference method is described in 4.5.3.

5.2.2 Elemental silicon

The content of elemental silicon, determined according to ISO 9286, shall not be greater than 0,5 % by mass.

5.2.3 Total calcium oxide

The total calcium oxide content, as determined by the reference method described in EN 196-2, shall be in the range of 10 % to 20 % by mass.

5.2.4 Free calcium oxide

The content of free calcium oxide, free CaO, as determined by the method described in EN 451-1, shall not be greater than 1,0 % by mass.

5.2.5 Sulfate

The sulfate content, as determined by the method described in EN 196-2 and expressed as SO_3, shall not be greater than 2,0 % by mass.

5.2.6 Total content of alkalis

The total content of alkalis determined by the method described in EN 196-2 and calculated as "Na_2O equivalent" shall be declared.

NOTE Different national provisions adopt different principles but in general only a small proportion of alkalis in the components of the concrete including silica-calcium fume are considered to contribute to alkali silica reaction, see CEN/TR 16349. Normally silica fumes are considered to reduce the risk of alkali aggregate reactions, see 5.3 in CEN/TR 16349:2012.

5.2.7 Chloride

The content of chloride, calculated as Cl^- and determined in accordance with the method described in EN 196-2, shall not be greater than 0,30 % by mass. If the Cl^- content is above 0,10 % by mass, the upper limit for its characteristic value shall be declared by the manufacturer.

5.2.8 Loss on ignition

The loss on ignition, as determined in accordance with the method described in EN 196-2, but using an ignition time of 1 h, shall not be greater than 6,5 % by mass.

NOTE The loss on ignition is dominated by free carbon. There is also some carbonate coming from the unburnt limestone used in the process.

5.3 Physical requirements

5.3.1 Specific surface

The specific surface, as determined by nitrogen adsorption according to the method given in ISO 9277, shall not be less than 12 m^2/g, and shall be declared.

5.3.2 Activity index

The activity index is determined as the ratio (in percent) of the compressive strength of standard mortar bars, prepared with 90 % test cement plus 10 % SCF per mass of total binder, to the compressive strength of standard mortar bars prepared with 100 % test cement, when tested at the same age.

The test cement shall be a selected brand of Portland cement of type CEM I, strength class 42,5 N or higher, conforming to EN 197-1 to be used for carrying out the tests needed to evaluate conformity to the requirement of 5.3.2 in this European Standard.

Test cement is selected by the SCF manufacturer and is further characterized by its fineness and contents of tricalcium aluminate and alkalis as follows:

— fineness: 300 m^2/kg to 400 m^2/kg when determined in accordance with EN 196-6;

— tricalcium aluminate: 8 % to 12 % when determined in accordance with EN 196-2;

— Alkalis (Na_2O eqv): 0,6 % to 1,2 % when determined in accordance with EN 196-2.

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 mortar containing SCF shall be mixed with an amount of superplasticizer (conforming to EN 934-2) so that the mortar has a consistency equivalent to the reference mortar when tested by the flow table method given in EN 413-2.

The activity index shall be at least 95 % when tested at a mortar age of 28 days.

NOTE 1 The result of the activity index tests gives no direct information on the strength contribution of SCF in concrete, nor is the use of SCF limited to mixing ratio used in these tests.

NOTE 2 In the 2005 edition of EN 413–2, the flow table method is described in 5.3.

5.3.3 Particle density

The density shall be determined in accordance with EN 1097-7 and shall be declared.

6 Assessment and verification of constancy of performance – AVCP

6.1 General

The compliance of silica-calcium fume for concrete (SCF) with the requirements of this European Standard and with the performances declared by the manufacturer in the Declaration of Performance (DoP) shall be demonstrated by:

— determination of the product type;

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

The manufacturer shall always retain the overall control and shall have the necessary means to take responsibility for the conformity of the product with its declared performances.

NOTE The assignment of tasks to the notified body(ies) and the manufacturer is shown in Annex ZA, Table ZA.3.

6.2 Type testing

6.2.1 General

All performances related to characteristics included in this European Standard shall be determined when the manufacturer intends to declare the respective performances.

Assessment previously performed in accordance with the provisions of this European Standard, may be taken into account provided that they were made to the same or a more rigorous test method, under the same AVCP system on the same product or products of similar design, construction and functionality, such that the results are applicable to the product in question.

NOTE 1 Same AVCP system means testing by an independent third party, under the responsibility of a notified product certification body.

For the purposes of assessment, the manufacturer's products may be grouped into families, where it is considered that the results for one or more characteristics from any one product within the family are representative for that same characteristics for all products within that same family.

NOTE 2 Products may be grouped in different families for different characteristics.

Reference to the assessment method standards should be made to allow the selection of a suitable representative sample.

In addition, the determination of the product type shall be performed for all characteristics included in the standard for which the manufacturer declares the performance

— at the beginning of the production of a new or modified SCF (unless a member of the same product range); or

— at the beginning of a new or modified method of production (where this may affect the stated properties); or

— they shall be repeated for the appropriate characteristic(s), whenever a change occurs in the SCF design, in the raw material or in the supplier of the components, or in the method of production (subject to the definition of a family), which would affect significantly one or more of the characteristics.

Where components are used whose characteristics have already been determined, by the component manufacturer, on the basis of assessment methods of other product standards, these characteristics need not be re-assessed. The specifications of these components shall be documented.

Products bearing regulatory marking in accordance with appropriate harmonized European specifications may be presumed to have the performances declared in the DoP, although this does not replace the responsibility on the SCF manufacturer to ensure that the SCF as a whole is correctly manufactured and its component products have the declared performance values.

6.2.2 Test samples, testing and compliance criteria

The number of samples of SCF to be tested/assessed shall be in accordance with Table 1.

Table 1 — Number of samples to be tested and compliance criteria

Characteristic	Requirement	Assessment method [a] [b]	Minimum No. of samples	Compliance criteria
Silicon dioxide	5.2.1	5.2.1	1	5.2.1
Elemental silicon	5.2.2	5.2.2	1	5.2.2
Total calcium oxide	5.2.3	5.2.3	1	5.2.3
Free calcium oxide	5.2.4	5.2.4	1	5.2.4
Sulfate	5.2.5	5.2.5	1	5.2.5
Total alkalis	5.2.6	5.2.6	1	5.2.6
Chloride	5.2.7	5.2.7	1	5.2.7
Loss on ignition	5.2.8	5.2.8	1	5.2.8
Specific surface	5.3.1	5.3.1	1	5.3.1
Activity index	5.3.2	5.3.2	1	5.3.2
Particle density	5.3.3	5.3.3	1	5.3.3

[a] According to 5.1, other test methods than those indicated may be used provided their correlation with the reference method is known.

[b] The methods used to take and prepare samples shall be in accordance with EN 196–7. 1 000 g dried SCF is an appropriate sample size. The sample shall be taken at the point(s) of release.

6.2.3 Test reports

The results of the determination of the product type shall be documented in test reports. All test reports shall be retained by the manufacturer for at least 10 years after the last date of production of the SCF to which they relate.

6.3 Factory production control (FPC)

6.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market comply with the declared performance of the essential characteristics.

The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

This factory production control system documentation shall ensure a common understanding of the evaluation of the constancy of performance and enable the achievement of the required product performances and the effective operation of the production control system to be checked. Factory production control therefore brings together operational techniques and all measures allowing maintenance and control of the compliance of the product with the declared performances of the essential characteristics.

6.3.2 Requirements

6.3.2.1 General

The manufacturer is responsible for organizing the effective implementation of the FPC system in line with the content of this product standard. Tasks and responsibilities in the production control organization shall be documented and this documentation shall be kept up-to-date.

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product constancy, shall be defined. This applies in particular to personnel that need to initiate actions preventing product non-constancies from occurring, actions in case of non-constancies and to identify and register product constancy problems.

Personnel performing work affecting the constancy of performance of the product shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

In each factory the manufacturer may delegate the action to a person having the necessary authority to:

— identify procedures to demonstrate constancy of performance of the product at appropriate stages;

— identify and record any instance of non-constancy;

— identify procedures to correct instances of non-constancy.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. The FPC system should achieve an appropriate level of confidence in the constancy of performance of the product. This involves:

a) the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;

b) the effective implementation of these procedures and instructions;

c) the recording of these operations and their results;

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-constancy of performance.

Where subcontracting takes place, the manufacturer shall retain the overall control of the product and ensure that he receives all the information that is necessary to fulfil his responsibilities according to this European Standard.

If the manufacturer has part of the product designed, manufactured, assembled, packed, processed and/or labelled by subcontracting, the FPC of the subcontractor may be taken into account, where appropriate for the product in question.

The manufacturer who subcontracts all of his activities may in no circumstances pass the above responsibilities on to a subcontractor.

NOTE Manufacturers having an FPC system, which complies with EN ISO 9001 standard and which addresses the provisions of this European Standard are considered as satisfying the FPC requirements of the Regulation (EU) No 305/2011.

6.3.2.2 Equipment

6.3.2.2.1 Testing

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.

6.3.2.2.2 Manufacturing

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

6.3.2.3 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their compliance. In case supplied kit components are used, the constancy of performance system of the component shall be that given in the appropriate harmonized technical specification for that component.

6.3.2.4 Controls during manufacturing process

The manufacturer shall plan and carry out production under controlled conditions.

6.3.2.5 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of the characteristics he declares are maintained. The characteristics, and the means of control, shall be in accordance with Table 2.

Table 2 — Number of samples to be tested after the initial period and routine situation

Characteristic	Assessment method [a] [b]	Minimum No. of samples	
		Routine situation[e]	Initial period
Silicon dioxide	5.2.1	1/week	2/week
Elemental silicon	5.2.2	1/month	2/month
Total calcium oxide	5.2.3	1/week	2/week
Free calcium oxide	5.2.4	1/month	2/month
Sulfate	5.2.5	1/week	2/week
Total content of alkalis	5.2.6	1/month	2/month
Chloride	5.2.7	1/week[c]	2/week
Loss on ignition	5.2.8	1/week[d]	2/week
Specific surface	5.3.1	1/month	2/month
Activity index	5.3.2	1/month	2/month
Particle density	5.3.3	1/month	2/month

[a] According to 5.1, other methods than those indicated may be used provided their correlation with the reference method is known.

[b] The methods used to take and prepare samples shall be in accordance with EN 196–7. 1 000 g dried SCF is an appropriate sample size. The sample shall be taken at the point(s) of release.

[c] When none of the test results within a period of 12 months exceeds 0,15 % by mass, the frequency may be reduced to 1/month.

[d] When none of the test results within a period of 12 months exceeds 2,0 % by mass, the frequency may be reduced to 1/ month.

[e] Samples to be used for assessing the compliance according to Clause 8 shall represent a period of 12 months.

6.3.2.6 Non-complying products

The manufacturer shall have written procedures which specify how non-complying products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.

Where the product fails to satisfy the acceptance criteria, the provisions for non-complying products shall apply, the necessary corrective action(s) shall immediately be taken and the products or batches not complying shall be isolated and properly identified.

Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records under the signature of the person responsible for the control/test.

With regard to any control result not meeting the requirements of this European Standard, the corrective measures taken to rectify the situation (e.g. a further test carried out, modification of manufacturing process, throwing away or putting right of product) shall be indicated in the records.

6.3.2.7 Corrective action

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence. The provisions regarding corrective actions of EN 13263-2 shall apply.

6.3.2.8 Handling, storage and packaging

The manufacturer shall have procedures providing methods of product handling and shall provide suitable storage areas preventing damage or deterioration.

6.3.3 Product specific requirements

The FPC system shall address this European Standard and ensure that the products placed on the market comply with the declaration of performance.

The FPC system shall include a product specific FPC, which identifies procedures to demonstrate compliance of the product at appropriate stages, i.e.:

a) the controls and tests to be carried out prior to and/or during manufacture according to a frequency laid down in the FPC test plan;

and/or

b) the verifications and tests to be carried out on finished products according to a frequency laid down in the FPC test plan.

If the manufacturer uses only finished products, the operations under b) shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

If the manufacturer carries out parts of the production himself, the operations under b) may be reduced and partly replaced by operations under a). Generally, the more parts of the production that are carried out by the manufacturer, the more operations under b) may be replaced by operations under a).

In any case the operation shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

NOTE Depending on the specific case, it can be necessary to carry out the operations referred to under a) and b), only the operations under a) or only those under b).

The operations under a) refer to the intermediate states of the product as on manufacturing machines and their adjustment, and measuring equipment etc. These controls and tests and their frequency shall be chosen based on product type and composition, the manufacturing process and its complexity, the sensitivity of product features to variations in manufacturing parameters etc.

The manufacturer shall establish and maintain records that provide evidence that the production has been sampled and tested. These records shall show clearly whether the production has satisfied the defined acceptance criteria and shall be available for at least three years.

6.3.4 Initial inspection of factory and of FPC

Initial inspection of factory and of FPC shall be carried out when the production process has been finalized and in operation. The factory and FPC documentation shall be assessed to verify that the requirements of 6.3.2 and 6.3.3 are fulfilled.

During the inspection it shall be verified:

a) that all resources necessary for the achievement of the product characteristics included in this European Standard are in place and correctly implemented;

and

b) that the FPC-procedures in accordance with the FPC documentation are followed in practice;

and

c) that the product complies with the product type samples, for which compliance of the product performance to the DoP has been verified.

All locations where final assembly or at least final testing of the relevant product is performed, shall be assessed to verify that the above conditions a) to c) are in place and implemented. If the FPC system covers more than one product, production line or production process, and it is verified that the general requirements are fulfilled when assessing one product, production line or production process, then the assessment of the general requirements does not need to be repeated when assessing the FPC for another product, production line or production process.

All assessments and their results shall be documented in the initial inspection report.

6.3.5 Continuous surveillance of FPC

Surveillance of the FPC shall be undertaken at least once per year. The surveillance of the FPC shall include a review of the FPC test plan(s) and production processes(s) for each product to determine if any changes have been made since the last assessment or surveillance. The significance of any changes shall be assessed.

Checks shall be made to ensure that the test plans are still correctly implemented and that the production equipment is still correctly maintained and calibrated at appropriate time intervals.

The records of tests and measurement made during the production process and to finished products shall be reviewed to ensure that the values obtained still correspond with those values for the samples submitted to the determination of the product type and that the correct actions have been taken for non-compliant products.

6.3.6 Procedure for modifications

If modifications are made to the product, production process or FPC system that could affect any of the product characteristics declared according to this European Standard, then all the characteristics for which the manufacturer declares performance, which may be affected by the modification, shall be subject to the determination of the product type, as described in 6.2.1.

Where relevant, a re-assessment of the factory and of the FPC system shall be performed for those aspects, which may be affected by the modification.

All assessments and their results shall be documented in a report.

7 Packaging, labelling and marking

SCF is delivered packed in bags or drums or in bulk.

The packaging of the SCF (or the delivery note following the bulk delivery) shall be marked with the following information.

a) the type of material, i.e. silica-calcium fume;

b) form of delivery: densified;

c) the quantity of SCF shall be marked on each package and in the delivery note;

d) the name or identification mark of the production plant where the SCF was manufactured;

e) date of packing or shipment;

f) the chloride content, if it is above 0,10 % by mass;

g) the number and year of this European Standard.

NOTE For CE marking and labelling, ZA.3 of Annex ZA applies.

8 Compliance criteria

8.1 General

Compliance of SCF with the requirements for physical and chemical properties in this European Standard is assumed if the compliance criteria specified in 8.2 and 8.3 are met. Compliance shall be assessed 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 samples taken during the control period.

8.2 Statistical compliance criteria

8.2.1 General

Compliance shall be formulated in terms of a statistical criterion based on

— the specified characteristic values for physical and chemical properties as given in 5.2 and 5.3 of this European Standard;

— the percentage P_k = 10 % on which the specified characteristic values are based;

— the allowable probability of acceptance CR (consumer's risk) of 5 %.

For specific surface and total calcium oxide content, the above values for P_k and CR apply to the upper and lower limits considered separately.

NOTE Compliance assessment 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 is the approximation. The selected probability of acceptance CR controls the degree of approximation by the sampling plan.

Compliance with the requirements of this European Standard shall be verified either by variables or by attributes, as described in 8.2.2 and 8.2.3.

The control period shall be 12 months.

8.2.2 Inspection by variables

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

Compliance is verified when inequality(ies) in Formulae (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 5.2 or 5.3;

U is the specified upper limit given in 5.2 or 5.3.

The acceptability constant k_A depends on the percentage 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 3.

The left side of the inequality(ies) in Formula (1) or (2) shall be rounded off to the same number of valid digits as given for the specified characteristic values L or U in Clause 5.

Table 3 — Acceptability constant k_A

Number of test results, n	k_A [a] **for** P_k **= 10 %**
20 to 21	1,93
22 to 23	1,89
24 to 25	1,85
26 to 27	1,82
28 to 29	1,80
30 to 34	1,78
35 to 39	1,73
40 to 44	1,70
45 to 49	1,67
50 to 59	1,65
60 to 69	1,61
70 to 79	1,58
80 to 89	1,56
90 to 99	1,54
100 to 149	1,53
150 to 199	1,48
200 to 299	1,45
300 to 399	1,42
> 400	1,40
NOTE Values given in this table are calculated for CR = 5 %.	
[a] Values of k_A valid for intermediate values of n may also be used.	

8.2.3 Inspection by attributes

The number c_D of test results outside the specified characteristic value shall be counted and compared with an acceptable number c_A, calculated from the number n of test results and the percentage P_k as specified in Table 3. Before counting, each test result shall be rounded off to the same number of valid digits as given for the specified characteristic values in Clause 5. Compliance is verified when Formula (3) is satisfied:

$$c_D \leq c_A \tag{3}$$

The value of c_A depends on the percentage 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 4.

Table 4 — 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 $n < 20$.	

8.3 Single result conformity criteria

In addition to the statistical conformity criteria, compliance of test results with the requirements of European Standard requires that it shall be verified that each test result remains within the single result limit values specified in Table 5.

Table 5 — Limit values for single results

Property	**Single result limit values**
Loss on ignition (upper limit)	7,5 % by mass
Silicon dioxide (lower limit)	65 % by mass
Elemental silicon (upper limit)	0,7 % by mass
Total calcium oxide (upper limit)	25 % by mass
Specific surface (lower limit)	10 m^2/g
Activity index (lower limit)	90 %

Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Regulation

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under Mandate M/128 "Concrete, mortar, grout and related products" given to CEN by the European Union and the European Free Trade Association.

If this European Standard is cited in the Official Journal of the European Union (OJEU), the clauses of this European Standard, shown in this annex, are considered to meet the provisions of the relevant mandate, under the Regulation (EU) No. 305/2011.

This annex deals with the CE marking of the silica-calcium fume for concrete (SCF) intended for the uses indicated in Table ZA.1 and shows the relevant clauses applicable.

This annex has the same scope as in Clause 1 of this European standard related to the aspects covered by the mandate and is defined by Table ZA.1.

Table ZA.1 — Relevant clauses for product SCF and intended use

Product: Silica-calcium fume for concrete (SCF) **Intended use:** Type II addition for concrete, mortar and grout			
Essential characteristics	**Clauses in this European Standard related to essential characteristics**	**Regulatory classes**	**Notes**
Silicon dioxide (SiO_2) content	5.2.1	None	Requirement expressed in terms of lower limit (to be declared)
Elemental silicon (Si) content	5.2.2	None	Requirement expressed in terms of upper limit
Total calcium (CaO) content	5.2.3	None	Requirement expressed in terms of upper and lower limits
Free calcium oxide (CaO) content	5.2.4	None	Requirement expressed in terms of upper limit
Sulfate content (as SO_3)	5.2.5	None	Requirement expressed in terms of upper limit
Chloride (Cl^-) content	5.2.7	None	Requirement expressed in terms of upper limit (to be declared if above 0,10 %)
Loss on ignition	5.2.8	None	Requirement expressed in terms of upper limit
Fineness – Specific surface	5.3.1	None	Requirement expressed in terms of upper and lower limits (lower limit to be declared)
Activity index	5.3.2	None	Requirement expressed in terms of lower limit (Pass/fail to be declared)
Content and/or release of dangerous substances and emission of radioactivity	Clause 4	None	

The declaration of the product performance related to certain essential characteristics is not required in those Member States (MS) where there are no regulatory requirements on these essential characteristics for the intended use of the product.

In this case, manufacturers placing their products on the market of these MS are not obliged to determine nor declare the performance of their products with regard to these essential characteristics and the option “No performance determined” (NPD) in the information accompanying the CE marking and in the declaration of performance (see ZA.3) may be used for those essential characteristics.

ZA.2 Procedure for AVCP of SCF

ZA.2.1 System of AVCP

The AVCP system(s) of SCF indicated in Table ZA.1, established by EC Decision 99/469/EC amended by 2001/596/EC (OJ L184 of 1999-07-17 and OJ L209 of 2001-08-02) is shown in Table ZA.2 for the indicated intended use.

Table ZA.2 — System of AVCP

Product	Intended use	Level or class of performance	AVCP system
Additions (Type II)	For concrete, mortar and grout	.....	1+
System 1+: See Regulation (EU) No. 305/2011 (CPR) Annex V, 1.1 with audit testing of samples taken before placing the product on the market.			

The AVCP of the SCF in Table ZA.1 shall be according to the AVCP procedures indicated in Table ZA.3 resulting from application of the clauses of this European Standard indicated therein. The content of tasks of the notified body shall be limited to those essential characteristics as provided for, if any, in Annex III of the relevant mandate and to those that the manufacturer intends to declare.

Table ZA.3 — Assignment of AVCP tasks for SCF under system 1+

Tasks		Content of the task	AVCP clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to essential characteristic of Table ZA.1 relevant for the intended use which are declared	6.3.1 6.3.2 6.3.3
	Further testing of samples taken at factory according to the prescribed test plan	Essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.3
Tasks for the notified product certification body	Determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product	Essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.2
	Initial inspection of the manufacturing plant and of FPC	Parameters related to essential characteristic of Table ZA.1 relevant for the intended use which are declared. Documentation of the FPC.	6.3.4
	Continuous surveillance, assessment and evaluation of FPC	Parameters related to essential characteristic of Table ZA.1 relevant for the intended use which are declared. Documentation of the FPC.	6.3.5
	Audit testing of samples taken before placing the product on the market	Essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.3

ZA.2.2 Declaration of performance (DoP)

ZA.2.2.1 General

The manufacturer draws up the DoP and affixes the CE marking on the basis of the AVCP system set out in Annex V of the Regulation (EU) No 305/2011:

— for products under system 1+:

— the factory production control and the further testing of samples taken at the factory according to the prescribed test plan, carried out by the manufacturer; and

— the certificate of constancy of performance issued by the notified product certification body on the basis of determination of the product type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product; initial inspection of the manufacturing plant and of factory production control; continuous surveillance, assessment and evaluation of factory production control and audit-testing of samples taken before placing the product on the market.

ZA.2.2.2 Content

The model of the DoP is provided in Annex III of the Regulation (EU) No 305/2011.

According to this Regulation, the DoP shall contain, in particular, the following information:

— the reference of the product-type for which the declaration of performance has been drawn up;

— the AVCP system or systems of the construction product, as set out in Annex V of the CPR;

— the reference number and date of issue of the harmonized standard which has been used for the assessment of each essential characteristic;

— where applicable, the reference number of the Specific Technical Documentation used and the requirements with which the manufacturer claims the product complies.

The DoP shall in addition contain:

a) the intended use or uses for the construction product, in accordance with the applicable harmonized technical specification;

b) the list of essential characteristics, as determined in the harmonized technical specification for the declared intended use or uses;

c) the performance of at least one of the essential characteristics of the construction product, relevant for the declared intended use or uses;

d) where applicable, the performance of the construction product, by levels or classes, or in a description, if necessary based on a calculation in relation to its essential characteristics determined in accordance with the Commission determination regarding those essential characteristics for which the manufacturer shall declare the performance of the product when it is placed on the market or the Commission determination regarding threshold levels for the performance in relation to the essential characteristics to be declared.

e) the performance of those essential characteristics of the construction product which are related to the intended use or uses, taking into consideration the provisions in relation to the intended use or uses where the manufacturer intends the product to be made available on the market;

f) for the listed essential characteristics for which no performance is declared, the letters “NPD” (No Performance Determined).

Regarding the supply of the DoP, Article 7 of the Regulation (EU) No 305/2011 applies.

The information referred to in Article 31 or, as the case may be, in Article 33 of Regulation (EC) No 1907/2006, (REACH) shall be provided together with the DoP.

ZA.2.2.3 Example of DoP

The following gives an example of a filled-in DoP for SCF

DECLARATION OF PERFORMANCE

No. 001CPR2013-07-14

1) Unique identification code of the product-type:

Silica-calcium fume

2013 – CHF – B 02 01.2012

2) Type, batch or serial number or any other element allowing identification of the construction product as required under Article 11(4):

Silica-calcium fume

2013 – CHF – B 02 01.2012

3) Intended use or uses of the construction product, in accordance with the applicable harmonized technical specification, as foreseen by the manufacturer:

Type II addition in concrete, mortar and grout

4) Name, registered trade name or registered trade mark and contact address of the manufacturer as required under Article 11(5):

AnyCo SA,

PO Box 21

B-1050 Brussels, Belgium

Tel. +32987654321

Fax: +32123456789

e-mail: anyco.sa@provider.be

5) Where applicable, name and contact address of the authorized representative whose mandate covers the tasks specified in Article 12(2):

Anyone Ltd

Flower Str. 24

West Hamfordshire

UK-589645 United Kingdom

Tel. +44987654321

Fax: +44123456789

e-mail: anyone.ltd@provider.uk

6) System or systems of assessment and verification of constancy of performance of the construction product as set out in DoP, Annex V:

System 1+

7) Notified product certification body No. 5678 performed the initial inspection of the manufacturing plant and of factory production control and the continuous surveillance, assessment and evaluation of factory production control and issued the certificate of conformity of the factory production control. It also performed the determination of the product type and audit testing of samples.

8) Declared performance

Essential characteristics	Performance	Harmonized technical specification
Silicon dioxide (SiO_2) content	Declared value and ≥ 70 % by mass	EN 16622:2015
Elemental silicon (Si) content	≤ 0,5 % by mass	
Total calcium oxide (CaO) content	≥ 10 % and ≤ 20 % by mass	
Free calcium oxide (CaO) content	≤ 1,0 % by mass	
Sulfate content	≤ 2,0 % by mass	
Total content of alkalis	Declared value	
Chloride (Cl^-) content	≤ 0,30 % by mass and declared value if > 0,10 %	
Loss on ignition	≤ 6,5 % by mass	
Specific surface	Declared value and ≥ 12 m^2/g	
Activity index	≥ 95 %	
Particle density	Declared value	
Content and/or release of dangerous substances and emission of radioactivity	NPD	

9) The performance of the product identified in points 1 and 2 is in conformity with the declared performance in point 8. This declaration of performance is issued under the sole responsibility of the manufacturer identified in point 4. Signed for and on behalf of the manufacturer by

……

(name and function)

…… ……..

(place and date of issue) (signature)

ZA.3 CE marking and labelling

The CE marking symbol shall be in accordance with the general principles set out in Article 30 of Regulation (EC) No 765/2008 and shall be affixed visibly, legibly and indelibly to the packaging or to the accompanying documents.

The CE marking shall be followed by:

— the last two digits of the year in which it was first affixed;

— the name and the registered address of the manufacturer, or the identifying mark allowing identification of the name and address of the manufacturer easily and without any ambiguity;

— the unique identification code of the product-type;

— the reference number of the declaration of performance;

— the level or class of the performance of the essential characteristics declared (see Table ZA.1);

— the dated reference to this European Standard (EN 16622:2015);

— the identification number of the notified body;

— the intended use (Type II addition for concrete, mortar and grout).

The CE marking shall be affixed before the construction product is placed on the market. It may be followed by a pictogram or any other mark notably indicating a special risk or use.

Figure ZA.1 gives an example of the information related to SCF subject to AVCP under system 1+ to be given on the packaging or the accompanying documents.

CE	*CE marking, consisting of the "CE"-symbol*
5678	*Identification number of the product certification body*
AnyCo Ltd, PO Box 21, B-1050, Brussels, Belgium	*name and the registered address of the manufacturer, or identifying mark*
15	*Last two digits of the year in which the marking was first affixed*
00001-CPR-2013/05/12	*reference number of the DoP*
EN 16622:2015	*No. of this European Standard*
Silica-calcium fume – CHF – B02	*Unique identification code of the product-type*
intended to be used as type II addition in concrete, mortar and grout	*Intended use of the product as laid down in the European Standard applied*
SiO_2 content: Declared value and ≥ 70 % **Elemental Si content:** ≤ 0,5 % **Total CaO content:** ≥ 10 % and ≤ 20 % **Free CaO content:** ≤ 1,0 % **Sulfate content:** ≤ 2,0 % **Alkalis content:** Declared value **Chloride content:** ≤ 0,30 %, declared value if > 0,10 % **Loss on ignition:** ≤ 6,5 % **Specific surface:** Declared value and ≥ 12 m^2/g **Activity index:** ≥ 95 % **Particle density:** Declared value **Content and/or release of dangerous substances and emission of radioactivity:** NPD	*Level or class of the performance declared*

Figure ZA.1 — Example CE marking information of products under AVCP system 1+

For bulk SCF, the CE marking and all the accompanying information shall be given on the commercial documents.

For bagged SCF, the CE marking and the accompanying information shall be affixed either on the bag or on the accompanying commercial documents or on a combination of these. If all the information is not placed on the bag, but only part, then the full information should be given on the accompanying commercial documents.

For reasons of practicality, selections from the following alternative arrangements concerning the presentation of the accompanying information for bagged SCF 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 location of the point of release;

— the year of affixing the CE marking;

— the number of the declaration of performance.

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 3 months.

c) Where the last two digits of the year in which the marking was 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.

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[3] EN ISO 9000:2015, *Quality management systems — Fundamentals and vocabulary (ISO 9000:2015)*

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[6] EN 206, *Concrete — Specification, performance, production and conformity*

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