



## EUROPEAN ASSESSMENT DOCUMENT

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# CALCIUM ALUMINATE BASED REFRACTORY CEMENT

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# 1 SCOPE OF THE EAD

## 1.1 Description of the construction product

Refractory cement made up of calcium aluminates and alumina-rich materials with high compressive strength and high refractoriness. Its main constituents are:

### 1. Calcium Aluminate Cement clinker

Calcium Aluminate Cement clinker is produced by fusing or sintering a precisely specified mixture of aluminous and calcareous material. The main component is monocalcium aluminate ( $\text{CaO}\cdot\text{Al}_2\text{O}_3$ ). Other mineralogical compounds include calcium alumino-ferrites, dicalcium silicate, and calcium silico-aluminate or gehlenite.

### 2. Alumina-rich material (ARM)

Material with an alumina content (expressed as  $\text{Al}_2\text{O}_3$ ) higher than 35%. For example, it could be bauxite mineral.

### 3. Additives

Chemical substances or proprietary products that do not modify the essential characteristics, for example grinding aids, pigments, etc.

The product is not fully covered by EN 14647 *Composition, specifications and conformity criteria for calcium aluminate cement*, mainly due to:

1. Composition (changes in chapters 5 and 6 of EN 14647):

<b>Constituents <sup>1)</sup></b>	<b>Calcium aluminate based refractory cement (CABRC)</b>	<b>Calcium aluminate cement constituents according to EN 14647</b>
1. Calcium Aluminate cement clinker	$\geq 70 \%$	$\geq 99,8 \%$
2. Alumina-rich material (ARM)	$\leq 30 \%$	Not considered
3. Additives	Additives <sup>2)</sup> $\leq 0,2 \%$	Grinding aids $\leq 0,2 \%$

<sup>1)</sup> Percentages by mass.

<sup>2)</sup> Chemical substances or proprietary products that do not modify the essential characteristics, for example grinding aids, pigments, etc.

**Table 1:** Composition differences from EN 14647.

2. Characteristic "refractoriness", according to EN 993-12 (not included as a declarable characteristic in EN 14647).

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

The performance assessment of mortars or concretes prepared with CABRC (Calcium Aluminate Based Refractory Cement) is not considered in this EAD. These performances strongly depend on the aggregates used in the mix, the installation process and the initial thermal treatment. The designer of the mortar or concrete is expected to carry out specific verification tests of the final product according to relevant European standards (e.g. EN 993 parts 1 to 19, EN ISO 1927 parts 1 to 8, EN ISO 1893, etc.) taking into account the end use of the product.

Guidance for the use of Calcium Aluminate Cements in mortars and concretes, as stated in annex A of EN 14647 can be taken into account, where applicable.

Common mix design parameters are indicated in table 2.

Use	Aggregates / cement ratio (in volume)	Water / cement ratio (in volume)
Mortar	Usual value: between 2,0 and 4,0	Usual value: between 0,3 and 0,6
	Maximum value: $\leq 6,0$	Maximum value: $\leq 1,0$
Concrete	Usual value: between 3,0 and 5,5	Usual value: between 0,3 and 0,6
	Maximum value: $\leq 9,0$	Maximum value: $\leq 1,0$

**Table 2:** Common mix design parameters for mortars and concrete with CABRC.

In special mortars or concretes for insulating applications in which high temperature conditions are envisaged but high compressive strength is not required, it could be useful to raise water/cement ratio. For instance, some insulating concretes have been prepared with a water/cement ratio close to 1,0.

## 1.2 Information on the intended use(s) of the construction product

### 1.2.1 Intended use(s)

The CABRC is used as hydraulic binder in applications where high compressive strength and high refractoriness is needed. It is intended to be used for preparation of refractory concrete and mortar. Refractory applications could be:

- Industrial fields requiring construction materials that could work at high temperatures (iron and steel industry, ceramics, petrochemistry, aluminium...)
- Incinerators
- Fireplaces and barbecues
- Mortar for refractory bricks
- Refractory and/or insulating concretes

It is also used in insulating applications at high temperatures where high compressive strength is not required.

### 1.2.2 Working life/Durability

Not applicable to the CABRC itself.

The working life of refractory mortars and concretes is expressed in terms of the number and the conditions of thermal cycles they can undergo. On the other hand, the working life does not depend only on the cement but also on the aggregates and additives used, installation and start-up procedures (initial thermal treatment), which are not part of this assessment.

### **1.3 Specific terms used in this EAD (if necessary in addition to the definitions in CPR, Art 2)**

#### **1.3.1 CABRC**

Calcium Aluminate Based Refractory Cement (see definition in 1.1).

#### **1.3.2 ARM**

Alumina Rich Material (see definition in 1.1).

## 2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

### 2.1 Essential characteristics of the product

Table 3 shows how the performance of CABRC is established in relation to the essential characteristics.

The assessment shall be done on an individual cement with defined composition and raw materials.

The assessed composition and the nature of raw materials shall be stated in the ETA.

The ARM used in the manufacturing of the assessed cement should be characterised and described in detail in the ETA (e.g. loss on ignition, main elements, refractoriness, etc.). The nature and sources of raw materials used in the manufacturing of the assessed cement shall be recorded by the TAB and handed over to the Notified Body for AVCP purposes.

**Table 3 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics**

No	Essential characteristic	Assessment method	Type of expression of product performance
<b>Basic Works Requirement 1: Mechanical resistance and stability</b>			
1	Composition	2.2.1	Level
2	Compressive strength	2.2.2	Level
3	Initial setting time	2.2.3	Level
4	Alumina content (as Al <sub>2</sub> O <sub>3</sub> )	2.2.4	Level
5	Chloride content	2.2.5	Level
6	Alkalis content <sup>1)</sup>	2.2.6	Level
7	Sulfate content (as SO <sub>3</sub> )	2.2.7	Level
8	Sulfide content (as S <sup>2-</sup> )	2.2.8	Level
9	Refractoriness	2.2.9	Level
<b>Basic Works Requirement 2: Safety in case of fire</b>			
10	Reaction to fire	2.2.10	Class
<b>Basic Works Requirement 3: Hygiene, health and the environment</b>			
11	Water soluble chromium (VI) content	2.2.11	Level
<sup>1)</sup> Expressed as Na <sub>2</sub> O equivalent (Na <sub>2</sub> O + 0,658 K <sub>2</sub> O).			

### 2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

#### 2.2.1 Composition

The CABRC composition shall be determined on samples taken from the expedition point according to assessment procedures and methods defined by the manufacturer for its particular production process, as considered in EN 197-2 chapter 4.2.1.2.

### **2.2.2 Compressive strength**

Tests according to EN 196-1.

Assessment according to EN 14647 chapter 7.1.

### **2.2.3 Setting time**

Tests according to EN 196-3.

Assessment according to EN 14647 chapter 7.2.

### **2.2.4 Alumina content (as $\text{Al}_2\text{O}_3$ )**

Tests according to EN 196-2.

Assessment according to EN 14647 chapter 7.3 table 2.

### **2.2.5 Chloride content**

Tests according to EN 196-2.

Assessment according to EN 14647 chapter 7.3 table 2.

### **2.2.6 Alkalis content (as $\text{Na}_2\text{O}$ equivalent)**

Tests according to EN 196-2.

Assessment according to EN 14647 chapter 7.3 table 2.

### **2.2.7 Sulphate content (as $\text{SO}_3$ )**

Tests according to EN 196-2.

Assessment according to EN 14647 chapter 7.3 table 2.

### **2.2.8 Sulphide content (as $\text{S}^{2-}$ )**

Tests according to EN 196-2.

Assessment according to EN 14647 chapter 7.3 table 2.

### **2.2.9 Refractoriness**

Tests according to EN 993-12.

Refractoriness test result shall be reported.

### **2.2.10 Reaction to fire**

The CABRC is considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire, in accordance with the provisions of EC Decision 96/603/EC (as amended) without the need for testing on the basis of its listing in that Decision and its intended use being covered by that Decision.

Therefore the performance of the product is class A1.

### **2.2.11 Water soluble chromium (VI) content**

Tests according to EN 196-10.

Test result on water soluble chromium (VI) content shall fulfil the limit according to Regulation (EC) No 1907/2006, Annex XVII row 47.



### **3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE**

#### **3.1 System(s) of assessment and verification of constancy of performance to be applied**

For the products covered by this EAD the applicable European legal act is: Decision 1997/555/EC.

The system is: **1+**.

#### **3.2 Tasks of the manufacturer**

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 4.

**Table 4 Control plan for the manufacturer; cornerstones**

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Factory production control (FPC) including testing of samples taken at the factory in accordance with a prescribed test plan</b>					
1	Composition	2.2.1	Table 1	1	1 / month
2	Compressive strength	2.2.2	≥ 18 MPa after 6h ≥ 40 MPa after 24h	1	4 / week <sup>1)</sup> 2 / week <sup>2)</sup>
3	Initial setting time	2.2.3	≥ 90 min.	1	4 / week <sup>1)</sup> 2 / week <sup>2)</sup>
4	Alumina content (as Al <sub>2</sub> O <sub>3</sub> )	2.2.4	35% ≤ Al <sub>2</sub> O <sub>3</sub> ≤ 58%	1	1 / week <sup>1)</sup> 2 / month <sup>2)</sup>
5	Chloride content	2.2.5	≤ 0,10%	1	1 / week <sup>1)</sup> 2 / month <sup>2)</sup>
6	Alkalis content (as Na <sub>2</sub> O eq.: Na <sub>2</sub> O + 0,658 K <sub>2</sub> O)	2.2.6	≤ 0,4%	1	1 / week <sup>1)</sup> 1 / month <sup>2)</sup>
7	Sulfate content (as SO <sub>3</sub> )	2.2.7	≤ 0,5%	1	1 / week <sup>1)</sup> 1 / month <sup>2)</sup>
8	Sulfide content (as S <sup>2-</sup> )	2.2.8	≤ 0,10%	1	1 / week <sup>1)</sup> 1 / month <sup>2)</sup>
9	Refractoriness	2.2.9	Declared level	1	1 / 2 months
10	Soluble chromium (VI) content	2.2.10	See 2.2.10	1	1 / month (see note 4)
11	ARM alumina content (as Al <sub>2</sub> O <sub>3</sub> )	2.2.4	Acc. to 1.1 clause 2	1	1 / month
<p><b>Note 1:</b> Percentages by mass.</p> <p><b>Note 2:</b> Controls 2 to 8 are according to stipulations of EN 14647, clause 9.1. Conformity criteria as stated in clause 9.2 shall be taken into account.</p> <p><b>Note 3:</b> Chloride content: 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.</p> <p><b>Note 4:</b> According to EN 196-10, water soluble chromium VI content shall only be controlled once per month in those cases in which a reducing agent is added in order to fulfil the requirement. If the limit value is satisfied without any reducer agent, this control can be omitted.</p> <p><b>Note 5:</b> For limited productions, the TAB and the manufacturer can agree a different control frequency (e.g. on a per batch basis), consistent with the frequency stated in this table.</p> <p><sup>1)</sup> Initial period (3 months, according to EN 197-2)</p> <p><sup>2)</sup> Routine situation</p>					

### 3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for CABRC are laid down in Table 5.

**Table 5 Control plan for the notified body; cornerstones**

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Initial inspection of the manufacturing plant and of factory production control</b>					
1	The notified product certification body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product according to the European Technical Assessment. In particular the following items shall be appropriately considered <ul style="list-style-type: none"> <li>• personnel and equipment</li> <li>• the suitability of the factory production control established by the manufacturer</li> <li>• full implementation of the prescribed test plan</li> </ul>				---
<b>Continuous surveillance, assessment and evaluation of factory production control</b>					
2	The notified product certification body shall verify that <ul style="list-style-type: none"> <li>• the manufacturing process</li> <li>• the system of factory production control</li> <li>• the implementation of the prescribed test plan</li> </ul> are maintained.				Once a year (as indicated in EN 197-2)
<b>Audit-testing of samples taken before placing the product on the market</b>					
3	Composition	2.2.1	Table 1	1	2/year
4	Compressive strength	2.2.2	$\geq 18$ MPa after 6h $\geq 40$ MPa after 24h	1	6/year* (as indicated in EN 197-2)
5	Initial setting time	2.2.3	$\geq 90$ min.	1	
6	Alumina content (as Al <sub>2</sub> O <sub>3</sub> )	2.2.4	$35\% \leq \text{Al}_2\text{O}_3 \leq 58\%$	1	
7	Chloride content	2.2.5	$\leq 0,10\%$	1	
8	Alkalis content (as Na <sub>2</sub> O eq.: Na <sub>2</sub> O + 0,658 K <sub>2</sub> O)	2.2.6	$\leq 0,4\%$	1	
9	Sulfate content (as SO <sub>3</sub> )	2.2.7	$\leq 0,5\%$	1	
10	Sulfide content (as S <sup>2-</sup> )	2.2.8	$\leq 0,10\%$	1	
11	Refractoriness	2.2.9	Declared level	1	6/year*
12	Soluble chromium (VI) content	2.2.10	See 2.2.10	1	1/year
13	ARM alumina content (as Al <sub>2</sub> O <sub>3</sub> )	2.2.4	Acc. to 1.1 clause 2	1	2/year
<p>*) The frequency of control shall be at least 6 per year for each certified cement dispatched continuously from the factory. When certain certified cements are not dispatched continuously, this frequency and the point of sampling may be altered by mutual agreement between the certification body and the manufacturer.</p> <p>The frequency of control during the initial period (3 months acc. to EN 197-2) shall be at least one per month.</p> <p><b>Note 1:</b> Percentages by mass.</p> <p><b>Note 2:</b> The notified body shall be made aware of any change on the sources of raw materials, and verify that these changes do not affect the constancy of performances, following EN 197-2 procedures.</p>					

## 4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment, is of relevance.

- EN 14647. Calcium aluminate cement - Composition, specifications and conformity criteria.
- 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 196-3. Methods of testing cement - Part 3: Determination of setting times and soundness.
- EN 196-6. Methods of testing cement. Part 6: Determination of fineness.
- EN 196-10. Methods of testing cement - Part 10: Determination of the water-soluble chromium (VI) content of cement.
- EN 197-2. Cement - Part 2: Conformity evaluation.
- EN 993-12. Methods of test for dense shaped refractory products. Part 12: determination of pyrometric cone equivalent (refractoriness).
- Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.