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Calcined and non-calcined pozzolanic ash — Specification

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

RS 425 was prepared by Technical Committee RSB/TC 9, *Civil engineering and building materials*.

In the preparation of this standard, reference was made to the following standards:

1) GBT 1596, *Fly Ash Used for Cement and Concrete*

2) ASTM C618-19, *Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*

The assistance derived from the above source is hereby acknowledged with thanks.

This second edition cancels and replaces the first edition (RS 425: 2020), Clause 1, 3, 4, 5, 6, 7 and 8, which have been technically revised.

Committee membership

The following organizations were represented on the Technical Committee on *Civil engineering and building materials* (RSB/TC 9) in the preparation of this standard.

ASTRIK International

CAMOSAG Ltd

Cleaner Production and Climate Innovation Centre (CPCIC)

Consulting Engineering Group (CEG Ltd)

HOSHAN LTD

Independent Experts

NPD Ltd

Rwanda Housing Authority (RHA)

Rwanda Inspectorate, Competition and Consumer Protection Authority (RICA)

Rwanda Transport development Agency (RTDA)

University of Rwanda – College of Science and Technology (UR-CST)

Rwanda Standards Board (RSB) – Secretariat

Calcined and non-calcined pozzolanic ash — Specification

1 Scope

This Draft Rwanda Standard specifies requirements for pozzolanic ash, whether calcined or non-calcined, intended for use in the manufacture of cement and in the production of concrete and mortar.

The pozzolanic ash covered by this Standard is derived from naturally occurring siliceous or aluminous materials, including but not limited to volcanic materials, clays, shales, and other mineral sources, which have been processed by crushing, grinding, and, where applicable, calcination to achieve pozzolanic reactivity.

This Standard is applicable to pozzolanic ash used as:

— a constituent in factory-produced blended cements; and

— a supplementary cementitious material added directly during the production of concrete or mortar, where appropriate quality control measures are in place.

The requirements of this Standard are based on performance-oriented criteria, including physical, chemical, and mechanical properties relevant to durability, strength development, and compatibility with cement.

NOTE This Standard does not cover coal-derived fly ash produced from the combustion of coal, and therefore coal fly ash classifications such as Class F and Class C are covered in ASTM 618.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ASTM C187, *Standard Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste*

RS ASTM C 311/C 311M, *Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete*

RS EAS 18-2, Cement — Part 2: *Conformity evaluation*

RS EAS 131-1, *Concrete — Part 1: Specification, performance, production and conformity*

RS EAS 148-1, *Cement — Test methods — Part 1: Determination of strength*

RS EAS 148-2, *Cement — Test methods — Part 2: Chemical analysis of cement*

RS EAS 148-3, *Cement — Test methods — Part 3: Determination of setting time and soundness*

RS EAS 148-5, *Cement — Test methods — Part 5: Pozzolanicity test for Pozzolanic cements*

RS EAS 148-6, *Cements — Test methods — Part 6: Determination of fineness*

RS 211-3, *Mortar for masonry — Methods of Test: Part 3: Determination of consistence of fresh mortar (by flow table)*

3 Terms and definitions

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

3.1

fly ash

powder collected in power plant pulverized coal furnace flue gas

Note 1 to entry: The fly ash does not include the followings:(1) When the coal is burnt with urban garbage or other wastes; (2) when the industrial or urban garbage is burnt in the incinerator; (3) the powder collected at time of combustion of the circulating fluidized bed boiler.

3.2

reference cement

Portland cement or ordinary Portland cement conforming to provisions of RS EAS 18, and satisfying the strength grade 42.5 required in relevant requirements in the Standard

3.3

testing sample

reference cement and pozzoranic ash to be inspected are mixed in the mass ratio 7:3

3.4

reference mortar

reference cement and normal sand with specified grading are mixed in the mass ratio 1:3

3.5

testing mortar

reference cement and normal sand with specified grading are mixed in the mass ratio 1:3

3.6

strength activity index

compressive strength ratio between the testing mortar and reference mortar in specified age is expressed in percentage

3.7

pozzolan

siliceous or siliceous and aluminous material which in finely divided form reacts with calcium hydroxide to form a cementitious material

4 Classification

4.1 General

Pozzolanic ash covered by this Standard shall be classified based on its processing route and pozzolanic reactivity, rather than on combustion origin. The classification recognizes materials that develop pozzolanic properties through natural occurrence, mechanical processing, and, where applicable, thermal activation (calcination)

4.2 Classification of Pozzolanic Ash

Pozzolanic ash shall be classified into the following categories:

4.2.1 Class PA-NC — Non-Calcined Pozzolanic Ash

Non-calcined pozzolanic ash shall consist of naturally occurring siliceous or aluminous materials that exhibit pozzolanic properties after crushing and grinding, without thermal activation.

Typical sources include, but are not limited to:

— Volcanic ash derived from volcanic rock

— Pumice, scoria, and related volcanic materials

— Other naturally reactive mineral materials

Characteristics include:

— predominantly low-calcium;

— pozzolanic reactivity dependent on fineness and mineralogy;

— typically, slower early-age strength development compared to calcined materials.

4.2.2 4.2.2 Class PA-C — Calcined Pozzolanic Ash

Calcined pozzolanic ash shall consist of natural siliceous or aluminous materials whose pozzolanic reactivity is enhanced through controlled thermal treatment (calcination) followed by grinding.

Typical sources include, but are not limited to:

— calcined volcanic materials;

— calcined clays;

— calcined shales or other sedimentary materials;

— characteristics:

— increased pozzolanic reactivity due to thermal activation;

— improved early-age strength contribution compared to non-calcined pozzolanic ash;

— processing temperature and residence time shall be controlled to ensure consistent performance.

4.3 Performance requirements

Regardless of classification, all pozzolanic ash shall conform to the physical, chemical, and mechanical performance requirements specified in this Standard, including but not limited to:

— strength activity index;

— fineness;

— soundness;

— compatibility with cement.

Classification alone shall not be used as a substitute for demonstrated performance.

4.4 Exclusions

Coal-derived fly ash produced from the combustion of coal, including materials traditionally classified as Class F or Class C, is excluded from this classification system and is outside the scope of this Standard.

NOTE This classification framework is intended to reflect pozzolanic materials applicable to Rwanda's geological and industrial context and does not preclude reference to international standards for coal fly ash where such materials are imported; however, such materials are not regulated by this Standard.

4.5 Grading

The pozzoranic ash as cement active addition is not graded. pozzoranic ash for mixing mortar and concrete is divided into three grades: grade I, II and III as specified in the technical requirements in Table 1.

5 Performance requirements

5.1 Physical and chemical property requirements

Pozzoranic ash for mortar and concrete and pozzoranic ash used as cement active addition shall conform to the physical requirements specified in Table 1 respectively.

5.2 Chemical Composition

Pozzoranic ash shall conform to the requirements as to chemical composition specified in Table 1.

NOTE The chemical component determinations and the limits placed on each do not predict the performance of the pozzoranic ash with hydraulic cement in concrete, but collectively help describe composition and uniformity of the material.

Table 1 — Physical and chemical property requirements of the Pozzoranic ash for mixing mortar and concrete

Physical requirements				
Item	**Type of Pozzoranic ash**	**Grade I**	**Level II**	**Level III**
Fineness (Amount retained when wet-sieved on 45 µm (No 325) sieve, max, %.	PA-NC, PA-C	≤ 34	≤ 34	≤ 34
Water Demand Ratio (%) max, percent of control	PA-NC, PA-C	115	115	115
Strength activity index A With portland cement at 7 days, and at 28 days, min percentage of control	PA-NC, PA-C	> 70	>70	> 70
Moisture content max, %	PA-NC, PA-C	≤ 5.0		
Density (g/cm^3)	PA-NC, PA-C	≤ 5.0		
Autoclave expansion or contraction, max, %	PA-NC, PA-C	0.8		
Stability (Le chatelier soundness test)/(mm) or	PA-NC, PA-C	≤ 5.0		
Chemical requirements				
Item	**Class of fly ash**	**Requirements**		
Total mass fraction of silicon dioxide (SiO2), aluminum oxide (A12O3) and iron sesquioxide (Fe2O3), %	PA-NC, PA-C	≤ 70		

Free calcium oxide (f-CaO) mass fraction, %	PA-NC, PA-C	≤ 50.0
Sulfur trioxide (SO3) mass fraction/%	PA-NC, PA-C	Report only
Ignition loss (Loss) max, %	PA-NC, PA-C	4.0

A The strength activity index with portland cement is not to be considered a measure of the compressive strength of concrete containing the pozzoranic ash. The mass of pozzoranic ash specified for the test to determine the strength activity index with portland cement is not considered to be the proportion recommended for the concrete to be used in the work. The optimum amount of pozzoranic ash for any specific project is determined by the required properties of the concrete and other constituents of the concrete and is to be established by testing. Strength activity index with portland cement is a measure of reactivity with a given cement and is subject to variation depending on the source of both the pozzoranic ash and the cement.

B Meeting the 7 day or 28-day strength activity index will indicate specification compliance.

C If the pozzoranic ash will constitute more than 20 % by mass of the cementitious material in the project mixture, the test specimens for autoclave expansion shall contain that anticipated percentage. Excessive autoclave expansion is highly significant in cases where water to cementitious material ratios are low, for example, in block or shotcrete mixtures.

5.3 Alkali content

Expressed in $Na_2O+0.658K_2O$ calculation value. When there is alkali content requirement in the pozzoranic ash application, it shall be determined through negotiation between the supply and requisitioning parties.

Table 2 — The Physical and chemical property requirements of the pozzoranic ash as cement active addition

Item	Physical and chemical performance requirement
	PA-NC, PA-C
Ignition loss (Loss), %	≤ 8.0
Water content/%	≤ 1.0
Sulfur trioxide (SO3) mass fraction, %	≤ 3.5
Free calcium oxide (f-CaO) mass fraction, %	≤ 4.0
Total mass fraction of silicon dioxide (SiO2), aluminum oxide (Al2O3) and iron sesquioxide (Fe2O3), %	≥ 70.0
Density/(g/cm^3)	≤ 2.6
Stability (Le chatelier soundness test)/mm	≤ 5.0
Strength activity index	≥ 70.0

5.4 Calcium sulphate hemi hydrate content

For the pozzoranic ash discharged by the dry method or semi-dry desulphurization process, the calcium sulfate hemihydrate content is required to be tested ($CaSO_3$*1/2H_2O), which shall be not more than 3.0 %.

5.5 Uniformity

Characterized by fineness, the fineness of single sample shall be not more than the maximum deviation of the average fineness value of previous 10 samples (average value of all aforementioned samples, if the sample size is less than 10), the maximum deviation scope shall be determined through negotiation between the buyer and seller.

6 Methods of sampling and testing

Sampling and testing pozzolanic ash shall be done in accordance with RS ASTM C 311/C 311M.

7 Storage and inspection

7.1 The pozzoranic ash shall be packaged in a material that safeguards the quality, safety and integrity of the product. It shall also be stored so as to permit easy access for proper inspection and identification of each shipment.

7.2 The pozzoranic ash shall be stored in dry and cool place that allows easy access for inspection and identification, and in suitable waterproof building to maintain quality of the cement. It shall be stored on pallets not in contact with the walls / floors and roof.

8 Packaging, labelling and marking

8.1 Packaging

When the pozzoranic ash pozzoranic ash is delivered in packages, the class, name, and brand of the producer, and the weight of the material contained therein, shall be plainly marked on each package. Similar information shall be provided in the shipping invoices accompanying the shipment of packaged or bulk material.

8.2 Marking and labelling

Each bag of pozzoranic ash shall be legibly and indelibly marked with the following information in English language:

a) the manufacturer’s name, address, (factory physical address) and/or trademark;

b) class of pozzoranic ash;

c) net weight in kilograms;

d) date of packing and/or batch number;

9 Supplier’s certification.

Upon request of the purchaser, in the contract or the order, a supplier’s report shall be furnished stating the results of tests made on samples of the material and certifying the product conforms to all applicable requirements of this standard. In addition, the report shall include the percentages of magnesium oxide (MgO), sodium oxide (Na2O), potassium oxide (K2O), and calcium oxide (CaO), all determined in accordance with RS ASTM C 311/C311M. The report shall also include the total alkali content of the material, expressed as equivalent percentage of sodium oxide (Na2Oe).

Annex A
(normative)

Effectiveness of pozzolanic ash in preventing excessive expansion of concrete due to alkali silica reaction

If properly proportioned in concrete mixtures, pozzolanic have been shown to prevent excessive expansion due to alkali silica reaction. The quantity pozzoranic ash required to mitigate alkali silica reaction, measured in terms of portland cement replacement, is dependent on the properties of the pozzoranic ash, reactivity of the aggregate and the alkali loading of the concrete.

Annex B
(informative)

Supplier's certification report (Example)

To provide uniformity for reporting the results of tests performed on pozzolans under this specification, and affirming compliance to the applicable limits of this standard, an example report of analysis is shown in Figure 1 below.

REPORT OF POZZOLAN ANALYSIS

Plant: XYZ Power Station **Date:** March 10, 20XX
Supplier: ABC Materials Company
Product Class: CLASS F
Sampling Period: January 10, 20XX to February 10, 20XX **Type:** Composite

STANDARD REQUIREMENTS (ASTM C618 Tables 1 and 2)

Chemical Composition (mass %)	Result	ASTM C618 Limits Class N	Class F	Class C
Silicon Oxide (SiO_2)	61			
Aluminum Oxide (Al_2O_3)	18			
Iron Oxide (Fe_2O_3(T))	5.2			
SUM (SiO_2+Al_2O_3+Fe_2O_3(T))	84.2	70.0 min.	50.0 min.	50.0 min.
Sulfur Trioxide (SO_3)	2.3	4.0 max.	5.0 max.	5.0 max.
Calcium Oxide (CaO)	6.0	report only	18.0 max.	>18.0
Magnesium Oxide (MgO)	1.1			
Sodium Oxide (Na_2O)	0.7			
Potassium Oxide (K_2O)	0.8			
Sodium Oxide Equivilant (Na_2O+0.658K_2O)	1.2			
Moisture Content	0.5	3.0 max.	3.0 max.	3.0 max.
Loss on Ignition	0.2	10.0 max.	6.0 max.	6.0 max.
Physical Tests				
Fineness				
Retained on a 45-µm sieve (%)	12.0	34 max.	34 max.	34 max.
Strength Activity Index				
Ratio to Control @ 7 days	94	75 min.	75 min.	75 min.
Ratio to Control @ 28 days	103	75 min.	75 min.	75 min.
Water Requiremnt (% of Control)	98	115 max.	105 max.	105 max.
Soundness				
Autoclave Expansion (%)	0.05	0.8 max.	0.8 max.	0.8 max.
Density (grams per cubic cm)	2.45			
Unifomity (average established from ten preceding tests or all tests if less than 10 values are available)				
Fineness (percentage points from avg.)	−1.1	±5 max.	±5 max.	±5 max.
Density (percentage points from avg.)	+1.5	±5 max.	±5 max.	±5 max.

SUPPLEMENTARY OPTIONAL PHYSICAL REQUIREMENTS (ASTM C618 Table 3)

No tests requested

Signature: _____ Title: _____

Price based on 10 pages