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**Concrete building blocks and bricks —
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 144 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) ASTM C55-17, *Standard Specification for Concrete Building Brick*
- 2) BS771-3: 2003, *Specification for masonry units — Part 3: Aggregate concrete masonry units (dense and lightweight aggregates)*
- 3) SANS 1215: 2008, *Concrete masonry units*

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

This third edition cancels and replaces the Second edition (RS 144: 2012), Clause 2 and 4, which has been technically revised.

Committee membership

The following organizations were represented on the Technical Committee on *Building materials and civil engineering* (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)

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Concrete building blocks and bricks — Specification

1 Scope

This Draft Rwanda Standard specifies precast solid and precast hollow concrete masonry building blocks and bricks for use in interior and exterior use in constructing structural and non-structural masonry walling, and are made from Portland cement, water and suitable mineral aggregates with or without the inclusion of other materials.

Building block and bricks covered by this standard are:

- a) hollow load bearing and non-load bearing cement blocks; and
- b) solid load-bearing cement blocks and bricks.

This Standard specifies performance requirements related to dimensional accuracy, density, strength, water absorption, shrinkage and moisture movement for hollow blocks and solid cement blocks or bricks.

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.

RS ASTM C140/C140M, *Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units*

RS ASTM C426, *Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units*

ISO 18985, *Recycled aggregates for concrete*

ISO 18985, *Recycled aggregates for concrete*

RS ISO 19596, *Admixtures for concrete*

RS ISO 12439, *Mixing water for concrete*

RS EAS 18-1, *Cement — Part 1: Composition, specification and conformity criteria for common cement*

RS 96, *Methods of test for aggregates*

RS 107, *Building sands — Specification*

RS 425, *Calcined and non-calcined pozzolanic ash — Specification*

3 Terms and definitions

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

3.1

masonry unit

preformed component intended for use in masonry construction

3.2

facing masonry unit

masonry unit intended for use with one or more faces left visible and which may or may not be exposed to external climatic conditions

3.3

exposed masonry unit

facing masonry unit exposed to external climatic conditions without render or other equivalent protection

3.4

grading

particle size distribution of the aggregate

3.5

segregation

separation of the different sizes in the aggregate

3.6

block

masonry unit, either hollow or solid, any one of the external dimension of which is greater than the corresponding dimension of a brick

3.7

brick

masonry unit with dimensions that satisfy all of the following conditions:

- a) length not exceeding 300 mm;

- b) width not exceeding 130 mm; and
- c) height not exceeding 120 mm.

3.8

solid blocks

block which has solid material not less than 75 percent of the total volume of the block calculated from the overall dimensions

3.9

hollow blocks

unit that

- a) contains at least one large hole or cavity of such size that the solid material in the unit constitutes between 50 % and 75 % of the total volume of the unit calculated from its overall dimensions, or
- b) when used in a wall (or in a leaf of a cavity wall), forms internal cavities that have a total area, in a horizontal plane, of more than 25 % of the horizontal cross-sectional area of the wall (or leaf of a cavity wall)

3.10

cellular blocks

blocks which contain one or more formed voids which do not fully penetrate the block

3.11

block density

the density calculated by dividing the mass of a block by the overall volume, including holes or cavities

3.12

drying shrinkage

difference between the length of specimen which has been immersed in water and then subsequently dried to constant length, all under specified conditions; expressed as a percentage of the dry length of the specimen

3.13

face shells

two outer plates of the hollow block that are connected together by webs

3.14

shell

peripheral solid material between the hole(s) and the face or the header of a hollow block

3.15

gross area

total area occupied by a block on its bedding face, including areas of the cavities

3.16

hollow (open or closed cavity) block

block having one or more large holes or cavities which either pass through the block (open cavity) or do not effectively pass through the block (closed cavity) and having the solid material between 50 and 75 percent of the total volume of the block calculated from the overall dimensions

3.17

moisture movement

difference between the length of the specimen when dried to constant length and when subsequently immersed in water, all under specified conditions, expressed as a percentage of the dry length of the specimen

3.18

solid block

block which has solid material not less than 75 percent of the total volume of the block calculated from the overall dimensions

3.19

webs

solid sections of the hollow blocks which connect the face shells

3.20

nominal dimension

dimension including the thickness of the mortar joint

3.21

curing

process of maintaining a satisfactory moisture content and a favourable temperature in the blocks to ensure hydration of the cement and development of optimum strength

3.22

Face Unit Aesthetic (FUA)

unit especially made for its aesthetic effect deriving from non-uniformity of the surface of the intended exposed face(s)

4 Materials and manufacture

4.1 Materials

4.1.1 Cementitious materials such as hydraulic cement, coal ash and raw or calcined natural pozzolan shall be established as suitable for use in concrete masonry units. Hydraulic cement shall conform to the requirement of RS EAS 18-1. Pozzolanic ash shall be in accordance with RS 425.

4.1.2 The aggregates shall conform to the requirements of RS 373. except that grading requirements shall not necessarily apply. Finer aggregates shall conform to the requirements given in RS 107. The use of recycled aggregates shall be in accordance with principles and framework provided in ISO 18985:2025.

4.1.3 The mixing water for use in the manufacture of the blocks and bricks and shall comply with the requirements of RS ISO 12439.

4.1.4 Other constituents — Air-entraining agents, colouring pigments, integral water repellents, finely ground silica, and other constituents shall be previously established as suitable for use in concrete masonry units and shall conform to applicable Rwanda Standard or shall be shown by test or experience not to be detrimental to the durability of the concrete masonry units or any material customarily used in masonry construction.

4.1.5 Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to mix. Additives or admixtures used in the manufacture of blocks and bricks may be:

- a) accelerating, water-reducing and air-entraining admixtures such as fly ash;
- b) waterproofing agents; and
- c) colouring pigments.

4.1.6 When concrete admixtures are used, the requirements concerning composition, mixing, placing, curing, shall be in accordance with RS ISO 19596.

4.2 Manufacture

4.2.1 Materials should be protected from deterioration or contamination until used methods of storing, handling and batching should ensure minimum segregation of the aggregates all materials shall be batched to acceptable degrees of accuracy.

4.2.2 The water: cement ratio should be 0.4 for dry materials. In the other case, the quantity of water to be added into the mix shall depend on the moisture content of cement and aggregates until the consistency is reached.

4.2.3 Mixing shall be carried out manually or mechanically.

4.2.4 Placing and compaction shall be done properly such that no voids or honeycombs shall appear after the mould is removed.

4.2.5 The wet mix should not be allowed to stand for more than half an hour to avoid the loss of strength of the final products when working in hot weather.

4.2.6 Curing

4.2.6.1 Blocks and bricks shall be cured to ensure that sufficient moisture is available and that the temperature is suitable for the chemical reaction (hydration) between cement and water to occur. Curing should be cured in one of the following ways:

- a) immersing in water;
- b) spraying continuously with water; and
- c) wetting the products and wrapping or covering with a plastic sheet.

4.2.6.2 Curing should be continued for at least 7 days in normal weather (20 °C to 25 °C).

5 Requirements

5.1 Shape, appearance and colour

5.1.1 Shape

All units shall be solid or hollow, shall be of nominally rectangular shape and true to the appropriate acceptable pattern, and may in the case of solid units be manufactured with or without frogs. They shall be acceptably free from visible defects that could interfere with the proper laying of the units or impair the strength or the stability (or both) of a construction.

5.1.2 Appearance and texture

5.1.2.1 The surface(s) of face units used for exposed work shall be acceptably uniform in colour and texture (see 3.2), and acceptably free from chips, cracks and other imperfections, except that if not more than 5 % of the units of a sample of a consignment contain slight cracks or small chips not larger than 10 mm, this shall not be deemed to be grounds for rejection.

5.1.2.2 When the surface of facing units are declared by the manufacturer to be plane, they shall not deviate from a plane by more than $(0.1\sqrt{ld})$ mm or 2 mm whichever is the greater, where ld is the length of the diagonal of the surface of the unit declared plane, based on the actual size of the unit. The requirements for flatness shall not apply to the surfaces of units which are manufactured to be non-planar.

5.1.2.3 Blocks or bricks should be given a variety of surface textures ranging from a very fine close texture to a coarse open texture by the proper selection, grading, and proportioning of aggregates at the time of manufacture.

5.1.3 Colour

When face units are required to have coloured surfaces the colour shall be as agreed upon between the manufacturer and the purchaser and the manufacturer shall supply to the purchaser for his retention three units of the agreed colour to serve as an example of the possible range of such colour.

5.1.4 Surface Texture

The surface characteristics of units intended for use with plaster or other types of surface finish shall be such that the surface will provide adequate adhesion for the plaster or other finish.

5.2 Dimensions and permissible variations

5.2.1 No overall dimension (width, height and length) shall differ by more than 3.2 mm from the specified standard dimensions.

NOTE Standard dimensions of concrete building brick are the manufacturer's designated dimensions. Nominal dimensions of modular size concrete building brick are equal to the standard dimensions plus the thickness of one mortar joint. Nominal dimensions of non-modular size concrete building brick usually exceed the standard dimensions by 3.2 to 6.4 mm.

5.2.2 Coring: Unless otherwise specified, brick shall be either solid or cored at the option of the seller. For cored concrete building brick, the net cross-sectional area in any plane parallel to the surface containing the cores shall be at least 75 % of the gross cross-sectional area measure in the same plane. No part of any hole shall be less than 19.1 mm from any edge of the unit.

5.2.3 The work size of a unit, as indicated by the overall length L , overall width W and overall height H , shall be as stated by the manufacturer and, when determined in accordance with 5.3, shall not differ from the stated nominal values by more than the applicable tolerance given in Table 1.

Table 1 — Tolerances on work sizes

Overall Size	Tolerances mm
Length	+2 -4
Width	$\pm 3^*$
Height	± 3
NOTE In the case of FUA units, the tolerance on the overall width shall be ± 10 mm.	

5.2.4 Shell and web thicknesses (hollow units)

The shell thickness and, when applicable, the transverse web thickness of the unit, determined in accordance with RS ASTM C140 shall be at least one-sixth of the overall width of the unit or 25 mm, whichever is the greater.

Table 2 — Transverse web thickness of the unit

Nominal block width	Face thickness	shell	Thickness of web
100 or less	25		25
Over 100 to 150	25		25
Over 150 to 200	30		25
Over 200	35		30

5.2.5 Squareness

In the case of units of overall height exceeding 90 mm, any out-of-squareness of a unit, determined in accordance RS ASTM C140 shall not exceed 2 mm.

5.3 Physical requirements

5.3.1 General

At the time of delivery to the purchaser, units shall conform to the physical requirements prescribed in Table 2. All units shall be sound and free of cracks or other defects that interfere with the proper placement of the units or significantly impair the strength or permanence of the construction. Minor cracks incidental to the usual method of manufacture or minor chipping resulting from customary methods of handling in shipment and delivery are not grounds for rejection.

5.3.2 Compressive strength

5.3.2.1 When higher compressive strengths than those listed in Table 2 are specified, the tested average net area compressive strength of three units shall equal or exceed the specified compressive strength, and the following single unit strength requirements shall apply.

5.3.2.2 The nominal compressive strength of units shall be one of the values given in column 1 of Table 2. The average and individual compressive strengths of units, determined in accordance with RS ASTM C140, shall comply with the appropriate values given in Table 2.

Table 2 — Minimum net Area Compressive strength

Type of Blocks	Grades	Density of blocks Kg/m ³	Nominal compressive strength Mpa	Compressive strength Mpa, min	
				Average for 5* units	individual units
Hollow load bearing unit	A (3.5)	> 1 500	3.5	4.0	3.0
	A (4.5)		4.5	5.0	4.0
	A (7.0)		7.0	8.0	5.5
Hollow non-load bearing unit	B (2.5)		2.5	3.5	2.0
	B (3.0)		3.0	3.5	2.5
Solid load bearing unit	C (7)		> 1 800	7.0	8.0
	C (14) ¹	14.0		15.5	11.0
	C (21) ¹	21.0		23.5	17.0
* In the case of units having an overall length of 290 mm or less, an average for 12 units is taken					
¹ Classes C 14 and C21 are used in structural retaining					

5.3.3 Drying shrinkage

At the time of delivery to the purchaser, the average total linear drying shrinkage of the three units tested shall not exceed 0.065 % when tested in accordance with RS ASTM C426.

5.3.4 Soundness

When units manufactured from slag or clinker or burnt clay brick aggregates are tested in accordance with Annex 1, the following surface pop-outs shall be allowed:

- a) A maximum of two pop-outs of mean diameter 2 mm - 5 mm in each of only two of the six units tested and none in the remaining four; or
- b) a maximum of two pop-outs of mean diameter 5 mm - 10 mm in only one of the six units tested and none in the remaining five. None of the six units shall have pop-outs of mean diameter exceeding 10 mm.

6 Methods of sampling and testing

6.1 The purchaser or authorized representative shall be accorded proper facilities to inspect and sample the concrete building brick at the place of manufacture from the lots ready for delivery.

6.2 Compressive strength, absorption, density, and dimensional tolerances shall be based on tests of concrete building brick of any configuration or dimensions made with the same materials, concrete mix design, manufacturing process, and curing method, conducted in accordance with Test Methods RS ASTM C140 and not more than 12 months prior to delivery.

6.3 Total linear drying shrinkage shall be based on tests of concrete building brick of any configuration or dimensions made with the same materials, concrete mix design, manufacturing process, and curing method, conducted in accordance with RS ASTM C426 and not more than 24 months prior to delivery.

7 Conformity

7.1 If a sample fails to conform to the specified requirements, the manufacturer shall be permitted to remove units from the shipment. A new sample shall be selected by the purchaser from remaining units from the shipment with a similar configuration and dimension and tested at the expense of the manufacturer. If the second sample meets the specified requirements, the remaining portion of the shipment represented by the sample meets the specified requirements. If the second sample fails to meet the specified requirements, the remaining portion of the shipment represented by the sample fails to meet the specified requirements.

NOTE Unless otherwise specified in the purchase order, the costs of tests is typically borne as follows: (1) if the results of the tests show that the units do not conform to the requirements of this specification, the cost is typically borne by the seller; (2) if the results of the tests show that the units conform to the specification requirements, the cost is typically borne by the purchaser.

7.2 The lot shall be considered as conforming to the requirements of the specification if the conditions mentioned in this clause are satisfied.

7.3 The number of blocks with dimensions outside the tolerance limit and/or with visual defects, among those inspected shall be not more than two.

7.4 For block density (see Note in Table 2) and compressive strength, the mean value determined shall be greater than or equal to the minimum limit specified in table 2.

7.5 For drying shrinkage and moisture movement, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements.

7.6 For water absorption, the mean value determined shall be equal or less than maximum limit specified in Table 2.

8 Marking

Each consignment of units shall be accompanied by a despatch or consignment note in which the following information is given:

- a) The manufacturer's name, trade name, or trademark;
- b) the date of manufacture or related batch number;
- c) whether solid or hollow units;
- d) the work size;
- e) the nominal compressive strength (as given in column 1 of Table 2) of the units;

- f) the average drying shrinkage;
- g) in the case of face units having a coloured finish, the colour; and
- h) when relevant, that the units contain a slag or clinker or burnt clay brick aggregate.

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Annex A (normative)

Soundness test

A.1 Apparatus

A.1.1 A pressure vessel capable of maintaining a steam pressure of 100 kPa - 120 kPa, of suitable volume for the size and number of specimens to be tested, equipped with a pressure release valve that can be set at 100 kPa - 120 kPa, and a safety valve.

A.1.2 A heating facility, either as a built-in unit or an external source of heat at the base of the pressure vessel.

NOTE Domestic pressure cookers of various types and sizes complying with the above description are readily available. It is recommended that, in respect of safety aspects.

A.2 Preparation of test specimens

A.2.1 Cut from a stretcher face of each unit (see 5.3) a test specimen of length approximately 200 mm and cross-section at least 70 mm × 25 mm.

A.2.2 Prepare a "lime paint" consisting of hydrated lime with enough water to allow the "lime paint" to be brushed onto the test specimens to obtain a uniform and thin coating.

A.2.3 Coat the surface of the uncut face (i.e. the intended exposed face) of the specimen (including interstices between aggregate particles) with "lime paint", using a brush to apply a thin coating of uniform colour and texture, and allow it to dry.

NOTE It is recommended that a "stock" of a lime mixture of the consistency of a stiff putty be kept in airtight non-corrodible containers and that, from this mixture, "lime paint" (see (b) above) be prepared just prior to use. This procedure will enhance the plasticity properties of the lime. Alternatively, commercially available "lime wash" that contains no water-repellents may be used.

A.3 Procedure

A.3.1 Ensure that the pressure vessel contains enough water (usually about one-third of its capacity) and so place the specimens on a rack above the water level that all sides of the specimens will be exposed to steam.

A.3.2 Secure the lid of the vessel, open the release valve and raise the temperature of the water until escaping steam from the release valve is evident. Set the release valve at its working pressure (100 kPa - 120 kPa) and so raise and so maintain the temperature of the water that steam just escapes occasionally from the release valve. Maintain this pressure for 6 h.

A.3.3 Shut off the heat and cool the vessel by allowing cold water to flow over it until ambient temperature is reached, or gradually release the steam pressure by slightly opening the release valve until atmospheric pressure is reached. Open the vessel and remove the specimens for examination.

A.4 Examination of test specimens

A.4.1 General - Inspect the coated surface of each specimen for pop-outs.

A.4.1.1 Surface pop-outs caused by expansion of unsound material typically appear as small eruptions on the surface, with cracks radiating from their apexes. When the material from such an eruption is gently removed and any loose material blown off, a crater-like hole will be evident at the base of which the remnants of a nodule of the expansive substance is likely to be found.

Alternatively, the expansive forces of unsound nodules may be so great that surface material is pushed off completely and the crater thus formed is directly and positively identifiable. It is usual that large nodules of unsound material bedded fairly deep in the specimen will cause the largest craters and can be readily identified. On the other hand, if such nodules are close to the surface of the specimen, the apparent disruption of the surface is less and the crater formed comparatively small.

A.4.1.2 It is also possible that "blow-holes" are formed on the surface of the specimen under the skin of cement formed during manufacture of units or under the layer of "lime paint" applied during preparation of the specimens. This skin of layer may, owing to the steaming or other mechanical handling, either be broken or appear to form small eruptions in places. If the broken layer is carefully brushed off, the underlying hole will be almost hemispherical and smooth of texture. Such holes shall not be construed as pop-outs.

A.4.2 Evaluation - Record the number and size of surface pop-outs as identified in accordance with (a)(1) above, and check for compliance with the requirements of 3.9.

Bibliography

- [1] RS EAS 94: 1999, *Burnt clay building blocks — Specification*
- [2] RS EAS 54: 1999, *Burnt building bricks — Specification*
- [3] RS 107: 2018, *Building sand — Specification*
- [4] RS 144: 2012, *Cement blocks and bricks — Specification*
- [5] ISO 19595: 2017, *Natural Aggregates for concrete*

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