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Natural stone masonry units — Specification

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Rwanda Standards Board

P.O Box 7099 Kigali-Rwanda

KK 15 Rd, 49

Tel. +250 788303492

Toll Free: 3250

E-mail: info@rsb.gov.rw

Website: www.rsb.gov.rw

ePortal: www.portal.rsb.gov.rw

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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.

DRS 517 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) BS EN 771-6:2011, *Specification for masonry units - Part 6: Natural stone masonry units*

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

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.

A+Construction Group Ltd

Africeramics Ltd

Consultants Engineers Group (CEG) Ltd

D&D Resources Ltd

Dutureheza Ltd

Enabel Rwanda

Greenpack Africa Ltd

Integrated Polytechnic Regional Centre (IPRC) - Musanze

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NP Construction Construction Company (NPCC) Ltd

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Standards for Sustainability (SfS)

Stonecraft Industries Ltd

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

Rwanda Standards Board (RSB) – Secretariat

Natural stone masonry units — Specification

1 Scope

This Draft Rwanda Standard specifies the characteristics, performance requirements, sampling and test methods for masonry units manufactured from natural stone the width of which is equal to or greater than 80 mm, for which the main intended uses are common, facing or exposed masonry units in loadbearing or non-loadbearing building and civil engineering applications. These units are suitable for all forms of coursed or random masonry walling, including single leaf, cavity, partition, retaining and the external masonry to chimneys. They can provide fire protection, thermal insulation, sound insulation and sound absorption.

This Draft Rwanda Standard includes natural stone masonry units of an overall non-rectangular parallelepiped shape, specially shaped and accessory units for internal and external application.

It defines the performance related to e.g. strength, petrographic description, density, porosity, dimensional accuracy, thermal conductivity and water absorption. The declaration of performance and marking requirements for products covered by this Draft Rwanda Standard are also included.

This Draft Rwanda Standard does not cover storey height panels, natural stone for paving, chimney flue linings nor units intended for use as damp proof course.

2 Normative references

The following referenced documents are indispensable for the application 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 108-2, *Specification for mortar for masonry — Part 2: Masonry mortar*

RS ISO 1920, *Testing hardened concrete*

DRS 524, *Masonry and masonry products — Methods for determining thermal properties*

DRS 526, *Natural stone test methods — Determination of real density and apparent density, and of total and open porosity*

DRS 527, *Natural stone test methods —Petrographic examination*

DRS 528, *Natural stone — Denomination criteria*

ISO 10456: *Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values*

DRS 549, *Methods of test for masonry units - Determination of water absorption of aggregate concrete, autoclaved aerated concrete, manufactured stone and natural stone masonry units due to capillary action and the initial rate of water absorption of clay masonry units*

DRS 530, *Natural stone test methods — Determination of geometric characteristics on units*

DRS 536, *Determination of dimensions*

DRS 539, *Determination of flexural strength*

DRS 540, *Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item*

DRS 547, *Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests*

ISO 12572, *Hygrothermal performance of building materials and products — Determination of water vapour transmission properties — Cup method*

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

3 Terms and definitions

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

3.1

apparent density

ratio between the mass of the dry specimen and its apparent volume

3.2

masonry unit

preformed component intended for use in masonry construction

3.3

face

exposed surface of natural stone masonry units

3.4

natural stone

natural product obtained by mining or by quarrying and made into masonry units by a manufacturing process

3.5

natural stone masonry unit

masonry unit manufactured from natural stone

3.6

dimensions and surfaces

defined by reference to Figure 1 relates to the name of the dimensions and surfaces for dimensioned stone and squared rubble stone

3.7

co-ordinating size

size of the co-ordinating space allocated to a masonry unit including allowances for joints and tolerances

3.8

work size

size of a masonry unit specified for its manufacture, to which the actual size conforms within permissible deviations

3.9

actual size

size of a masonry unit as measured

3.10

rubble stone

masonry unit squared or not of any shape with variable dimensions, whose face is rough or worked

3.11

squared rubble stone

rubble stone which is squared and worked to dimensions declared by the manufacturer

3.12

regular shaped masonry unit

masonry unit with an overall rectangular parallelepiped shape

3.13

specially shaped masonry unit

masonry unit which is not rectangular parallelepiped

3.14

accessory masonry unit

masonry unit which is shaped to provide a particular function, e.g. to complete the geometry of the masonry

3.15

dimensioned stone

stone worked on all faces to declared dimensions

3.16

extra width

width exceeding the work size, to be adjusted to work-size width after application of the unit on site

3.17

declared value

value that a manufacturer is confident of achieving bearing in mind the precision of the test and the variability of the manufacturing process

3.18

indicative samples

piece of natural stone of sufficient size to indicate the appearance of the finished work, regarding the colouring, the vein pattern, the physical structure and face finish

3.19

category I masonry units

units with a declared compressive strength with a probability of failure to reach it not exceeding 5 %

Note 1 to entry: This may be determined via the mean or characteristic value.

3.20

category II masonry units

units not intended to comply with the level of confidence of Category I units

3.21

normalised compressive strength of masonry units

compressive strength of masonry units converted to the air dry compressive strength of an equivalent 100 mm wide × 100 mm high masonry unit

3.22

mean compressive strength of masonry units

arithmetic mean of the compressive strengths of masonry units

3.23

characteristic compressive strength of masonry units

compressive strength corresponding to the 5 % fractile of the compressive strength of masonry units

3.24

product group

products from one manufacturer having common values for one or more characteristics

4 Materials of natural stone

The following groups of materials are considered as natural stones:

a) **Magmatic or igneous rocks:** Rocks formed by the cooling and solidification of the magma, e.g. granite, basalt, diorite, porphyry.

b) **Sedimentary rocks:** Rocks formed by deposition (generally in water) and consolidation of organic or inorganic particles. For example limestone, sandstone, travertine.

c) **Metamorphic rocks:** Transformed rocks resulting from action of heat and/or pressure on the pre-existing rocks. For example slate, gneiss, quartzite, marble.

5 Requirements for natural masonry units

5.1 Denomination

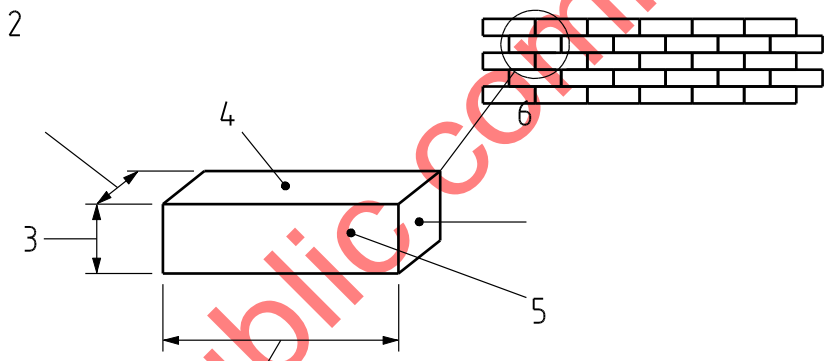
The denomination shall be declared in accordance with DRS 528.

The petrographic name shall be declared in accordance with DRS 527.

5.2 Dimensions and tolerances

5.2.1 Dimensions

The dimensions of a natural stone masonry unit shall be declared (by the manufacturer/supplier) in mm for length, width and height in that order. They shall be given in terms of work size and in addition the coordinating size may be given. The assembly dimensions may also be given.



Key
1 Length
2 Width
3 Height
4 Bed
5 Face
6 Header

Figure 1 — Dimensions and surfaces for dimensioned stone and squared rubble stone

5.2.2 Dimensional tolerances

The permissible deviations for individual masonry units shall be as given in Table 1. The manufacturer shall also declare which tolerance category the dimensioned natural stone masonry units shall fulfil. The manufacturer may declare closer tolerances for one or more dimensions.

When sampled in accordance with Annex A and tested in accordance with DRS 536 using measurement method a), the deviation from the declared dimensions shall not exceed the tolerances for the dimensions in question taken from Table 1 or any closer tolerance the manufacturer has declared.

In addition, the definition of dimensioned stone (finished units) includes the requirement that the faces and headers are plane without a separate declaration and that the bed faces of category D3 masonry units are suitable for use with thin layer mortar. When sampled in accordance with Annex A and tested in accordance with Annex F, the flatness shall meet the requirements of Table 1. When sampled in accordance with

Annex A and tested in accordance with RS ASTM C140 the out-of-squareness shall meet the requirements of Table 1.

When dimensioned stone masonry units category D3, intended for use with thin layer mortar, are sampled in accordance with Annex A and tested in accordance with DRS 536 by procedure d, the deviation from plane parallelism shall not exceed the values given in Table 1

Table 1 — Dimensional tolerances for natural stone masonry units

Dimensions	Dimensioned stone			Squared rubble stone	Rubble stone
	Sawn faces			Faces roughly cut	
	D1	D2	D3		
Length	± 5 mm	± 2 mm	± 2 mm	± 15 mm	No requirement
Width[a]	± 5 mm	± 2 mm	± 2 mm	No requirement	No requirement
Height	± 5 mm	± 2 mm	± 1 mm	± 15 mm	No requirement
Flatness	0,5 % of the longest dimension of the face	0,3 % of the longest dimension of the face	0,3 % of the longest dimension of the face and not more than ± 1mm for the bed face	± 1,5 % for longest straight edge of the face	No requirement
Squareness	0,5 % for the longest straight edge of the face	0,3 % for the longest straight edge of the face	0,3 % for the longest straight edge of the face	± 1,5 % for longest straight edge of the face	No requirement
Plane parallelism			≤ 1,0 mm		
a Not in the case of extra width					

5.3 Configuration and appearance

5.3.1 Configuration

When relevant to the uses, for which they are put on the market, the geometry, shape and features of natural stone masonry units shall be declared by the manufacturer. The declaration may be made by reference to one or another of the groups defined in national building codes.

NOTE Dimensioned natural stone units are considered to be Group 1.

The test shall be carried out according with DRS 530.

5.3.2 Surface appearance

An indicative sample shall be delivered to the customer upon request. It shall show the general tonality and finish of the natural stone, but does not imply any total uniformity in colour, and veins between the sample and supply.

Indicative samples shall also show the surface finish proposed.

NOTE Indicative samples should be delivered to the customer as an indication of specific characteristics such as glass seams, spots, holes for travertine, worm holes for marble, crystalline veins, rust stains, geodes, lens etc. which should not be considered as flaws.

When an indicative sample cannot exhibit sufficiently the characteristic features of the stone, at least three specimens shall be delivered.

One specimen out of three should indicate the average appearance and the other two the extreme appearance.

5.4 Apparent density

The manufacturer shall declare the apparent density of six specimens sampled in accordance with Annex A and tested in accordance with DRS 526.

5.5 Mechanical strengths

5.5.1 Compressive strength

The manufacturer shall declare the mean normalised compressive strength (fb). In addition, the manufacturer shall declare whether the natural stone masonry unit is classified as Category I or Category II.

The normalised compressive strength procedure of a natural stone masonry unit is given in DRS 537.

When the natural stone masonry units are sampled from a consignment in accordance with Annex A and tested in accordance with DRS 537 and conditioned in accordance with DRS 537), the mean compressive strength of the specified number (at least 10 specimen) of natural stone masonry units from a consignment shall be not less than the declared compressive strength and no individual unit shall have a compressive strength of less than 80 % of the declared mean value.

When it is not convenient to test whole units the test specimen may be cubes with (100 ± 5) mm (70 ± 5) mm or (50 ± 5) mm edge or right circular cylinders with diameter and height which are equal to (100 ± 5) mm (70 ± 5) mm or (50 ± 5) mm.

The number of specimens shall be at least 10.

Sawn test specimens shall be representative of the original unit section.

The declaration shall relate to and indicate the intended orientation of natural stone masonry units as tested and the method of bedding the units. Where, due to its means of formation, the strength properties of the stone are not isotropic, e.g. due to presence of bedding planes, it may be necessary to declare the compressive strength normal to more than one face of the test specimen. If the grinding process significantly alters the contact area of the faces tested or if the flatness tolerance cannot be achieved and the capping procedure is thereby used, this shall be declared.

The size and shape of the specimen tested shall be reported.

NOTE When shape factors are available e.g. in a database to be used to normalize the compressive strength from cut cubes or cylinders, these may be used.

5.5.2 Flexural strength

For natural stone masonry units that could be subjected to flexural stress during use, the manufacturer shall declare the mean flexural strength of ten specimens sampled in accordance with Annex A and tested in accordance with Annex B. When the stone shows bedding planes or anisotropy features, the declaration shall give the orientation of the force relatively to them.

5.6 Shear bond strength

5.6.1 General

For natural stone masonry units to be used in elements subjected to structural requirements, the shear bond strength of the unit in combination with mortar shall be declared in terms of the characteristic initial shear strength (DRS 538). The declaration shall be made in accordance with 5.6.2. the manufacture shall declare whether the value of bond strength has been obtained from fixed values or from the test.

5.6.2 Declaration based on fixed values

When no declaration is made on initial shear strength og th unit in combination with a specific type of mortar, , the characteristic initial shear strength of the unit in combination with mortar may be declared by reference to RS 108.

5.7 Flexural bond strength

When relevant to the uses for which natural stone masonry units are put on the market, the flexural bond strength of masonry made with the units and mortar specified in accordance with RS 108 shall be declared. The declaration shall give the value of the characteristic flexural strength of the masonry combination for either a plane of failure perpendicular to the bed joints or a plane of failure parallel to the bed joints or both, as relevant, and the mortar specification for which the declaration is valid.

When natural stone masonry units are sampled in accordance with Annex A and tested in combination with the specified mortar, in accordance with DRS 539, the characteristic flexural strength of the relevant masonry specimens shall not be less than the declared value for the plane of failure.

5.8 Open porosity

The manufacturer shall declare the average open porosity of six specimens sampled in accordance with Annex A and tested in accordance with DRS 526.

5.9 Water absorption coefficient by capillarity

When relevant for the uses of the product the water absorption coefficient due to the capillary action shall be declared by the manufacturer. When the natural stone masonry units are sampled from a consignment in accordance with Annex A and tested in accordance with DRS 549 then the mean water absorption of the specified number of natural stone masonry units shall be not greater than the declared water absorption.

When it is not convenient to test whole units, the test specimen may be cubes with (70 ± 5) mm edge or cylinders with diameter and height which are equal to (70 ± 5) mm. The area of the base to be immersed shall be calculated by measurements of two medians to the nearest 0,1 mm. The mass of the specimen shall weigh to the nearest 0,01 g. The specimens shall be weighed a minimum of 7 times, at the following intervals ± 5 %:

a) High absorbent stone: time = 1 min, 3 min, 5 min, 10 min, 15 min, 30 min, 60 min, 480 min and 1 440 min

b) Low absorbent stone: time = 30 min, 60 min, 180 min, 480 min, 1 440, 2 880 min and 4 320 min.

When the stone shows bedding planes or anisotropy features, the test shall be carried out with the base immersed parallel to that which will be horizontal during use. If no arrangement of use is established (e.g. isometric units), two values of coefficient of absorption due to capillary action shall be declared: normal and parallel to the bedding or anisotropy. In that case, two sets of six specimens shall be tested.

5.10 Thermal properties

When relevant to the uses for which the unit is put on the market and in all cases for masonry units intended to be used in elements subject to thermal insulation requirements, the manufacturer shall provide the mean $\lambda_{10,dry,unit}$-value and the determination model as prescribed in DRS 524.

Additionally another fractile may be provided. In such cases both the additional fractile and the corresponding

$\lambda_{10,dry,unit}$-value shall be given.

When the natural stone masonry units are sampled in accordance with Annex A and tested in accordance with DRS 524. following the model provided, then the obtained λ-value of the specified number of natural stone masonry units shall be not greater than the provided λ-value.

When relevant to the use for which the units are put on the market, the value of specific heat capacity given in DRS 524.

5.11 Reaction to fire

For natural stone masonry units intended to be used in elements subject to fire requirements, the manufacturer shall declare the reaction to fire classification of the masonry unit in accordance with DRS 547.

For natural stone masonry units containing ≤ 1.0 % by mass or volume (whichever is the most onerous) of homogeneously distributed organic materials, the declaration may be fire Class A1 without the need to test.

Natural stone masonry units containing > 1.0 % by mass or volume (whichever is the most onerous) of homogeneously distributed organic materials shall be tested in accordance with DRS 540 and the appropriate fire classification in accordance with DRS 547, declared.

Information on reaction to fire class of supplementary insulation material shall be on basis of relevant Rwanda Standards as declared by the supplier of insulating material.

NOTE Non-combustible masonry units containing not more than 1 % (by mass or volume whichever is the more onerous) of homogeneously distributed organic materials are classified as reaction to fire Class A1 without testing.

5.12 Water vapour permeability

This characteristic shall be declared upon request (e.g.: when the unit is to be used in a location subject to vapour control requirements and fixed by means of mortar or adhesives).

The permeability shall be given by making reference to tabulated values in ISO 10456, or by determining the permeability using the test method in ISO 12572 and the results expressed accordingly.

6 Description, designation and classification of natural stone masonry units

6.1 Description and designation

The description and designation of a natural stone masonry unit shall comprise at least the following:

a) number, title and date of issue of this document;

b) work size dimensions and tolerance category (for dimensioned natural stone masonry units) (see 5.3);

c) denomination (see 5.2); and

d) mean compressive strength and the size and shape of the specimen tested (see 5.5.1).

When relevant to the uses for which the unit is placed on the market, the description and designation shall include:

a) normalised compressive strength (see 5.5.1);

b) mean flexural strength (see 5.5.2);

c) shear bond strength (see 5.5.6);

d) flexural bond strength (see 5.7);

e) open porosity (see 5.8);

f) apparent density (see 5.4);

g) water absorption coefficient by capillarity (see 5.9);

h) thermal properties (see 5.10); and

Other technical information may optionally be provided.

6.2 Classification

Specification of the properties of masonry units may be given by reference to classification systems provided those systems are based only on those properties included in this Standard and do not themselves constitute a barrier to trade.

This does not remove the requirement that all manufacturers claiming compliance with this standard

Standard shall state declared values of the properties of their products, when required.

7 Marking

The following particulars shall be clearly marked in one of the following: the units, the packaging, the delivery note or any certificate supplied with the masonry units:

a) name, trademark or other means of identification of the manufacturer/supplier;

b) means of identifying the masonry units and relating them to their description and designation.

8 Assessment and verification of constancy of performance (AVCP)

8.1 General

The manufacturer shall demonstrate compliance of the product with the requirements of this Rwanda Standard and with the declared performance for the product properties by carrying out both:

a) product type determination (see 8.2), which can be physical testing, calculation, reference to tabulated values or combinations of these methods; and

b) factory production control (see 8.3).

Alternative methods of test to the reference methods specified in this Rwanda Standard may be adopted except for the product type determination tests and in case of dispute, provided that these alternative methods satisfy the following:

a) a correlation can be shown to exist between the results from the reference method and those from the alternative method; or

b) a safe relationship can be demonstrated when using the alternative method compared to the reference methods; and

c) the information on which the relationship is based is available.

8.2 Product type determination

After completion of the development of a new product type and before placing on the market, appropriate product type determination shall be carried out to confirm that the properties predicted from the development meet the requirements of this standard and the performance of the characteristics to be declared for the product.

Whenever a major change in the source, blend, or nature of raw materials occurs, or when there is a change in processing conditions, leading to what the manufacturer considers will constitute a new product type being produced, the appropriate product type determination shall be repeated.

The manufacturer may define product groups. The product group may differ according to the characteristics in question.

In the product type determination process a manufacturer may take in consideration already existing test results.

A manufacturer may use the product type determination results determined by someone else (e.g. another manufacturer or a research technology & development service provider) to justify his own declaration of performances regarding a product that is manufactured according to the same design and with raw materials, constituents and manufacturing methods of the same kind, provided that permission is given by the owner of the results, and the results are valid for both products.

The tests to be conducted shall be the tests or calculations as described in Table A.1 for the properties selected from the following list relevant to the manufacturer's declaration for the product type's intended use:

a) dimensions and tolerances;

b) configuration;

c) apparent density;

d) compressive strength;

e) flexural strength;

f) shear bond strength;

g) flexural bond strength;

h) open porosity;

i) water absorption coefficient by capillarity;

j) thermal properties;

k) reaction to fire;

l) water vapour permeability.

Sampling for type testing shall be in accordance with Annex A. The results of type tests shall be recorded.

NOTE For the performance characteristics to be determined in order to address the Declaration of Performance and marking provisions, see Table A.1.

8.3 Factory production control

8.3.1 General

The manufacturer shall establish, document and maintain a factory production control system to enable continuing conformity with this Rwanda Standard and the declared performance of the characteristics of the products placed on the market.

The factory production control system may consist of procedures related to the process only (full process control and consequently no finished product testing), to finished products only (consequently no process control;) or any combination of both. Consequently, conformity criteria depend on the individual factory production procedures.

As appropriate, the responsibility, authority and interrelation of all personnel who manage, perform and verify work affecting the quality of masonry unit products shall be established.

The factory production control system shall describe the control procedure of production, the regular checks by the manufacturer and testing, depending on the combination of the procedures related to process control and/or finished product testing. Controls and tests may include the characteristics of raw materials and finished products, the procedure of production, the production equipment or the production machines, the test equipment or the testing instruments and the marking of the product.

The test results shall be recorded.

Actions to be taken when the control test values or criteria do not meet those specified should be documented by the manufacturer.

8.3.2 For Category I masonry units the factory production control system shall be designed so that the probability of failure to reach the declared compressive strength is not exceeding 5 % corresponding to 95 % confidence level.

8.3.3 Testing and measuring equipment

All relevant weighing, measuring and testing equipment, that has an influence on the declared values, shall be verified and regularly inspected/calibrated.

8.3.4 Production equipment

When the factory production control system includes process control procedures, all production equipment, that forms part of these procedures and has an influence on the declared values, shall be regularly inspected.

8.3.5 Raw materials

As appropriate, the manufacturer shall define the acceptance criteria of raw materials and the procedures operated to ensure that these are met.

8.3.6 Production process

As appropriate, the relevant features of the production processes shall be defined giving the frequency of the manufacturer's checks together with the required criteria. Actions to be taken when the criteria are not achieved shall be specified by the manufacturer.

8.3.7 Finished product testing

As appropriate, the factory production control system shall incorporate a sampling plan and the frequency of testing of the finished product. The results of sampling and testing shall be recorded.

The sample shall be representative of the production.

Guidance on testing frequencies for the characteristics of the finished products is given in Table B.1. The guidance should only be used if no better information is available.

Depending on the corrective measure may result in higher frequencies of testing than the ones used.

8.3.8 Statistical techniques

Where and when possible and applicable, the results of checks and testing shall be interpreted by means of statistical techniques, by attributes or by variables, to verify the product characteristics and to determine if the production conforms to the compliance criteria and the product conforms to the declared values.

NOTE One method of satisfying this conformity criterion is to use the approach given in DRS ISO 12491.

8.3.9 Marking and stock control of products

The marking and stock control shall be documented. Lots (Batches) of products should be identifiable and traceable.

8.3.10 Traceability

As appropriate, systems of traceability shall be given in the factory production control system.

8.3.11 Nonconforming products

The procedure for dealing with nonconforming products shall be documented. Products that do not conform with the requirements or the performance of the product type shall be segregated and marked accordingly. However, these products may be reassessed by the manufacturer and assigned to a different product type.

The manufacturer shall take action to avoid a reoccurrence of the nonconformity.

Annex A
(normative)

Sampling for type testing and for independent testing of consignment

General

This sampling procedure shall apply for product type determination tests and in the event that there is a requirement for an assessment of product compliance.

Only those characteristics declared by the manufacturer shall be assessed by this procedure.

The number of units required to determine compliance with the specification shall be sampled from a consignment of up to 100 m^3 of gross volume or part thereof (see Table A.1).

Sampling procedure

General

NOTE The choice of the methods of sampling will normally be dictated by the physical form of the consignment in question.

Random sampling

Whenever possible, the random sampling methods shall be used, in which every masonry unit in the consignment has an equal chance of being selected for the sample. The appropriate number of units shall be selected at random from positions throughout the consignment without any consideration being given to the quality of those selected except that units damaged in transit shall not be selected.

NOTE In practice, random sampling is normally only convenient either when the masonry units forming the consignment are being moved in a loose (unpacked) form from one place to another or when they have been split into a large number of small stacks, e.g. on scaffolding awaiting laying.

Representative sampling

General

When random sampling is impracticable or not convenient, e.g. when the masonry units form a large stack or stacks with ready access to only a limited number, a representative sampling procedure shall be used.

Sampling from a stack

The consignment shall be divided into at least six real or imaginary sections, each of a similar size. An equal number of masonry units shall be selected at random from within each section in order to give the required

number without any consideration being given to the quality of those selected except that units damaged in transit shall not be selected.

NOTE It will be necessary to remove some sections of the stack or stacks in order to gain access to masonry units within the body of such stacks when taking samples

Sampling from a consignment formed of packs

At least six packs shall be selected at random from the consignment. The packaging shall be removed and an equal number of masonry units shall be sampled at random from within each of the opened packs in order to give the required number without any consideration being given to the quality of those selected except that units damaged in transit shall not be selected.

Dividing the sample

When the sample is to provide masonry units for more than one test, the total number shall be collected together and then divided by taking units at random from within the total sample to form each successive sub-sample.

Number of units required for testing

The sample size shall be in accordance with Table A.1.

Table A.1 — Number of units required for testing

Property	Clause number	Number of specimens[a]
Dimensions and dimensional tolerances	5.2	6
Configuration	5.3	6
Apparent density	5.4	6
Compressive strength	5.5.1	10
Flexural strength	5.5.2	10
Flexural bond strength	5.7	3
Open porosity	5.8	6
Water absorption by capillarity	5.9	6
Thermal properties	5.10	—
Water vapour permeability	5.12	—
Reaction to fire	5.11	—

Annex B
(normative)

Determination of flexural strength under concentrated load

Scope

This annex specifies a test method for determination of flexural strength under a concentrated load for natural stone. Both an identification and a technological product testing procedure are included.

Principle

The principle of this method is to place a specimen on two rollers and to progressively load the specimen in the middle. The breaking load is measured and the flexural strength calculated

Symbols

For the purposes of this document, the following symbols apply.

R_{tf} flexural strength, in Megapascals

F breaking load, in newtons

a load rate, in Megapascals/second

V loading rate, in newtons/second

l distance between the supporting rollers, in millimetres

b width of the specimen adjacent to the plane of fracture, in millimetres

h thickness of the specimen adjacent to the plane of fracture, in millimetres

L total length of the specimen, in millimetres

Apparatus

a) A balance capable of weighing the specimen with an accuracy of 0,01 % of the mass of the specimen.
b) A ventilated oven capable of maintaining a temperature of (70 ± 5) °C.
c) A linear measuring device with an accuracy of 0,05 mm.
d) A testing machine of appropriate force, in accordance with the RS ISO 1920 and calibrated according to this Rwanda Standard.
e) A device for applying loads on the specimen by a centre-point load. It consists of two lower rollers (supporting rollers) and one upper roller (load-applying roller) which shall be centred exactly in the

middle between the two supporting rollers (see Figure 1). The distance between the two supporting rollers shall be reported as requested in 6.2.2.

f) A room which can be maintained at a temperature of (20 ± 10) °C.

Preparation of Specimens

Sampling

The sampling is not the responsibility of the test laboratory except where specially requested. At least 10 specimens shall be selected from a homogeneous batch.

Test specimens

Surface finish

As a standard reference, the surface finish of the faces of the specimens shall be sawn, honed or polished (identification test). In case of necessity to test specimens with other surface finishes (e.g. flamed, sandblasted) as required for application, this may be done (technological test). For the technological test the specimens may be final products or sawn from final products. The surface intended for use shall be in contact with the two supporting rollers (facing downwards). In any case the kind of surface finish shall be stated in the report.

Dimensions

For stones with a size of the largest grain lower than 25 mm, preferred dimensions are 50 X mm X 50 mm X 300 mm.

Other dimensions are possible, but shall fulfil the following requirements:

the thickness h shall be between 25 mm and 100 mm and shall be greater than twice the size of the largest grain in the stone;

the total length L shall be equal to six times the thickness;

the width b shall be between 50 mm and three times the thickness (50 mm $\leq$ b $\leq$ 3h), and in no case it shall be less than the thickness.

The distance between the supporting rollers l shall be equal to five times the thickness.

Tolerance

The tolerance on the distance between the supporting rollers l shall be ± 1 mm

Planes of anisotropy

If the stone shows planes of anisotropy (e.g. bedding, foliation) the specimens shall be prepared in accordance with at least one of the arrangements shown in Figures 2 to 4 and the direction of the planes of anisotropy shall be marked on each specimen by at least two parallel lines.

If the use of the stone in respect of the position of the planes of anisotropy is known, the test shall be carried out with the force applied on the face that will be loaded during use

Conditions before testing

The specimens shall be dried at (70 ± 5) °C to a constant mass.

Constant mass is reached when the difference between two weighings carried out (24 ± 2) h apart is no greater than 0,1 % of the first of the two masses.

After drying and prior to testing the specimens shall be stored at (20 ± 5) °C until the thermal equilibrium is reached. After that the test shall be performed within 24 h

Test procedure

Wipe the surface of the rollers clean and remove any loose grits from the faces of the specimen that will be in contact with the rollers.

The specimen is placed centrally on the supporting rollers (see Figures 1 to 4). The loading roller is placed in the middle of the specimen.

The load is increased uniformly at a rate of (0,25 ± 0,05) MPa/s until the specimen breaks.

NOTE 1 The breaking load is rounded to the nearest 10 N and also the place where the fracture occurs. The width and the thickness of the specimen are measured adjacent to the fracture plane and the dimensions are expressed in millimetres to the nearest 0,1 mm.

NOTE 2 Where the loading rate (V) is needed in N/s the following equation can be used to determine the required rate in N/s:

$$V = \frac{2abh^2}{3l} \text{ (N/s)} \quad (1)$$

Expression of results

The flexural strength Rtf of each specimen is calculated using the following equation:

$$R_{tf} = \frac{3Fl}{2bh^2} \quad (2)$$

The result shall be expressed in Megapascals to the nearest 0,1 MPa.

If the fracture is situated more than 15 % of the distance between the supporting rollers from the middle of the specimen and/or flaws are present (veins, fissures etc.) it shall be mentioned in the test report.

Test report

The test report shall contain the following information:

a) unique identification number of the report;

b) the number, title and date of issue of this Rwanda Standard,

c) the name and address of the test laboratory and the address where the test was carried out if different from the test laboratory;

d) the name and address of the client;

e) it is the responsibility of the client to supply the following information:

1) the petrographic name of the stone;
2) the commercial name of the stone;
3) the country and region of extraction;
4) the name of the supplier;
5) the direction of any existing plane of anisotropy (if relevant to the test) to be clearly indicated on the sample or on each specimen by means of two parallel lines;
6) the name of the person or organization which carried out the sampling;
7) the surface finish of the specimens (if relevant to the test);

f) the date of delivery of the sample or of the specimens;

g) the date when the specimens were prepared (if relevant) and the date of testing;

h) the number of specimens in the sample;

i) the dimensions of the specimens;

j) the surface finish of the specimens;

k) the rate of loading in Megapascals per second to the nearest 0,05 MPa/s;

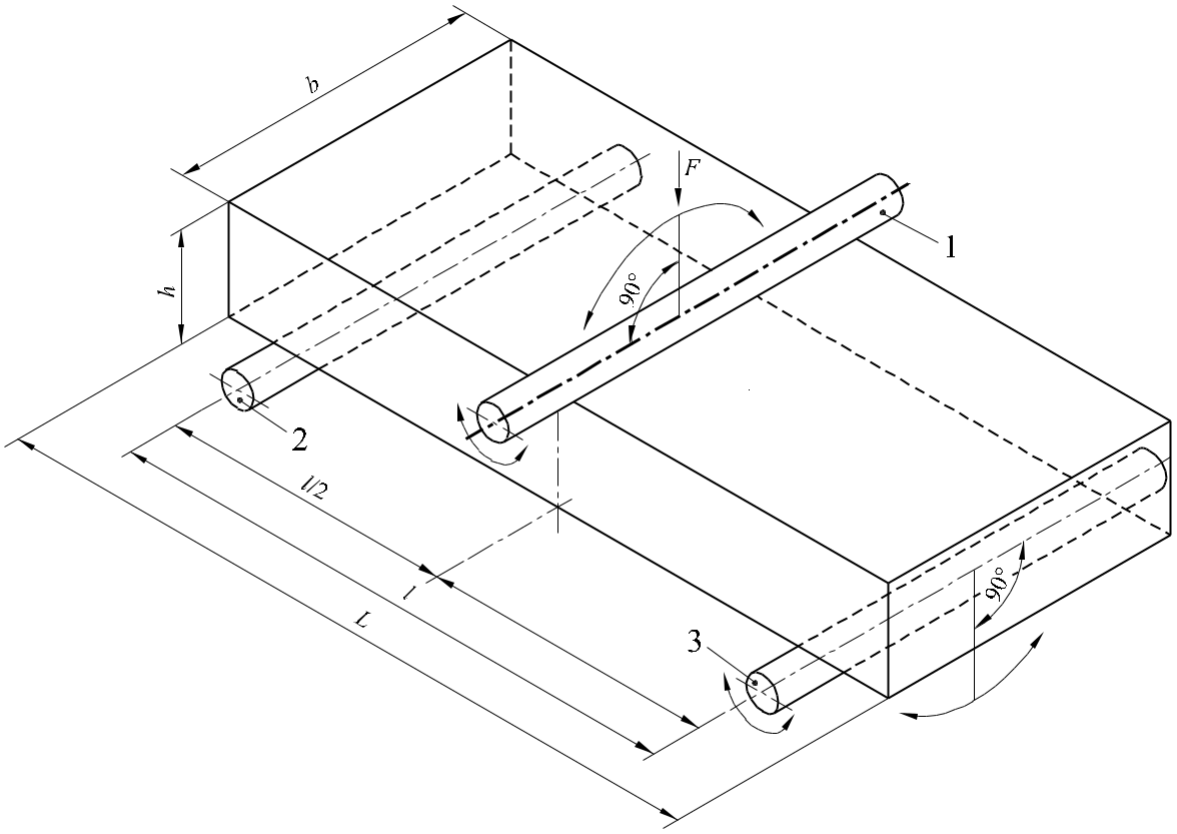
l) for each specimen: the width and thickness adjacent to the fracture plane and the distance between the supporting rollers in millimetres to the nearest 0,1 mm, the orientation of the force relatively to any plane of anisotropy following Figures 2 to 4, the breaking force in newton to the nearest 10 N, the flexural strength in Megapascals to the nearest 0,1 MPa, the location of the fracture and any anomalies observed;

m) for each relevant direction of loading the mean value Rtf of the flexural strength and the standard deviations, in Megapascals to the nearest 0,1 MPa;

n) all deviations from the standard and their justification;

o) remarks.

The test report shall contain the signature(s) and the role(s) of the responsible(s) for the testing and the date of issue of the report. It shall also state that the report shall not be partially reproduced without written consent of the test laboratory.

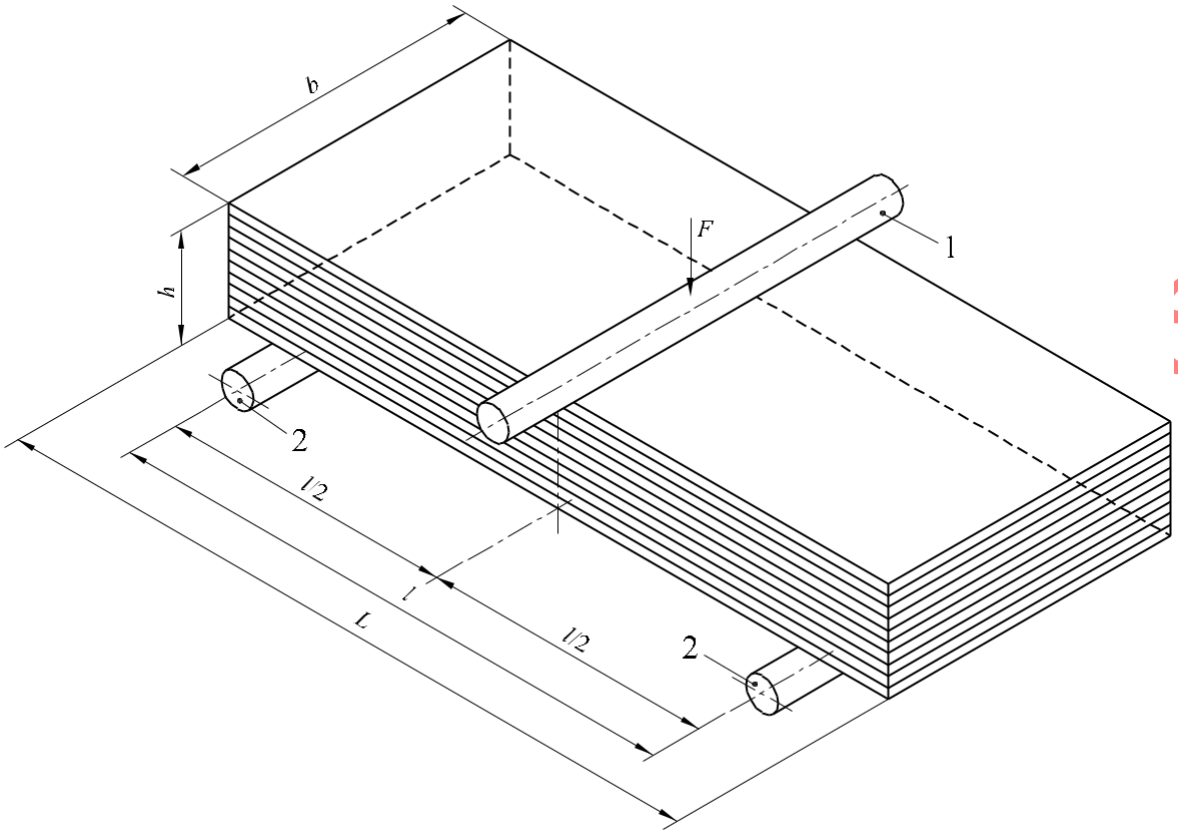


Key

1 loading roller

2 supporting roller

Figure 1 — Arrangement of loading of test specimen (centre point loading)

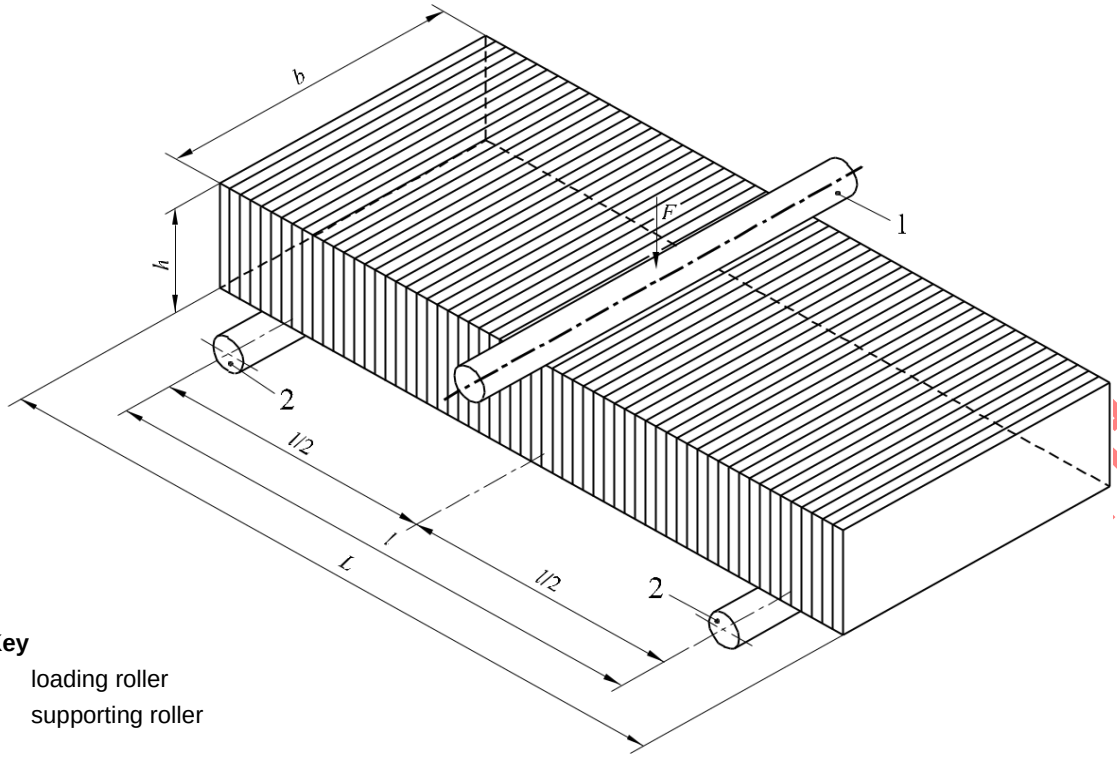


Key

1 loading roller

2 supporting roller

Figure 2 — Test arrangement for a specimen with the load applied perpendicular to the planes of anisotropy

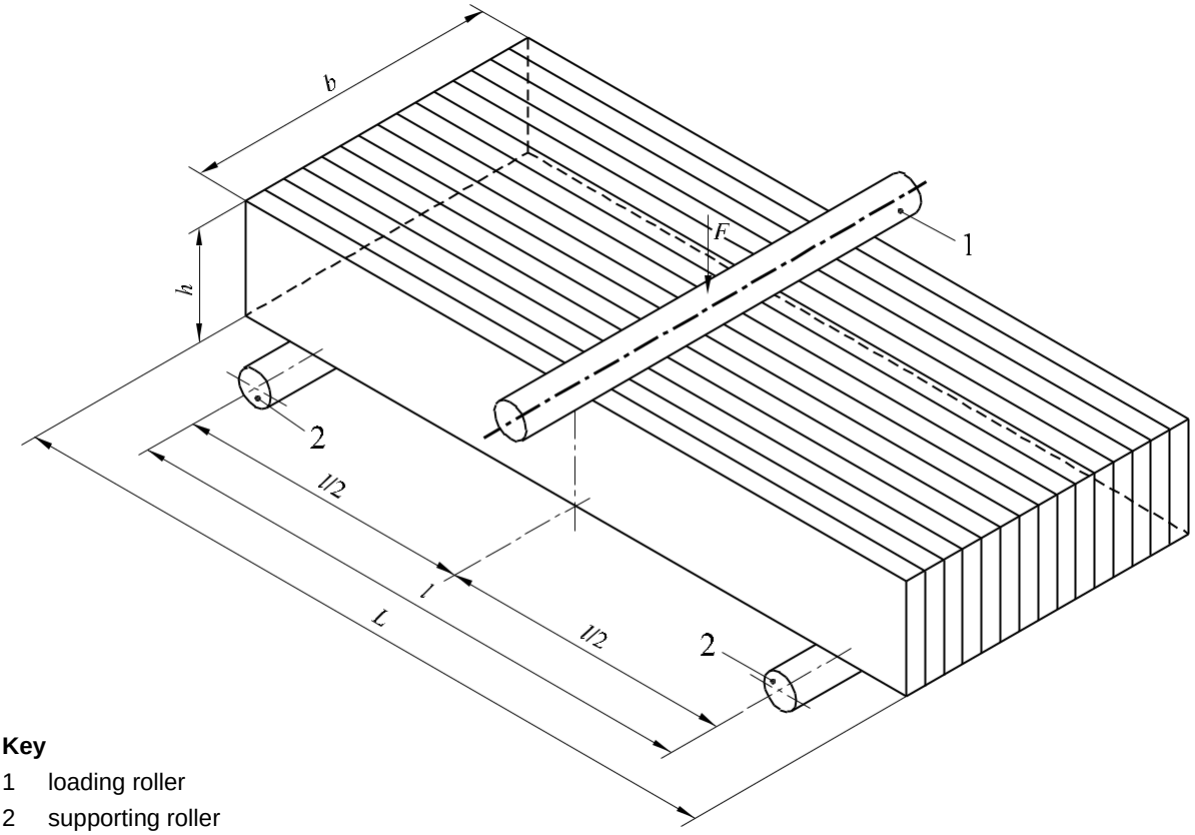


Key

1 loading roller

2 supporting roller

Figure 3 — Test arrangement for a specimen with the load applied parallel to the planes of anisotropy



Key

1 loading roller

2 supporting roller

Figure 4 — Test arrangement for a specimen with the load applied perpendicular to the edges of the planes of anisotropy

Annex C
(informative)

Guidance for test frequencies for designing a FPC system to demonstrate conformity of finished products with the requirements of the standard and the declaration of the manufacturer"

Table C.1 — Checking of finished products

Subject	Purpose of checking	Test method in accordance with b	Frequency of checking by the manufacturer for product range
Dimensions	Conformity with the declared dimensions and the permissible dimensional deviations	DRS 536	— every production lot or — as given in the FPC documentation
Apparent density and open porosity	Conformity with the declared apparent density and open porosity	DRS 547	— every 2 years or — as given in the FPC documentation
Compressive strength	Conformity with the declared compressive strength	RS 144	— at least every 2 years[a] or — as given in the FPC documentation
Flexural strength	Conformity with the declared flexural strength	Annex B of this standard or DRS 539	— every 2 years or — as given in the FPC documentation
Petrographic examination	Conformity with the declared petrographic examination	DRS 527	— every 10 years or — as given in the FPC documentation
Water absorption by capillarity	Conformity with declared value	DRS 525	— every 10 years or — as given in the FPC documentation
Flexural bond strength	Conformity with declared value	Annex B of this standard or DRS 539	— every 10 years or — as given in the FPC documentation
Thermal conductivity	Conformity with declared value	DRS 524	— every 10 years or — as given in the FPC documentation
Water vapour permeability	Conformity with declared value	ISO 12572	upon request or as given in the FPC documentation

Reaction to fire	Conformity with declared value	DRS 540	every 10 years or as given in the FPC documentation

[a] Only for loadbearing. For non-loadbearing, the control frequency is at least every 10 years.

[b] The manufacturer does not necessarily have to declare a value against every property and some may be on the basis of, for example, tabulated values. Where the declared value is from a tabulated value, no testing is required. In these cases, certification can be based on evidence that the tables are being used correctly. The tests should be carried out in accordance with the reference methods mentioned in the standard or by applying alternative test methods with a proven correlation or a safe relationship to the reference methods.

Annex D
(informative)

Declaration of performance (DoP), Marking and Labelling

General

a) the determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product; the factory production control and the testing of samples taken at the factory according to the prescribed test plan, carried out by the manufacturer; and
b) the certificate of conformity of the factory production control, issued by the notified production control certification body on the basis of:
c) initial inspection of the manufacturing plant and of factory production control and
d) continuous surveillance, assessment and evaluation of factory production control.

Content

The DoP shall contain, in particular, the following information:

a) the reference of the product-type for which the declaration of performance has been drawn up;
b) the reference number and date of issue of the harmonized standard which has been used for the assessment of each essential characteristic;
c) where applicable, the reference number of the Specific Technical Documentation used and the requirements with which the manufacturer claims the product complies.
d) the intended use or uses for the construction product, in accordance with the applicable harmonized technical specification;
e) the list of essential characteristics, as determined in the harmonized technical specification for the declared intended use or uses;
f) the performance of at least one of the essential characteristics of the construction product, relevant for the declared intended use or uses;

Marking and labelling

The marking symbol shall be affixed visibly, legibly and indelibly consist of the following:

— to the natural stone masonry unit or

— to a label attached to it.

Where this is not possible or not warranted on account of the nature of the product, it shall be affixed:

— to the packaging or

— to the accompanying documents.

— 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 declared;

— the reference to the harmonized technical specification applied;

— the identification number of the notified body

— the intended use as laid down in the harmonized technical specification applied.

Annex F
(normative)

Determination of flatness of faces of aggregate concrete, manufactured stone and natural masonry units

F.1 Apparatus

Graduated straight edge which is longer than the diagnosis of the long faces of the unit being tested.

Set of feeler gauges capable of measuring with an accuracy to 0.05mm

F.2 Preparation of Specimens

F.2.1 Sampling

The method of sampling shall be stated in the test report. The minimum number of specimens shall be six except in the case of the determination of flatness of bed face where it shall be three, but a larger minimum number may be specified in the product specification, in which case that larger number shall be used.

F.2.2 Surface Treatment

Remove any superfluous material adhering to the unit as a result of the manufacturing process before measuring

F.3 Procedure

F.3.1 Unit surface

Ensure that the masonry unit is positioned in a stable manner prior to measurement. For each face specified as being plane follow the procedures in 5.2 and 5.3. For units specified as being suitable for thin layer masonry carry out the procedure in 5.3 on each bed face.

F.3.2 Measurement of diagonals

For each surface specified as plane, measure the length of the two diagonals with the graduated straight edge (3.1) to the nearest 0,5 mm.

F.3.3 Measurement of deviation

Place the straight edge across each diagonal in turn and use the feeler gauge (3.2) to measure the distance from the face of the masonry unit to the straight edge. Where the face of the masonry unit is concave, measure the greatest distance from the surface of the straight edge to the nearest 0,05 mm. Where the surface of the masonry unit is convex, place the straight edge on it such that the greatest distances to the surface on either side of the point of contact are approximately equal. Measure them both to the nearest 0,05 mm.

F.4 Calculation and expression of results

F.4.1 Calculation of results

For each surface specified as being plane calculate the mean length of the diagonal.

In the case of concave faces calculate the mean deviation from flatness as the mean of the maximum distances of the face of the masonry unit from the straight edge on each diagonal. In the case of convex faces calculate the mean of the maximum distances of the face of the masonry unit from the straight edge for each diagonal and then calculate the mean deviation from flatness as the mean of these two results.

F.4.2 Expression of results

F.4.2.1 Flatness of surfaces specified as being plane

Express the mean length of the diagonal to the nearest millimetre. Express the mean maximum deviation from flatness to the nearest 0,1 mm.

F.4.2.2 Flatness of bed faces

Express the maximum deviation from flatness to the nearest 0,1 mm. Express the mean maximum deviation from flatness to the nearest 0,1 mm.

F.5 Test report

The test report shall contain the following information:

a) the number, title and date of issue of this Standard;
b) the name of the organization that carried out the sampling and the method used;
c) the date of testing;
d) the type, origin and designation of the masonry unit by reference to the relevant part of this standard;
e) the number of specimens in the sample;
f) the date of receipt of the specimens in the testing laboratory;
g) for each surface specified as being plane, the length of the individual diagonals of each face and the mean length of the diagonals to the nearest millimetre;
h) for each surface specified as being plane the maximum distance from the surface of the masonry unit to the straight edge for each diagonal and the mean deviation to the nearest 0.1 mm;
i) for each bed face of units specified as being unsuitable for thin layer masonry the maximum distance from the surface of the masonry unit to the straight edge for each diagonal. The flatness of the bed faces is taken as the largest individual maximum distance from the sample of units expressed to the nearest 0.1 mm;
j) whether the surface of the masonry unit is concave or convex or any other configuration;
k) remarks, if any.

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