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Setts of natural stone for external paving —Requirements and test methods Specification for stabilized soil blocks

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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 521 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 standard:

BS EN 1342:2012 Setts of natural stone for external paving — Requirements and test methods

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.

Enabel Rwanda

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

Integrated Polytechnic Regional Centre (IPRC) — Musanze

Rwanda Housing Authority

Road Transport Development Agency (RTDA)

Rwanda Inspectorate, Competition and Consumer Protection Authority (RICA)

Mass Design Group

Rwanda Quarries Association (RQA)

St Joseph Engineering Company (SJEC) Ltd

Standards for Sustainability (SfS)

Africeramics Ltd

SKAT Consult

A+ Construction Group Ltd

Consultants Engineers Group (CEG) Ltd

D&D Resources Ltd

Dutureheza Ltd

Stonecraft Industries Ltd

Greenpack Africa Ltd

NP Construction Company (NPCC) Ltd

Rwanda Standards Board (RSB) – Secretariat

Rwanda Standards Board (RSB) – Secretariat

Setts of natural stone for externa paving — Requirements and test methods Specification for stabilized soil blocks

1 Scope

This Standard specifies the performance requirements, sampling and the corresponding test methods for all natural stone sets used for external paving and road finishes.

External paving use includes all pavements typical of road works, such as pedestrian and trafficked areas, outdoor squares and similar to be used in an outdoor condition that are subject to the weathering agents, such as temperature changes, rain, wind, etc.

This Standard provides also for the evaluation of conformity and for marking of the natural stone setts.

This Standard also covers characteristics that are of importance to the trade.

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

DRS 515, Natural stone – Terminology

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

DRS 528, Natural stone — Denomination criteria

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

DRS 532, Natural stone test methods — Determination of the abrasion resistance

DRS 534, Natural stone test methods — Determination of the slip resistance by means of the pendulum tester

DRS 537, Natural stone test methods — Determination of uniaxial compressive strength

DRS 550, Natural stone test methods — Determination of water absorption at atmospheric pressure

3 Terms and definitions

For the purposes of this document, the terms and definitions given in DRS 515 and the following apply.

3.1

sett

unit of natural stone obtained by cutting or splitting used as a paving material, in which the working width does not exceed two times the thickness, and the length does not exceed two times the width

Note 1 to entry: The minimum working thickness is 40 mm

3.2

work dimension

dimension of a sett specified for its manufacture to which the actual dimension should conform within specified permissible tolerances

3.3

actual dimension

dimension of a sett as measured

3.4

overall length L

longer side of the rectangle with the smallest length able to enclose the sett

3.5

overall width W

shorter side of the rectangle with the smallest area able to enclose the sett

3.6 thickness T

distance between the upper face and the bedface of the sett

3.7

upper face

surface of a sett intended to be seen when in use

3.8

bed face

surface of a sett intended to be in contact with the bedding material when in use

3.9

side face

surface of a sett intended to be vertical when in use

3.10

textured

sett with a surface finish produced by secondary processing, from a saw or hewn surface

3.11

fine textured

surface finish with a maximum difference of 1,0 mm between peaks and depressions (for example polished, honed or sawn with a diamond disc or blade)

3.12

coarse textured

surface finish with more than 1,0 mm difference between peaks and depressions (for example dolly pointed, shot blasted or flame textured)

3.13

hewn

sett with a rough surface finish, for example a riven or split face

3.14

lower expected value

EL

value which corresponds to the 5 %-quantile of a logarithmic normal distribution for a confidence level of 75 %

3.15

higher expected value

EH

value which corresponds to the 95 %-quantile of a logarithmic normal distribution for a confidence level of 75 %

4 Requirements

4.1 General

4.1.1 Denomination

The denomination shall always be declared in accordance with DRS 528. The denomination shall include traditional name, petrological family, typical colour and place of origin as precisely as possible for example geo coordinates.

4.1.2 Alteration of physical properties of the natural stone

If during production the natural stone setts have been subjected to a treatment process that physically alters the properties of the stone (for example chemical treatment, patching, or filling or other similar products for natural holes, faults or cracks) then the use of such a treatment shall be stated.

In addition, specimens for testing shall be representative of the product and any processes that the stone is subjected to.

4.2 Dimensions

4.2.1 General

4.2.1.1 The work dimensions of the setts shall be declared.

Dimensions between faces shall be stated as a unitary nominal dimension or as a range of nominal minimum-maximum dimensions, e.g. (100 - 200) mm.

Dimensions of each shall be measured in accordance with DRS 530.

4.2.2 Tolerances

4.2.2.1 Plan dimensions and thickness

Plan dimensions and thickness of a sett shall be measured in accordance with 5.2 and 5.3 of DRS 530 and the deviations from the declared plan dimensions and thickness shall conform to tolerances given in Table 1.

Different deviations may be declared for plan dimensions and thickness.

Unless stated otherwise, a consignment of setts shall be intended to be laid in rectilinear patterns and all setts within a consignment, when measured in accordance with DRS 530, 5.4, shall conform with the tolerances from the plan and thickness dimensions described in Table 1.

Table 1 — Tolerances on nominal plan dimensions and thickness

Nominal dimension		Class 0	Class 1	Class 2
≤ 60 mm	Textured	No requirements	± 7 mm	± 5 mm
	Hewn		± 10 mm	± 7 mm
> 60 mm ≤ 120 mm	Textured		± 10 mm	± 5 mm
	Hewn		± 15 mm	± 10 mm
> 120 mm	Textured		± 10 mm	± 7 mm
	Hewn		± 15 mm	± 12 mm

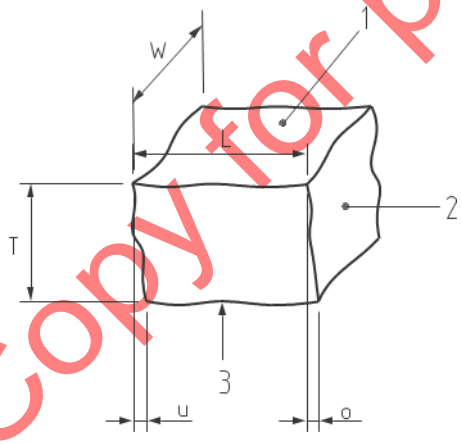
Where a consignment of setts is specifically designated for being laid in radial or arch patterns then it may include a proportion of the total agreed by the specifier, that are bigger, smaller and trapezoidal setts not varying from the dimensions allowed by the stated tolerance by more than 10 %.

When dimensions between faces are declared as a range of nominal minimum – maximum thickness, the deviation shall be declared on the limits of the range. This is particularly applicable to hewn setts.

In all cases the thickness of the setts shall be observed.

4.2.2.2 Undercut of sides

When measured in accordance with DRS 530, 5.5, deviations of the undercut of a side shall not exceed the tolerances given in Table 2 with respect to the perpendicularity of the upper face (see Figure 1).



Key

1 = upper face

2 = side face

3 = bed face

u = undercut of side face o = overcut of side face

T = thickness

W = overall width

Figure 1 — Tolerances on under and overcut faces

Table 2 Tolerances on the undercut of sides

Nominal Dimension	Class 0	Class 1		Class 2	
	No requirement	Maximum one side	Maximum sum	Maximum one side	Maximum sum
≤60 mm		10 mm	20 mm	5 mm	10 mm
>60 mm		15 mm	25 mm	10 mm	15 mm
>120 mm		25 mm	30 mm	15 mm	20 mm

4.2.2.3 Hewn and coarse textured face irregularities

When measured in accordance with DRS 530, deviations of upper and side face cavity and protrusions shall not exceed the tolerances given in Table 3.

Table 3 — Tolerances on hewn and coarse textured face irregularities

	Class 0	Class 1	Class 2
Hewn	No Requirements	± 10 mm	± 5 mm
Coarse Textured		± 5 mm	± 3 mm

4.3 Breaking strength Compressive strength

The compressive strength shall be determined using the test method in DRS 537 and the lower expected value (EL) shall be declared.

4.4 Abrasion resistance

The abrasion resistance shall be determined using the test method in DRS 532 and the higher expected value (EH) shall be declared.

4.5 Slip and skid resistance

4.5.1 Slip resistance

The slip resistance shall be declared when the intended use of the setts is subject to regulatory requirements, or upon request, and, in any case, when the roughness of the surface, measured following DRS 530, 5.3, is less than 1,0 mm.

The slip resistance shall be determined and the results expressed in accordance with the test procedure for both wet conditions in DRS 534.

Coarse textured and hewn setts are assumed to give satisfactory slip resistance. They cannot be reliably tested.

It should also be noted that the performance of setts when laid may have a different slip resistance value to that determined on individual setts or test specimens.

NOTE 1 The unpolished slip resistance value relates to setts as manufactured and helps to ensure adequate slip/skid resistance on installation.

NOTE 2 Experience has indicated that a USRV measurement made using a wide slider / full swing on a pendulum in wet conditions that is greater than 35 can usually be considered acceptable for surfaces that are horizontal or sloping at less than 6 %.

4.5.2 Skid resistance

Where required, skid resistance shall be tested and declared in accordance with national standard.

4.5.3 Durability of slip or skid resistance

When required, durability of slip and skid resistance shall be tested and declared in accordance with national standard.

4.6 Appearance

4.6.1 General

The colour, veining, texture, etc. of the stone shall be identified visually, typically by a reference sample of the same stone suitable for providing a general description of visual appearance.

A reference sample shall be provided by the supplier in accordance with 4.7.2.

4.6.2 Reference sample, visual inspection and acceptance criteria

A reference sample shall be an adequate number of setts of natural stone of sufficient size to indicate the general appearance of the finished work. They shall indicate the range of appearance regarding the colouring, the vein pattern, the physical structure and the surface finish. In particular the reference sample shall show

specific characteristics of the stone, such as specific holes, glass seams, spots, crystalline veins and rusty spots.

The reference samples does not imply strict uniformity between the sample itself and the actual supply; natural variations may always occur.

If the processing of the stone involves the use of patching, fillers or other similar products for natural holes, faults or cracks, then the reference sample shall similarly display the impact of the same on the finished surface.

All the characteristics as shown by the reference sample shall be considered typical of the stone and not as flaws, therefore they shall not become a reason for rejection, unless their concentration becomes excessive and the typical character of the stone is lost.

The name and address of the manufacturer or the supplier of the stone, as well as the denomination of the stone in accordance with 4.1 and/or information on the treatment in accordance with 4.1.2, above, shall be indicated on the reference sample.

Any comparison between production sample and reference sample shall be carried out by placing the reference sample against the production samples and viewing them at a distance of about 2 m under normal daylight conditions and recording any visible differences in the characteristics of the stones.

4.7 Water absorption

Where required the water absorption shall be determined using the test method in DRS 550 and the higher expected value (EH) shall be declared.

Apparent density and open porosity

The apparent density and open porosity shall be determined using the test method in DRS 526 and the mean values declared.

4.8 Petrographic description

A petrographic description shall be provided, including a petrographic name, of the stone type, in accordance with DRS 527.

4.9 Dangerous substances

No dangerous substances shall be used. Any substances used shall meet relevant national standards and applicable regulatory requirements.

5 Evaluation of conformity

5.1 General

The conformity of the product (i.e. natural stone setts) to the requirements of this standard and with the declared performances (e.g. values, classes) for the characteristics relevant for the intended use of the product, shall be demonstrated by:

a) initial type testing,

b) factory production control by the manufacturer, including product assessment.

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

A product may be in more than one family for different characteristics.

5.2 Initial type testing (ITT) and Type testing (TT)

Initial type testing and type tests, if any, shall be performed for all characteristics included in this standard for which the performances are to be declared:

1) when a new product type is developed (and before it is placed on the market) or

2) at the beginning of a new or modified method of production where this may affect the declared performances.

The declared performances should be representative of the current production, e.g. the lower expected value in normal production.

Whenever a significant change occurs in the raw material or the production process, which could change any of the declared performance of the product, this shall be considered as a new product and any of such characteristic shall be re-assessed for a new declared performance.

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

All essential characteristics, given in bold in Table 4, for which the manufacturer declares performances, are subject to Initial Type Testing.

In addition, the need to perform Type Tests applies to all other characteristics included in Table 4, when the manufacturer claims compliance, unless the standard gives provisions (e.g. use of previously existing data, CWFT and conventionally accepted performance) for declaring performances without performing tests.

Initial type testing of the product, as given in Table 4, shall be carried out on:

1) first application of this document or at the beginning of the production with a new type of stone;

2) when significant variations occur in the material, determined visually or by significant changes in FPC results.

Tests previously performed in accordance with the provisions of this document (i.e. same type of stone, same characteristic measured with the same test method, same sampling procedure and system of attestation of conformity) may be taken into account for the purpose of ITT.

Table 4 — Characteristics of natural stone setts for paving for initial type testing and type tests

Requirements Subclause	Characteristics (properties)	Test method in accordance with:	Expression of results
4.4	Breaking strength - Compressive strength	DRS 537	Declared value
4.6.1	Slipperiness - Slip resistance	DRS 534	Declared value
4.6.2	Skid resistance	See 4.6.2	Declared value
4.6.3	Durability of slip resistance	See 4.6.3	Declared value
4.6.3	Durability of skid resistance		Declared value
4.2.2.1	Tolerances – Plan dimensions	DRS 530, 5.2	Tables 1 and 2
4.2.2.1	Tolerances – Thickness	DRS 530, 5.2	Table 3
4.2.2.2	Tolerances – Face irregularities	DRS 530, 5.3	4.2.2.3
4.2.2.2	Tolerances - Undercuts	DRS 530, 5.5	Table 4
4.5	Abrasion resistance		Declared value
4.8	Water absorption	DRS 550	Declared value
4.9	Apparent density and open porosity	DRS 526	Declared values
4.10	Petrographic description	DRS 527	Declared description
4.11	Dangerous substances	See 4.11	Declared value or class, as relevant

Assessment of compliance should be undertaken using the same method (identification or technological).

The declared performances may be supported by a test report supplied with the block or raw slabs provided that test have been performed according to the requirements and test methods of this Standard.

The results of the selected tests shall be expressed as referred to in Clause 4.

5.3 Factory Production Control

5.3.1 A factory production control system (FPC) shall be established and documented. The factory production control system shall consist of procedures for the internal control of production. The results of the tests carried out during FPC shall demonstrate that products placed on the market conform to this document and with the declared performances of the product's characteristics, established under ITT in accordance with Clause 4.

In cases when the processing of the natural stone is likely to change any of these declared performances, relative to the initial stone (e.g. as a consequence of the type of processing or because the physical properties

have been modified by impregnation, use of patching, fillers or other similar products for natural holes, faults, cracks and similar), then this shall be considered within FPC as requested by this document.

5.3.2 The factory production control shall consist of regular inspection checks and tests and the utilisation of the results to control incoming materials (i.e. stone), equipment, the production process and the product.

When alternative tests to the reference tests are used for the test procedure, their correlation to the reference test shall be determined and available for inspection.

All test equipment shall be calibrated and the procedure, frequency and acceptance criteria stated.

5.3.3 A sampling plan for the testing of products shall be defined and the results shall be recorded and available for inspection.

NOTE Guidance on sampling is given in Annex B.

5.3.4 The stock control of the products, together with procedures for dealing with non-conforming products, shall be detailed.

5.3.5 Manufacturers' records shall include at least the following:

a) identification of the product tested;

b) information on sampling:

1) place and date of sampling;

2) identification of the production lot sampled;

3) frequencies of sampling;

4) size and number of samples;

c) test methods applied;

d) test and inspection results;

e) calibration records of apparatus.

5.3.6 Any testing procedure (reference or alternative tests) adopted for the FPC shall include the relevant acceptance criteria. In case of non compliance, a specific action plan shall be defined as part of the FPC. As a rule this plan shall include the repetition of the FPC procedure on an extended quantity of specimens or of products. In cases when the results of these tests do not conform with the declared performances, final assessment of compliance shall be provided adopting the same test method (identification or technological) as used in determination of declared performances and making reference to Table 5.

Table 5 — Characteristics of natural stone setts for paving for factory production control

Requirements Subclause	Characteristics (properties)	Verification during production	Test method in accordance with:	Minimum testing frequency (see 1) and 3) below)	Acceptance criteria
4.2.1	Dimensions	Continuous verification in accordance with manufacturer's factory production control (see 2) below)	DRS 530	Each lot	Within the tolerance range [a]
4.2.2.1	Tolerances – Plan dimensions		EN DRS 530, 5.2		
4.2.2.2	Tolerances – Thickness		DRS 530, 5.2		
4.2.2.3	Tolerances – Face irregularities		DRS 530, 5.3		
	Tolerances - Undercuts		DRS 530, 5.5		
4.4	Compressive strength		DRS 537	Every 2 years [b]	> 80 % of the individual results >declared value
4.8	Water absorption		DRS 550		> 80 % of the individual results >declared value
4.9	Apparent density and open porosity		DRS 526		No requirement
4.5	Abrasion resistance		DRS 532		> 80 % of the individual results <declared value
4.6.1	Slip resistance		DRS 534		≥ declared value
4.6.2	Skid resistance		See 4.6.2		≥ declared value
4.6.3	Durability of slip resistance Durability of skid resistance		See 4.6.3		≥ declared value ≥ declared value
4.10	Petrographic description		DRS 527		Complies with declared description
4.11	Dangerous substances		See 4.11		Individual results complying with
					declared value or class

1) The testing frequency should be established so that it represents a means to
of product's performance and a reliable declaration for both the users and the manufacturer.

2) The indirect test/check method(s), which is to be detailed in the manufacturer's quality control plan for the parameter(s), set up under ITT, if any, and related to the performance of such characteristic (e.g. incoming materials, composition).	
3) In cases product relative to the initial material (e.g. as a consequence of the type of processing or because the use of patching, fillers or other similar products for natural holes, faults, cracks and similar), then this has to be considered in determining the frequency of testing.	
[a] Usually referred to in the requirements subclause.	
[b] These represent the upper limits of the testing frequency (see 1)).	

6 Marking, labelling and packaging

As a minimum of identification, each consignment of natural stone setts shall carry the following indications:

a) the denomination of the natural stone in accordance with DRS 528 (see 4.1.1);

b) quantities and dimensions of the setts. Additional information is advisable:

c) the mass of the setts;

d) dimensions and mass of packaging.

These indications shall be given on labels, packaging or on accompanying documents.

An identification system may be used in order to identify individual setts; in such a case individual stones shall be clearly marked accordingly. Marking will usually consist of alphanumeric codes and symbols (e.g. to define proper orientation at installation).

The setts shall be clean before packaging.

Packaging shall allow adequate, solid and durable protection for packed stones, both during transport and during handling and storage. Movement of setts inside the packaging shall be prevented by securing individual pieces.

Packaging shall be of appropriate mass and size in consideration of transportation and lifting facilities; the top and bottom of the packaging as well as stacking possibility shall be indicated.

Safety against contamination, caused by packaging materials, in wet or dry conditions, shall be ensured. Packaging and tapes which are likely to stain shall not be used. Sensitive polished surfaces of the setts shall be protected by appropriate means (e.g. plastic foil). Products with caustic properties shall not be used.

Annex A
(normative)

Guidance on sampling

A.1 General

The annex specifies guidelines for methods for obtaining samples of natural stone from quarries, plants and construction works. Sampling from buildings may be necessary if the delivered natural stone slab is already applied in construction works.

The aim of sampling is to obtain a bulk sample that is representative of the average properties of the batch and of its variability.

The methods described are based on manual procedures. The methods described are limited to building and civil engineering purposes.

It is important that samplers are accordingly trained in the application of the methods set out in this Standard.

In case of dispute or if tests are to be done by more than one organisation, all interested parties should have the opportunity to observe the sampling and should agree upon the number of sampling increments to be taken.

A.2 Principles of sampling

Proper and careful sampling and sample transport is a prerequisite for an analysis to expect reliable results. An adequate number of samples have to be taken to obtain a good estimation of the natural heterogeneity of the batch.

The sampler shall be informed of the aim of the sampling.

A.3 Taking bulk samples

The number and sizes of samples shall depend on the test methods for which they are taken. The number and shapes of specimens required are given in the relevant test methods.

A.4 Preparing a sampling plan

A sampling plan shall be prepared, prior to sampling, taking into account the following:

type of natural stone (following DRS 528 and DRS 515);

aim of the sampling, including a list of the properties to be tested;

identification of sampling points;

orientation of samples relative to resource or bed, etc;

approximate size of samples;

number of samples;

sampling apparatus to be used;

methods of sampling;

marking, packaging and dispatch of the samples.

A.5 Sampling apparatus

Any suitable cutting equipment for natural stone may be used for sampling. In addition, drills, which are suitable for taking drill cores, may be used.

A.6 Sampling methods

A.6.1 General

The sampling methods will inevitably involve the samplers working at a quarry, plant or building. Standards for safety and ergonomics shall be followed.

A.6.2 Sampling from quarries

A.6.2.1 General

The main objective of sampling from such deposits is to establish, where possible, the average, the range of variations and the differences in the structure and properties of the rock, taking account of the fabric and geological structure and the anticipated mining conditions.

A.6.2.2 Sampling of solid rock

a) Identification of anisotropy and orientation of samples

If the exploratory work reveals a pronounced fabric or geological structure which is not necessarily visible at the sample scale (e.g. stratification, massive bedding, lamination, cleavage or rift), the sample shall be marked accordingly.

b) Sampling for petrographic analysis

For petrographic analysis, hand specimens shall be taken from all distinct types and varieties which characterise the rock in terms of mineral composition, fabric and geological structure.

Samples from drilling (cores and pieces) may also be used.

In addition to samples of fresh material, samples shall also be taken to illustrate the effects of weathering.

c) Sampling for physical testing

For physical testing, sample blocks and hand specimens shall be used as samples, their number and location depending on the results of the petrographic analysis and the test methods required.

The sample blocks shall measure approximately 0,40 m x 0,25 m x 0,25 m, or more where a coarse-grained and/or a large-pored rock is to be sampled.

The sample blocks shall be broken as carefully as possible. It is recommended that they are taken from larger natural stones which have been least affected by blasting. Care shall be taken to ensure that neither the sample blocks nor the hand specimens show any hairline cracks resulting from the removal process.

Samples may also be cut from rough blocks, slabs or dimension stones, the number and size of samples depending on the particular test method.

A.6.3 Sampling from production units and consignments

A representative sample of adequate size and characteristic of the rock in terms of mineral composition, fabric and geological structure, shall be taken from the material to be tested (e.g. setts, dimension stones), taking into account the intended use of the material.

A.6.4 Sampling from construction works

Sampling points should be selected according to the rules for obtaining a representative sample taking into consideration any differences in properties visible to the naked eye. Where necessary, taking a single slab to assess the mechanical properties of slabs, should be sufficient.

The location of the sample in the construction works shall be reported.

A.7 Marking, packaging and dispatch of the samples

The samples or containers shall be clearly and durably marked. Marking shall include:

a) unique code; or

b) identification of the laboratory samples, place of sampling, date of sampling and denomination of the material.

The laboratory samples shall be packed and transported in such a way that they are protected from damage.

A.8 A.8 Sampling report

A.8.1 The sampler shall prepare a sampling report for each laboratory sample or for each group of laboratory samples from a single source. The sampling report shall refer to this document and state:

d) sampling report identification (serial number);

e) laboratory sample identification mark(s);

f) date and place of sampling;

g) sampling point or identification of the batch sampled;

h) reference to the sampling plan prepared according to A.4;

i) name of the sampler(s).

A.8.2 Depending on the circumstances, other information might be relevant. Table A.1 shows an example of a comprehensive sampling report.

Table A.1 Example of a sampling report

Sampling report identification (serial n°):	
Laboratory sample identification mark:	no. of package

Description of the natural stone and sampling places

Name of the quarry or production plant or building:
Name of producer:
Origin of batch:
Purpose for which the natural stone is to be used:
Location of sampling point(s):
Identification of the batch:
Size of the batch:
Other comments (e. g. warnings, if appropriate):

Description of the sampling method

Date and time of sampling:
Reference to sampling plan used:
Sampling procedure (drilling, cutting, etc.):
Purpose of the sampling:

Samples

No. and dimensions of samples:
Other comments:
Dispatch of the samples:
Sampler(s) (print name):

Contract details

Contract identification:
Name and address of party requesting the sampling:…….. ……
Name of person(s) present at sampling:…… ……
Signatures:…… …… ……

Annex B
(informative)

Example of calculation of Lower Expected Value

B.1 Scope

This annex establishes a method for the lower expected value (EL).

Symbols and definitions
test method described in this standard.

B.2 Symbols and definitions

Measured values	$x_1, x_2, \ldots x_i \ldots, x_n$
Number of measured values	n
Mean value	$\bar{x}_1 = \frac{1}{n}\sum_i x$
Standard deviation	$\bar{s}_1 = \mp\sqrt{\frac{\sum(x_i-\bar{x})^2}{n-1}}$
Coefficient of variation	$V = \frac{s}{x}$, (for individual values)
Logarithmic mean	$\bar{x}_{ln} = \frac{1}{n}\sum_i lnx_i$
Logarithmic standard deviation	$\bar{s}_{ln} = \mp\sqrt{\frac{\sum(lnx_i-\bar{x}_{ln})^2}{n-1}}$
Maximum value Max	Max
Minimum value Min	Min
Lower expected value	$E = e^{(\bar{x}_{ln}-(k_s * s_{ln}))}$, where ks (quantile factor) is given in Table A.1
Quantile factor	k_s see Table A.1

B.3 B.3 Calculation of Lower Expected Value

For the calculation of the lower expected value (EL) a logarithmic normal distribution is assumed. The lower expected value (EL) corresponds to the 5 % quantile of a logarithmic normal distribution for a confidence level of 75 %.

Table B.1— Quantile factor (k_S) in dependence on the number of measured values (n) in correspondence to the 5 % quantile for a confidence level of 75 %

n	k_s
3	3,15
4	2,68
5	2,46
6	2,34
7	2,25
8	2,19
9	2,14
10	2,10
15	1,99
20	1,93
30	1,87
40	1,83
50	1,81
∞	1,64

Quantile factor (ks) dependent on the number of measured values (n) in correspondence to the 5 % quantile for a confidence level of 75 %.

The following examples should help to clarify the method:

EXAMPLE 1

Calculation of mean value, standard deviation, maximum value and minimum value of six measured values

Table B.2 Calculation of mean and standard deviation

Measurement no	Measured value *x*
1	2 000
2	2 150
3	2 200
4	2 300
5	2 350
6	2 400

Mean value	2 333
Standard deviation	147
Maximum value	2 400
Minimum value	2 000

EXAMPLE 2

Calculation of mean value, standard deviation, coefficient of variation and lower expected value of 10 measured values

Table B.3 Calculation of lower expected value

Measurement no	Measured value *x*	(ln *x*)
1	2 000	(7,60)
2	2 150	(7,67)
3	2 200	(7,70)
4	2 300	(7,74)
5	2 350	(7,76)
6	2 400	(7,78)
7	2 600	(7,86)
8	2 750	(7,92)
9	2 900	(7,97)
10	3 150	(8,06)
	---------	---------
Mean value	2 480	(7,807)
Standard deviation	363	(0,143)
Variation coefficient	0,15	

From Table B.1 for: n = 10 ks = 2,1 and the Lower expected value 1 819

Bibliography

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