



**RWANDA
STANDARD**

**DRS
529**

First edition

2023-mm-dd

**Natural stone test methods —
Determination of the breaking load at
dowel hole**

ICS 91.100.15

Reference number

DRS 529: 2023

© RSB 2023

In order to match with technological development and to keep continuous progress in industries, standards are subject to periodic review. Users shall ascertain that they are in possession of the latest edition

© RSB^{yyyy}

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without prior written permission from RSB.

Requests for permission to reproduce this document should be addressed to:

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

Contents	Page
Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principal	1
5 Symbols (and abbreviated terms)	1
6 Apparatus	2
7 Preparation of the specimens	2
7.1 Sampling and position of bedding	2
7.2 Test specimens	2
7.2.1 General	2
7.2.2 Number of specimens	2
7.2.3 Surface finish of the specimens	5
7.2.4 Dimensions of the specimens	6
7.2.5 Location of the holes	6
7.2.6 Dimensions and tolerances of the holes	6
7.2.7 Drilling the holes	7
7.2.8 Planes of anisotropy	7
7.2.9 Conditioning	7
7.2.10 Measuring d and d_1	7
8 Dowels	7
8.1 Dimensions and tolerances	7
8.2 Material	8
8.3 Placing the dowels	8
9 Test procedure	8
10 Expression of the results	9
11 Test report	9
Annex A (normative) Statistical evaluation of the test results	11
A.1 Scope	11
A.2 Symbols and definitions	11
A.3 Statistical evaluation of test results	12

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.

DRS529 was prepared by Technical Committee RSB/TC 529, *Civil engineering and building materials*.

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

BS EN 13364:2002, Natural stone test methods — Determination of the breaking load at dowel hole

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

Mass Design Group

NP Construction Company (NPCC) Ltd

Road Transport Development Agency (RTDA)

Rwanda Housing Authority (RHA)

Rwanda Inspectorate, Competition and Consumer Protection Authority (RICA)

Rwanda Quarries Association (RQA)

SKAT Consult

St Joseph Engineering Company (SJEC) Ltd

Standards for Sustainability (SfS)

Stonecraft Industries Ltd

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

Rwanda Standards Board (RSB) – Secretariat

Copy for public comments

Copy for public comments

Natural stone test methods — Determination of water absorption coefficient by capillarity

1 Scope

This draft Rwanda standard specifies a test method to determine the breaking load at the dowel hole of natural stones used for cladding or lining in building.

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 EAS 18-1, Cement — Part 1: Composition, specifications and conformity criteria for common cements.

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in DRS 515 and RS EAS 18-1 apply.

4 Principal

This test consists of applying a force in a direction perpendicular to the face of a specimen through a dowel previously placed in an hole drilled in one of its sides and measuring the breaking load of the specimen.

5 Symbols (and abbreviated terms)

d is the thickness of the test specimen, in millimetres

d_1 is the distance from the hole wall to the face where fracture occurs, in millimetres

b_A is the maximum distance of the centre of the hole to the fracture edge on the face, in millimetres

F is the individual breaking load, in newtons

$\overline{d_1}$ is the mean value of d_1 , in millimetres

6 Apparatus

- 5.1 A balance capable of weighing the specimens with an accuracy of 0,01 % of their mass.
- 5.2 A ventilated oven capable of maintaining a temperature of (70 ± 5) °C.
- 5.3 A linear measuring device with an accuracy of 0,05 mm.
- 5.4 A rotary drilling machine equipped with a diamond or tungsten carbide tipped bit.
- 5.5 A testing machine of appropriate force in accordance with EN 12390-4 and calibrated according to this standard.
- 5.6 A clamping device consisting of two metal plates having the shape and sizes shown in Figure 1.
- 5.7 A device for applying loads perpendicular to the axis of the dowel (see Figure 2).
- 5.8 A room or chamber in which the temperature of the air can be maintained at (20 ± 5) °C.

7 Preparation of the specimens

7.1 Sampling and position of bedding

The sampling is not the responsibility of the test laboratory except where specially requested.

The position of any bedding or anisotropy shall be indicated on each specimen by means of at least two parallel lines.

7.2 Test specimens

7.2.1 General

The test can be carried out as an identification test or as a technological test.

Identification tests are tests carried out when the use of the stone with respect to the position of the planes of anisotropy and the thickness and surface finish of the elements in the cladding are not known.

Technological tests are those carried out when the use of the stone with respect to the position of the planes of anisotropy and the thickness and surface finish of the elements in the cladding are known. In this case the major faces of the specimens shall have the same orientation of the face that will be loaded during use.

7.2.2 Number of specimens

The minimum number of test specimens depends on the presence of planes of anisotropy.

If the stone does not show planes of anisotropy 10 tests of Type 0 (see Figure 3) shall be made on three specimens.

If the stone shows planes of anisotropy:

- 10 tests of Type I (see Figure 4) shall be made on three specimens cut parallel to the planes of anisotropy;
- 10 tests of Type IIa (see Figure 5) and 10 tests of Type IIb (see Figure 6) shall be made on five specimens cut perpendicular to the planes of anisotropy.

a) General view

b) Detail of a plate suitable for tests on specimens having dimensions of 200 mm × 200 mm

Dimensions in millimetres

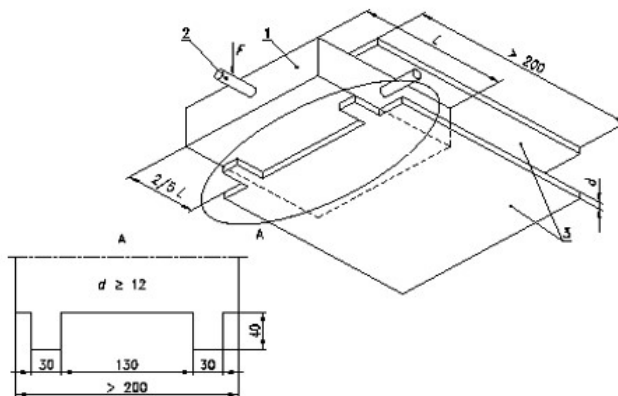
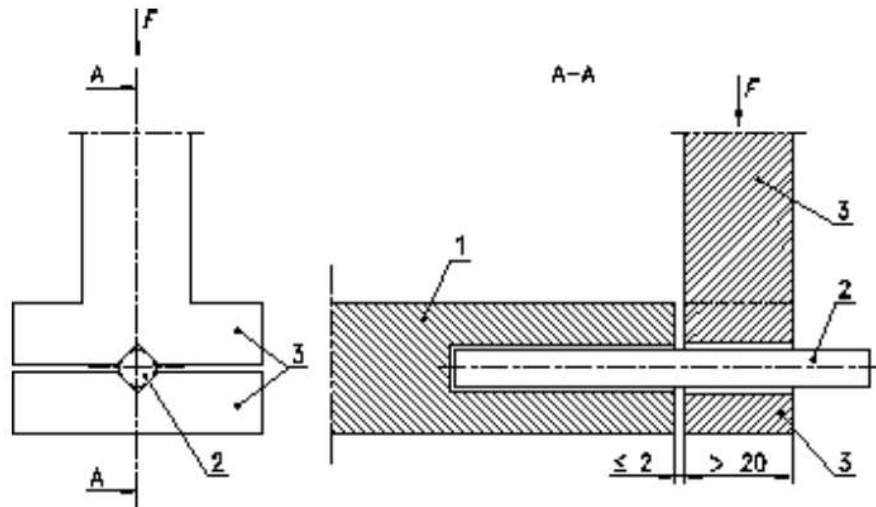


Figure 1 — Clamping device to hold the specimen in place Dimensions in millimetres

Key

1. Specimen
2. Dowel
3. Metal plate
4. Force applied on the specimen
5. Length of the specimen
6. Thickness of the metal plate

Dimensions in millimetres



Key

- 1 Specimen
- 2 Dowel
- 3 Device for applying load
- F* Force applied on the specimen

Figure 2 — Device for applying loads perpendicular to the axis of the dowel

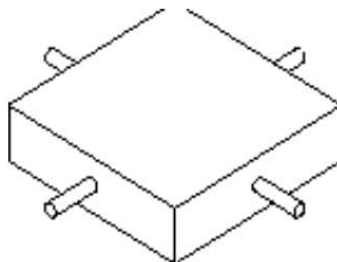


Figure 3 — Test arrangement for a specimen without planes of anisotropy (Type 0)

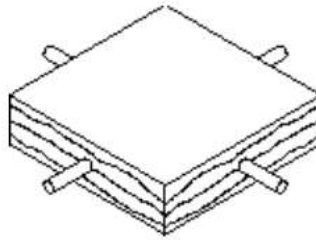


Figure 4 — Test arrangement for a specimen with the load applied perpendicular to the planes of anisotropy (Type I)

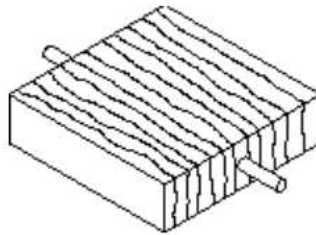


Figure 5 — Test arrangement for a specimen with the load applied parallel to the planes of anisotropy (Type IIa)

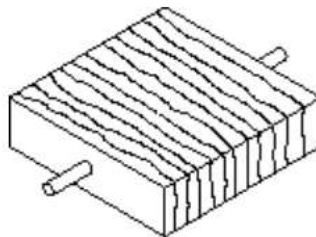


Figure 6 — Test arrangement for a specimen with the load applied parallel to the edges of the planes of anisotropy (Type IIb)

7.2.3 Surface finish of the specimens

a) Identification test

The surface finish on the faces and sides of the specimens shall be sawn, honed or polished.

b) Technological test

The surface finish on the faces and sides of the specimens shall be carried out according to the application (for example sawn, honed, polished, sanded, rubbed, flamed, bush-hammered, riven).

7.2.4 Dimensions of the specimens

c) Identification test

The specimens are square slabs with faces (200 ± 1) mm and a thickness of (30 ± 3) mm. The permissible deviation on the squareness is a maximum of 2 mm.

d) Technological test

The specimens are square slabs with the following dimensions:

Thickness	Dimensions
20 mm to 65 mm	200 mm 200 mm
> 65 mm to 80 mm	300 mm 300 mm

7.2.5 Location of the holes

a) Identification test

- The centre of the hole shall be situated between 98 mm and 102 mm from the other sides, measured to the nearest 0,5 mm.
- The thickness of stone between the edge of the hole and the two faces shall be $(10 \pm 2,0)$ mm, measured to the nearest 0,5 mm.

b) Technological test

- The centre of the hole shall be situated in the middle of the specimen's length.
- The thickness of stone between the edge of the hole and the face to be tested shall be according to the application, measured to the nearest 0,5 mm.

7.2.6 Dimensions and tolerances of the holes

a) Identification test

The diameter of the holes shall be $(10 \pm 0,5)$ mm. The depth of the holes shall be (30 ± 2) mm.

b) Technological test

The diameter of the holes shall be in accordance with the requirement of the application. The depth of the hole shall be (30 ± 2) mm.

7.2.7 Drilling the holes

The holes shall be wet drilled with a diamond or tungsten carbide tipped drill bit without hammering.

7.2.8 Planes of anisotropy

If the stone shows planes of anisotropy, the specimens are to be prepared in accordance with one of the arrangements shown in Figures 4, 5 and 6 and the position of the bedding or anisotropy is to be marked on the specimen by at least two parallel lines.

If the use of the stone with respect to the position of the planes of anisotropy is known, the test shall be carried out with the force applied on dowel placed in the hole in the side corresponding to the face that will be loaded during use.

If the use of the stone with respect to the position of the planes of anisotropy is not known or if more than one anisotropy is likely to be present, then the test shall be carried out in three perpendicular orientations and the total number of tests will be 30.

7.2.9 Conditioning

The specimens shall be dried to constant mass at (70 ± 5) °C in a ventilated oven after the drilling of the holes but before the dowels are fixed in place.

Constant mass is reached when the difference between two weighings carried out (24 ± 2) h apart is less than 0,1 % of the first of the two masses. After drying and prior to placing the dowels the specimens shall be stored at (20 ± 5) °C until the thermal equilibrium is reached.

7.2.10 Measuring d and d_1

After conditioning the thickness (d) and the distance from the edge of each hole to the lower face of the specimen in the direction of the force (d_1) shall be measured to the nearest 0,5 mm.

8 Dowels

8.1 Dimensions and tolerances

a) Identification test

The diameter of the dowels shall be $(6,0 \pm 0,1)$ mm. The length of the dowel shall be 50mm.

b) Technological test

The diameter of the dowels shall be in accordance with the required use. The length of the dowel shall be 50 mm

8.2 Material

The dowels shall be made of stainless-steel Type 1.4571 according to EN 10 088-1.

8.3 Placing the dowels

Place one of the sides of each specimen in an upper horizontal position. Place the dowel vertically and centrally in the hole. Fix the dowel in the hole for a length of (25 ± 1) mm using mortar prepared with cement CEM I 52,5 R in accordance with RS EAS 18-1 and a water/cement ratio of $(0,6 \pm 0,1)$ by mass.

Wait at least one hour and then repeat the same procedure for the other sides of the specimen that are to be tested (see Figures 3, 4, 5 and 6).

The specimens shall then be stored at (20 ± 5) °C for a minimum of 48 h prior to testing.

9 Test procedure

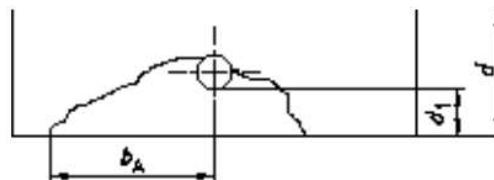
The specimen is clamped between the two metal plates of the clamping device on not more than 60 % of the specimen length (see Figure 1).

The load is exerted in a direction perpendicular to the axis of the dowel at a maximum distance of 2 mm from the edge of the specimen by means of the system shown in Figure 2.

The load is increased uniformly at a rate of (50 ± 5) N/s until the specimen breaks. The breaking load is recorded to the nearest 50 N.

If the dowel bends then the test shall be repeated with a larger diameter dowel and a new specimen.

After the specimen has failed the maximum distance from the centre of the hole to the fracture edge (b_A) shall be measured (Figure 7).



Key

d thickness of the test specimen

d_1 distance from the hole to the face in the direction of the force

b_A maximum distance of the centre of the hole to the fractures edge

Figure 7 — Dowel hole failure

10 Expression of the results

For each relevant direction of loading the following mean values shall be calculated from the individual results recorded for each test:

- the mean value of the distance from the hole to the face where the fracture occurs (d_1) expressed in millimetres to the nearest 1,0 mm;
- the mean value of the maximum distance from the centre of the hole to the edge of the fracture (b_A) expressed in millimetres to the nearest 1,0 mm;
- the mean value of the breaking load (F) expressed in newtons to the nearest 50 N.

11 Test report

The test report shall contain the following information:

- a) unique identification number for the report;
- b) the number, title and date of issue of this European Standard;
- c) the name and address of the test laboratory and the address of 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:
 - the petrographic name of the stone;
 - the commercial name of the stone;
 - the country and region of extraction;
 - the name of the supplier;
 - 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;
 - the name of the person or organization which carried out the sampling;
 - the surface finish of the specimens (if relevant to the test);
- f) the date of delivery of the samples 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 results of measurements
- for each specimen:
 - diameter of the hole;
 - diameter of the dowel;
 - dimensions of the specimen;
 - thickness of the specimen;
 - for each test:
 - distance from the hole to the face in the direction of the force (d_1) in millimetres to the nearest 1,0 mm;
 - maximum distance from the centre of the hole to the edge of the fracture (b_A) in millimetres to the nearest 1,0 mm;
 - breaking load (\bar{F}) in newtons to the nearest 50 N;
 - for each relevant direction of loading:
 - the mean value \bar{d}_1 and the mean value \bar{b}_A (in millimetres to the nearest 1,0 mm);
 - the mean value of breaking load (\bar{F}) in newtons to the nearest 50 N;
- j) all deviations from the standard and their justification;
- k) remarks.

The test report shall contain the signature(s) and role(s) of those 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.

Annex A (normative)

Statistical evaluation of the test results

A.1 Scope

This annex establishes a method for the statistical treatment of test results obtained following the natural stone test method described in this standard.

A.2 Symbols and definitions

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

A.3 Statistical evaluation of test results

For the calculation of the mean value \bar{x} , the standard deviation (s) and the coefficient of variation (v) a normal distribution is assumed.

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

Table A.1

Quantile factor (k_s) dependent 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
35	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
8	1,64

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

Measurementno.	Measuredvaluex
1	2000
2	2150
3	2200
4	2300
5	2350
6	2400
	—
Meanvalue	2333
Standarddeviation	147
Maximumvalue	2400
Minimumvalue	2000

Example 2:

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

Measurementno.	Measuredvaluex	(Inx)
1	2000	(7,60)
2	2150	(7,67)
3	2200	(7,70)
4	2300	(7,74)
5	2350	(7,76)
6	2400	(7,78)
7	2600	(7,86)
8	2750	(7,92)
9	2900	(7,97)
10	3150	(8,06)
	—	—
Meanvalue	2480	(7,807)
Standarddeviation	363	(0,143)
Variationcoefficient	0,15	
From Table 1 for: $n = 10$ $ks = 2,1$		
Lower expected value 1 819		

Copy for public comments

Bibliography

[1] DRS 528, Natural stone — Denomination criteria.

[2] DRS 515, Natural stone — Terminology.

Copy for public comments

Copy for public comments

Price based on 14pages

©RSB 2023- All rights reserved