

Setts of natural stone for external paving — Requirements and test methods

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National foreword

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The UK participation in its preparation was entrusted by Technical Committee B/507, Paving units and kerbs, to Subcommittee B/507/2, Natural stone paving units and kerbs, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 61 and a back cover.

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Setts of natural stone for external paving - Requirements and test methods

Pavés de pierre naturelle pour le pavage extérieur –
Exigences et méthodes d'essai

Pflastersteine aus Naturstein für Außenbereiche –
Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 20 August 1999.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 178, Paving units and kerbs, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1. Scope

This European Standard specifies the performance requirements and the corresponding test methods for all natural stone setts for external paving use.

It provides for product marking and for the evaluation of conformity of the product to this European Standard.

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

It does not cover the effect of de-icing salts.

2. Normative references

This European standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment, or revision. For undated references the latest edition of the publication referred to applies.

EN 10025, *Specification for hot rolled products of non-alloy structural steels and their technical delivery conditions*

ISO 48, *Rubber, vulcanized or thermoplastic - Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 2632, *Roughness comparison specimens*

ISO 4662, *Rubber - Determination of rebound resilience of vulcanizates*

ISO 7619, *Rubber - Determination of indentation hardness by means of pocket hardness meters.*

3. Definitions

For the purposes of this standard the following definitions apply.

3.1.1

sett

small natural stone paving block with work dimensions between 50 mm and 300 mm and no plan dimension generally exceeding twice the thickness. The minimum nominal thickness is 50 mm

3.1.2

textured sett

sett with a modified appearance resulting from one or several mechanical or thermal surface treatments

3.2

work dimension

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

3.3

actual dimension

any dimension of sett as measured

3.4

overall length

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

3.5

overall width

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

3.6

thickness

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

fine textured

surface treatment with a maximum difference of 0,5 mm between peaks and depressions (for example polished, honed or sawn with a diamond disc or blade)

3.9

honed

dull polish or matt finish

3.10

coarse textured

surface treatment with more than 2 mm difference between peaks and depressions (for example dolly pointed, tooled, shot blasted or flame textured)

3.11

dolly pointed

finish consisting of peaks and depressions achieved by using a four pointed dolly bit

3.12

tooled

finish resulting from mechanical surface treatment and showing tool marks

3.13

hewn

unworked, as-riven surface

4. Requirements

4.1. Dimensions

The supplier shall state the work dimensions of each sett that is tested, unless supplied in random sizes. Dimensions shall be measured in accordance with normative Annex A.

4.1.1. Permissible deviations

4.1.1.1. Plan dimensions and thickness

When measured in accordance with normative Annex A.2, the deviation from the work plan dimensions shall conform with Table 1.

Table 1 : Deviations on nominal plan dimensions

Between two riven faces	±15 mm
Between one textured face and one riven face	±10 mm
Between two textured faces	±5 mm

When measured in accordance with normative Annex A.2, the deviation from the work thickness shall conform with Table 2.

Table 2 : Deviations on nominal thickness

	Class 1	Class 2
Marking designation	T1	T2
Between two riven faces	±30 mm	±15 mm
Between one textured face and one riven face	±30 mm	±10 mm
Between two textured faces	±30 mm	±5 mm

When setts are laid in fan shaped arrangements not only cubic setts are required but also a number of trapezoidal and oblong setts. For setts intended for this use a maximum of 10 % of setts, the dimensions of which lie outside the permissible deviations by up to 10 mm, may be included in the delivery. In all cases the height of the setts shall be observed. If the setts are not to be laid in fans this shall be stated when ordering.

4.1.1.2. Undercut of riven sides

When measured in accordance with normative Annex A.3, the lack of perpendicularity of a side shall not exceed 15 mm with respect to the face.

4.1.1.3. Riven and coarse textured face irregularities

When measured in accordance with normative Annex A.2, face cavities and protrusions shall not exceed the deviation given in Table 3.

Table 3 : Deviations on face irregularity

Riven	Textured
5 mm	3 mm

4.2. Freeze/thaw resistance

The producer shall declare the freeze/thaw resistance of the stone in accordance with Table 4. If possible the stone shall be tested in accordance with normative Annex B and reported as the minimum value (number of cycles before failure occurs) expected for individual specimens. If there is no requirement for freeze/thaw resistance or no performance has been determined, then this shall be stated.

NOTE Reasons that would make it impossible to carry out the test in Annex B include time constraints and non-availability of suitable equipment.

Table 4 : Freeze/thaw resistance

Class	Marking designation	Requirement
Class 0	F0	No requirements for freeze/thaw resistance
Class 1	F1	Resistant

4.3. Compressive strength

The producer shall declare a compressive strength (in MPa) as the minimum value expected for individual test specimens when tested in accordance with normative Annex C. If no performance has been determined this shall be stated.

4.4. Abrasion resistance

The producer shall declare the abrasion resistance (length of chord in mm) as the maximum value expected for individual test specimens when tested in accordance with normative Annex D. If no performance has been determined this shall be stated.

4.5. Slip resistance

The producer shall declare the minimum Unpolished Slip Resistance Value (USRV) expected for individual test specimens of fine textured setts when tested in accordance with normative Annex E. If no performance has been determined this shall be stated.

NOTE 1 Coarse textured and riven 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 2 The unpolished slip resistance value relates to setts as manufactured and helps to ensure adequate slip/skid resistance on installation.

4.6. Aspects

4.6.1. Appearance

Stone is a naturally occurring material giving rise to variations in colour, veining and texture; therefore, general characteristics of the appearance may be given by one or more specimens (see 4.6.2).

4.6.2. Reference sample

A reference sample shall be a number of setts of natural stone of sufficient size to indicate the appearance of the finished work and the approximate appearance regarding the colouring, the vein pattern, the physical structure and face finish.

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.

The reference sample shall be provided and delivered to the customer as an indication to show specific characteristics such as holes for travertine, worm holes for marble, glass seams, spots, crystalline veins and rusty spots of the offered materials.

NOTE These characteristics should not be considered as flaws and should not be used as a reason for rejection.

The name and address of the producer or the supplier shall be indicated on the sample as well as identification of the material including the trade name, petrographic description, country of origin and extraction area.

Reference samples shall also show the surface finish proposed.

Any comparison between test and reference samples shall be carried out in accordance with normative Annex F.

4.7. Water absorption

Where required the producer shall declare the water absorption (% by mass) as the maximum value expected for individual specimens when tested in accordance with normative Annex G.

4.8. Petrographical description

The producer shall provide a petrographical description, including a petrographic name, of the stone type, in accordance with normative Annex H.

4.9. Chemical surface treatment

The producer/supplier shall declare if the product has been subjected to a chemical surface treatment and what the treatment was.

5. Evaluation of conformity

5.1. General

The producer or supplier shall demonstrate compliance of his product, either new or existing, with requirements of this standard and with the declared values for the product properties by carrying out initial testing and factory production control.

The value declared by the producer or supplier shall be representative of the current production, for example the lowest expected value or the minimum test value in normal production.

5.2. Initial type tests

When a product shall first demonstrate conformity with this standard, for example when a new product is developed, and before offering it for sale, appropriate tests shall be carried out to confirm that the properties of the product meet the requirements of this standard and the values to be declared for it by the producer. Whenever a significant change occurs in the raw material or the production process which could change the properties of the finished product, this shall be considered as constituting a new product type.

The type tests shall be the reference tests called up in this standard for the properties selected from the following list consistent with the product type's intended use:

- dimensions;
- flatness of surface;
- freeze/thaw resistance;
- compressive strength;
- abrasion resistance;
- slip resistance;

-
- aspects (for example visual appearance);
- water absorption;
- petrographic description;
- surface treatment.

The results of the initial tests shall be recorded.

5.3. Factory production control

A factory production control system shall be established and documented prior to commencing production. The factory production control system shall consist of procedures for the internal control of production to ensure that products placed on the market conform with this standard and the manufacturer's declared values.

The internal control shall consist of regular inspection checks and tests and the utilization of the results to control incoming materials, equipment, the production process and the finished product.

5.3.1. Raw materials

Specifications of all incoming materials and the procedures to be operated to ensure that they comply shall be documented.

5.3.2. Production process

The relevant features of the plant and production process shall be defined giving the frequency of the inspection checks and tests, together with the criteria required both on equipment and on work in progress. The action to be taken when control values or criteria are not met shall be given. Weighing and measuring equipment shall be calibrated and the procedure, frequency and criteria stated.

5.3.3. Finished product testing

A sampling plan for the testing of finished products shall be defined and the results shall be recorded and available for inspection. When alternative tests to the reference tests are used for the test procedure their correlation to the reference test shall be available for inspection. All test equipment shall be calibrated and the procedure, frequency and criteria stated.

5.3.4. Stock control

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

6. Acceptance criteria

6.1. Sampling

The sampling procedure from a batch to establish its conformity to this standard and the manufacturer's declared range of values shall be in accordance with normative Annex J.

6.2. Conformity criteria

6.2.1. Dimensions

When tested in accordance with normative Annex A, the mean value of the measurements taken of any one dimension on a single sett shall not vary from the manufacturer's declared work dimension by more than the permissible deviations given in 4.1.1.1 for the declared category.

6.2.2. Face irregularities

When tested in accordance with normative Annex A, no individual measurement of the deviation from a plane shall exceed the value given in 4.1.1.3.

6.2.3. Freeze/thaw resistance

When tested in accordance with normative Annex B the results for all of the test specimens shall not be less than the declared value.

6.2.4. Compressive strength

When tested in accordance with normative Annex C the results for all of the test specimens shall be not less than the declared value.

6.2.5. Abrasion resistance

When tested in accordance with normative Annex D the results for all of the test specimens shall be not greater than the declared value.

6.2.6. Slip resistance

When tested in accordance with normative Annex E the results for all of the test specimens shall be not less than the declared value.

7. Marking, labelling and packaging

Setts shall be packed in a manner to avoid damage in transit, and any metal banding used shall be corrosion resistant.

The following information shall be supplied either on the packaging, or on the delivery note:

- a) the petrographic name of the stone;
- b) the commercial name of the stone;
- c) the name and address of the supplier;
- d) the name and location of the quarry;
- e) the name, number and date of this standard;
- f) the declared values or marking designation classes (see clause 4);
- g) other information, for example surface chemical treatments.

Annex A (normative)

Measurement of dimensions

A.1 Preparation of specimens

Remove all burrs etc. from the setts to be measured.

A.2 Plan dimension

A.2.1 Apparatus

A.2.1.1 *Measuring equipment with an accuracy of 0,5 mm.*

A.2.1.2 *Callipers with an accuracy of 0,5 mm.*

A.2.1.3 *Graduated square with an accuracy of 0,5 mm.*

A.2.1.4 *Profile gauge (see Figure A.1) or equivalent apparatus.*

A.2.2 Procedure

A.2.2.1 Overall width and height of textured setts

Measure the overall width at the top and bottom of the nominally parallel faces, to the nearest 1 mm, at both ends of the sett. Measure the overall height at the back and front, at both ends of the sett. Record the mean height and width, together with larger and smaller dimension of each, if the difference between them exceeds 3 mm, all to the nearest 1 mm.

A.2.2.2 Face irregularity

Proceed as follows:

- a) Place the sett to be measured on a level surface.
- b) Set the needle support on the spacer/leveller and press the needles down onto the base.
- c) With the measuring equipment, measure and record the distance of the needles to the needle support (mm).
- d) Divide the sett area into four imaginary areas and with the profile gauge in one of these areas, press all the needles down onto the surface.
- e) Remove the profile gauge and measure and record the highest and lowest points from the needle support (mm).
- f) Subtract measurement (c) from measurement (e) to calculate the maximum and minimum profiles.
- g) Repeat in the other three areas and record the four answers.

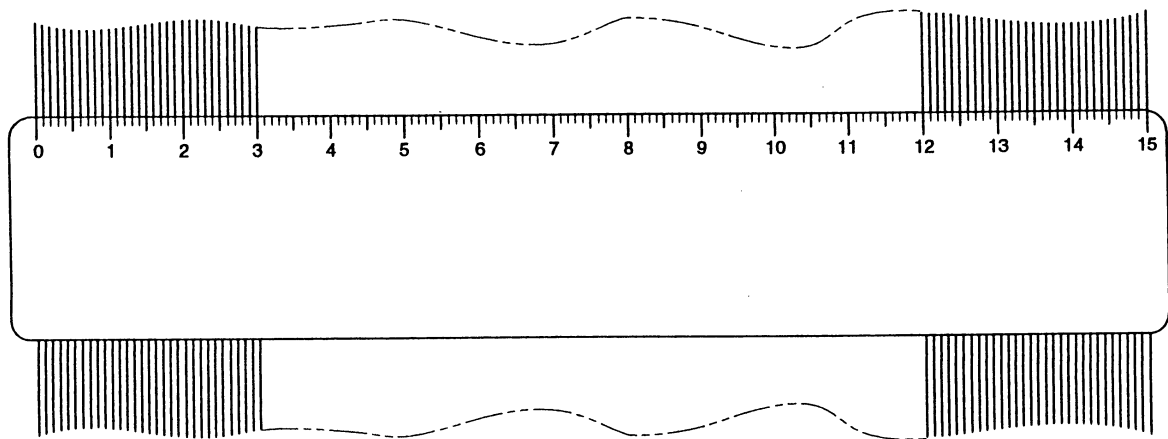


Figure A.1 : Profile gauge

A.3 Chamfers and undercut

Place one blade of the graduated square in contact with the face at one end of the sett and bring the other blade in contact with the vertical side. Record the appropriate dimensions to the nearest 1 mm using the markings on the square and the rule. Repeat at the other side and then at the other end of the sett.

A.4 Test report

The test report shall include the following information:

- a) name and address of testing laboratory and location where the test was carried out when different from the address of the testing laboratory;
- b) the number, title and date of issue of this standard;
- c) a description of the units or specimens tested to the relevant standard;
- d) unique identification of report (such as serial number) and of each page, and total number of pages of the report;
- e) name and address of client;
- f) date of receipt of test units or specimens and date(s) of performance of tests;
- g) identification of the test specification or description of the method or procedure;
- h) description of sampling procedure, where relevant;
- i) any deviations, additions to or exclusions from the test specification, and any other information relevant to a specific test;
- j) identification of any non-standard test method or procedure utilized;
- k) a description of the sample including:
 - the petrographic name of the stone;

- - the commercial name of the stone;
 - the name and address of the supplier;
 - the name and location of the quarry;
 - the direction of any bedding or anisotropic features;
- l) the results of measurements A.2 and, if appropriate, A.3;
- m) a statement on measurement uncertainty (where relevant);
- n) a signature and title or equivalent marking of person(s) accepting technical responsibility for the test report and date of issue;
- o) a statement that the test results relate only to the units or specimens tested;
- p) a statement that the report shall not be reproduced except in full without the written approval of the testing laboratory.

Annex B (normative)

Measurement of freeze/thaw resistance

B.1 Principle

The freeze/thaw resistance of natural stone setts is determined by a test comprising cycles of freezing in air and thawing in water.

B.2 Symbols

M_{s0}	mass of the specimen in air, after immersion in water to constant mass (g)
M_{h0}	mass of the specimen in water, after immersion in water to constant mass (g)
M_{sn}	mass of the specimen in air at n cycles (g)
M_{hn}	mass of the specimen in water at n cycles (g)
V_b	apparent volume (mm ³)
h	thickness of the specimen (mm)

B.3 Sampling

Sampling shall be carried out to conform to normative Annex J. At least six specimens shall be selected from a homogenous batch. Any observed anisotropy shall be marked on all samples by at least two parallel lines. One additional specimen shall be included to monitor the core temperature; this is not included in the test results.

B.4 Apparatus

B.4.1 *A freezing tank of sufficient capacity to hold at least seven specimens, possibly with an automatic control system to programme the freezing and thawing cycles (the tests can be executed manually).*

B.4.2 *A temperature recording system.*

B.4.3 *A hydrostatic balance to measure the apparent volume.*

B.5 Preparation of the specimens

B.5.1 Specimens

The specimens shall be in the form of rectangular prisms with dimensions of h mm $\times$ h mm $\times$ 280 mm where h = the thickness of the sett to a maximum of 70 mm. In cases where the longest plan dimension is less than 280 mm the specimen h shall be less than one quarter of the longest dimension.

B.5.2 Monitoring core temperature

One specimen in each sample shall be fitted with a device (for example a thermocouple) internally in the centre of the specimen to measure the temperature.

B.5.3 Drying the specimens

Dry the specimens at a temperature of $(70 \pm 5) ^\circ\text{C}$ to constant mass. This may be assumed to have been attained when the difference between two weighings at an interval of $24 \text{ h} \pm 2 \text{ h}$ is not greater than 0,1 % of the first of these two masses.

B.5.4 Immersion of the specimens

Immerse the specimens for a minimum of 24 hours up to constant mass in water at $(20 \pm 5) ^\circ\text{C}$. This may be assumed to have been attained when the difference between two weighings at an interval of $(2 \pm 0.5) \text{ h}$ is not greater than 0,1 % of the first of these two masses.

Quickly wipe the specimens after removal from the water. The second of these weighings is recorded as the initial apparent masses in air M_{s0} and in the water M_{h0} (hydrostatic weighing). These measurements are recorded as the original values of the specimens.

B.6 Test procedure

B.6.1 Arrangement of the specimens in the freezing tank

Place the specimens in the tank, vertically so that they do not come into contact with each other. Place them at least 10 mm apart, and at least 20 mm away from the tank side.

After each measurement turn the specimens over in the vertical plane, as shown in Figure B.1.

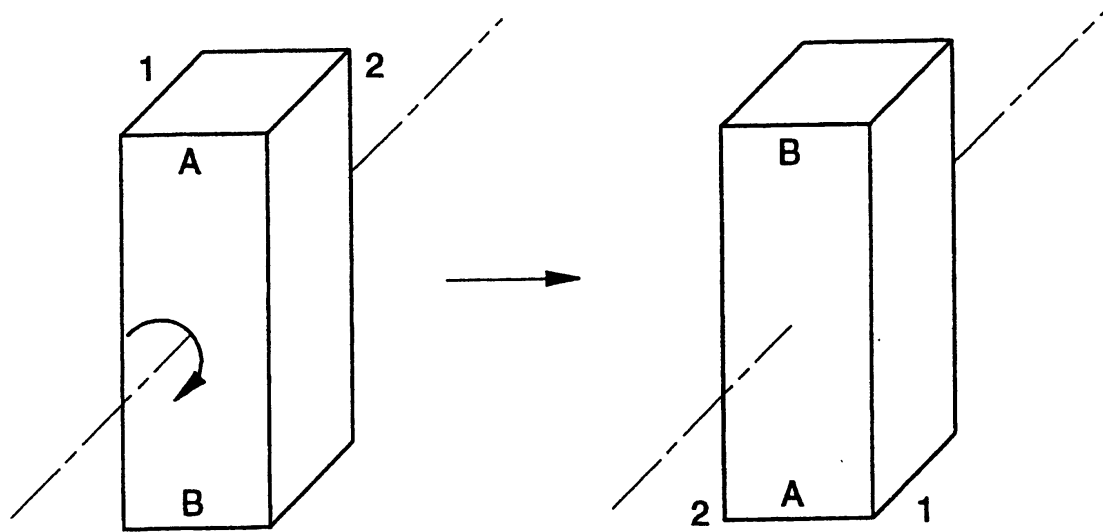


Figure B.1 : Arrangement of specimens