SLOVENSKI STANDARD
SIST EN 16306:2022

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Preskušanje naravnega kamna - Ugotavljanje odpornosti marmorja proti cikličnim toplotnim in vlažnostnim obremenitvam

Natural stone test methods - Determination of resistance of marble to thermal and moisture cycles

Prüfverfahren für Naturstein - Bestimmungen der Beständigkeit von Marmor bei zyklischer Belastung mit Wärme und Feuchte

Méthodes d'essai pour pierres naturelles - Détermination de la résistance du marbre aux cycles thermiques et d'humidité

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ICS:

91.100.15	Mineralni materiali in izdelki	Mineral materials and products

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EUROPEAN STANDARD

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English Version

Natural stone test methods - Determination of resistance of marble to thermal and moisture cycles

Méthodes d'essai pour pierres naturelles - Détermination de la résistance du marbre aux cycles thermiques et d'humidité

Prüfverfahren für Naturstein - Bestimmungen der Beständigkeit von Marmor bei zyklischer Belastung mit Wärme und Feuchte

This European Standard was approved by CEN on 1 August 2022.

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

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European foreword

This document (EN 16306:2022) has been prepared by Technical Committee CEN/TC 246 “Natural stones”, the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by March 2023, and conflicting national standards shall be withdrawn at the latest by March 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 16306:2013.

In comparison with the previous edition, the following technical modifications have been made:

— inclusion of a more detailed description of the test procedure and several clarifications;

— Clause 10, “Precision” has been deleted since data from precision trials is not yet available;

— Annex C has been amended with the recommendation to increase the number of measurement points in heterogeneous marble.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This document specifies a laboratory method for determining the resistance to thermal and moisture cycling of marble intended for the external cladding of building facades.

NOTE Bowing and rapid strength loss is known to occur in some marbles when used as exterior cladding.

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.

EN 12372, *Natural stone test methods - Determination of flexural strength under concentrated load*

EN ISO 4892-1, *Plastics - Methods of exposure to laboratory light sources - Part 1: General guidance (ISO 4892-1)*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
bowing
change in shape from flat and planar to a curved or dished shape in a convex or concave direction

Note 1 to entry: Other terms commonly used for the same phenomenon are dishing and warping.

Note 2 to entry: Convex bowing is quantified by positive values, concave bowing by negative values.

3.2
convex bowing
centre part of the specimen is bowing upwards, away from the moist substratum

3.3
concave bowing
centre part of the specimen is bowing downwards, away from the applied heat

3.4
marble
metamorphic rock containing more than 50 % vol. of carbonates (calcite and/or aragonite and/ or dolomite) formed by metamorphic recrystallization of a carbonate rock

Note 1 to entry: In this document, only geologically defined marble applies. The stones defined as marble only by the commercial meaning (e.g. polishable limestones) do not need to be tested.

[SOURCE: EN 12670:2019, 3.1.291, modified – deleted Notes to entry and added a new Note 1 to entry]

4 Symbols

T Temperature

H_0 Initial height of the specimen at the measuring point [mm]

H Difference between the initial height and the height after a specified number of cycles [mm]

H_N The normalized height difference, related to L_N = 1 m [mm]

B H_N / L_N = The normalized bowing value [mm/m]

B_n Bowing values after n cycles [mm/m]

L Distance between the supports under the specimen = 0,35 [m]

L_N Normalized length = 1 [m]

5 Principle

Bowing is measured on test samples placed within a test chamber, exposed to cycles of heat applied to one face while the reverse face is subjected to moisture. The temperature interval is from 20 °C to 80 °C, one cycle lasts 24 h. The temperature is measured on a black reference plate, placed on the surface of one specimen, to control the climate within the test chamber.

The strength loss shall be measured according to EN 12372 on reference and exposed specimens (see Annex A) and the results compared.

6 Apparatus

All measuring equipment shall be calibrated.

6.1 A non-corrosive test chamber (see Figure 1) of sufficient capacity to hold the required number of specimens, laid horizontally. The container shall be designed in a way that specimens receive continuous moisture from one side (the underside) and are exposed to cyclic heating on the other side (the upper side). The container shall be furnished with a device that ensures a constant water level for the duration of the test. Lying on the bottom of the container is a grating, which is covered by a sheet of heat stable filter cloth.

6.2 A non-corrosive grating that fits within the length and width of the container and has a height of at least 1 cm. The function of the grating is to ensure a water reservoir beneath the filter cloth.

6.3 A soft, heat stable, dimensionally stable, non-hygroscopic needle filter cloth of thickness approximately 5 mm and without any water-soluble substances or chemicals. The cloth (e.g. Polyester or PTFE (Polytetrafluoroethylene (PTFE)) needle felt) is to be placed on top of the grating. The function of the cloth is to deliver moisture and provide uniform support to the specimen.

6.4 Heating panels of sufficient sizes and numbers to cover the container. The panels shall be capable of providing a uniform heat flow, heating the black reference plate from 20 °C to 80 °C at average rate of 0,25 °C ± 0,1 °C per minute. The maximum permissible temperature difference within the test chamber, during heating exposure, is 3 °C. Panels of insulating material should preferably be placed around the container (see Figure 1), to avoid unwanted cooling or air circulation. Before the system is approved for use, trial measurements of the temperature shall be performed at 9 surface points widely distributed within the heating frame (see Figure 2). The temperature is measured on a uniform surface preferably with an infrared thermometer or a surface measuring thermometer. The temperature readings shall be taken on the surface of the black reference plate.

The heating rate may be adjusted by changing the distance between the heating device and the samples, or by controlling the effect of the heater. The heating curve is displayed in Figure 5.

6.5 A black reference plate, according to EN ISO 4892-1 (see Figure 3), to ensure proper temperature development and the maximum surface temperature at 80 °C. A thermocouple (cable type K), attached to the black reference plate, is connected to a high stability temperature and process controller. A simple data logger is also possible.

The black reference plate is placed on the surface of a sample, preferably near the middle of the container. The temperatures for the experimental exposure are programmed in advance. The heating elements are controlled by the process controller. The temperature of the black reference plate is read and the signal is sent to the process controller that adjusts the heating. The whole system can thus be computer controlled and the surface temperature can be monitored online.

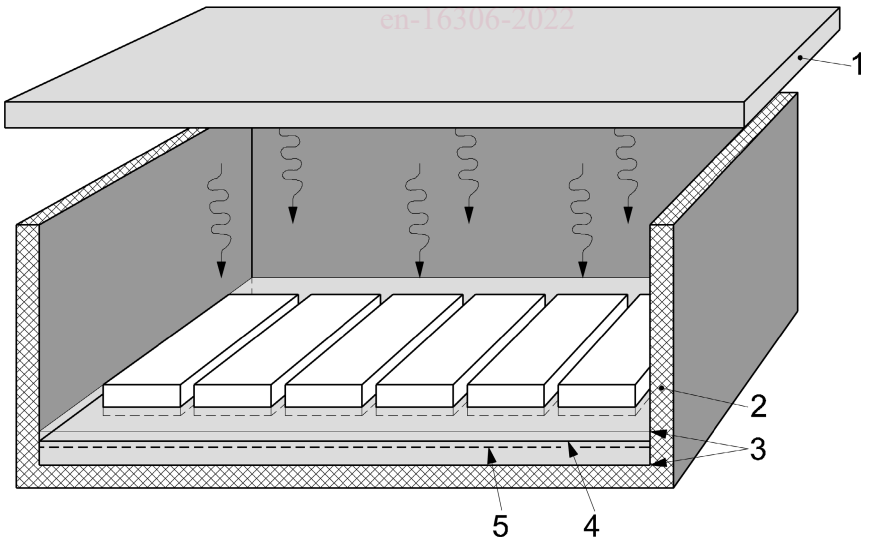
6.6 An infrared thermometer or other thermometer capable of measuring the surface temperature of the specimens. If an infrared thermometer is used it shall be checked against a material similar to marble, since the response of such a thermometer is influenced by the density and other parameters of the measured surface.

6.7 A bow-test rig for bowing measurements (see Figure 4). The rig comprises a steel plate, having three supporting points upon which the specimen is placed, and three cylinders which guide the edges of the specimen. The supporting points are situated (350 ± 5) mm apart from each other and shall be well rounded and smooth in order to accommodate for eventual irregularities in the sawn surface of the specimens. Above the centre of the specimen a gauge is mounted, which shall be readable to 0,001 mm. The whole system shall have an accuracy better than ± 0,01 mm.

6.8 A reference cylinder (co-planar bases with an accuracy better than ±0,005 mm) consisting of a material with a low linear expansion coefficient (e.g. quartz glass or invar steel).

6.9 A ventilated oven capable of maintaining a temperature of (40 ± 5) °C.

6.10 A weighing instrument which has an accuracy of at least 0,01 % of the mass to be weighed.



Key

1	heating device	4	filter cloth
2	insulation	5	grating
3	water level		

NOTE The front wall is omitted here for a better view of the interior.

Figure 1 — Principle sketch and an example of exposure equipment for testing the potential bowing properties of marble

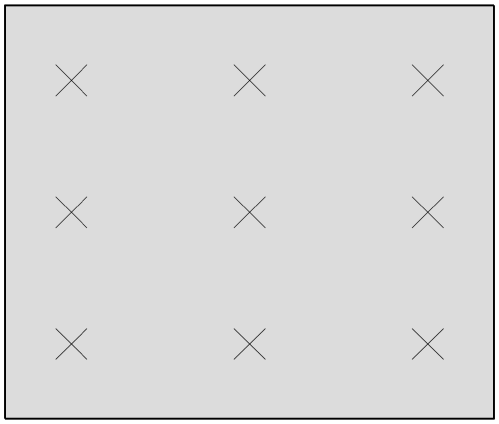
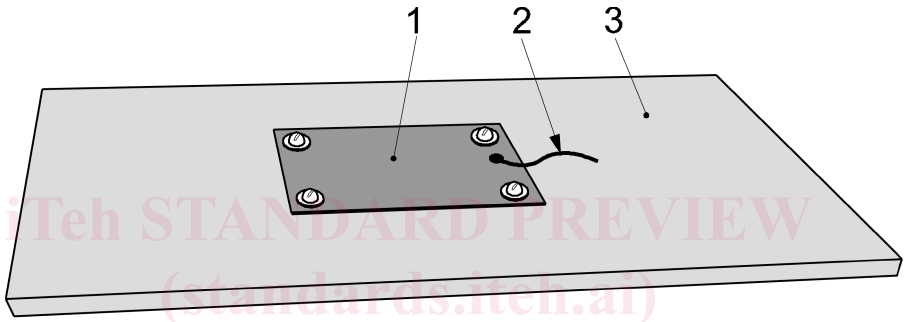


Figure 2 — Location of temperature control points

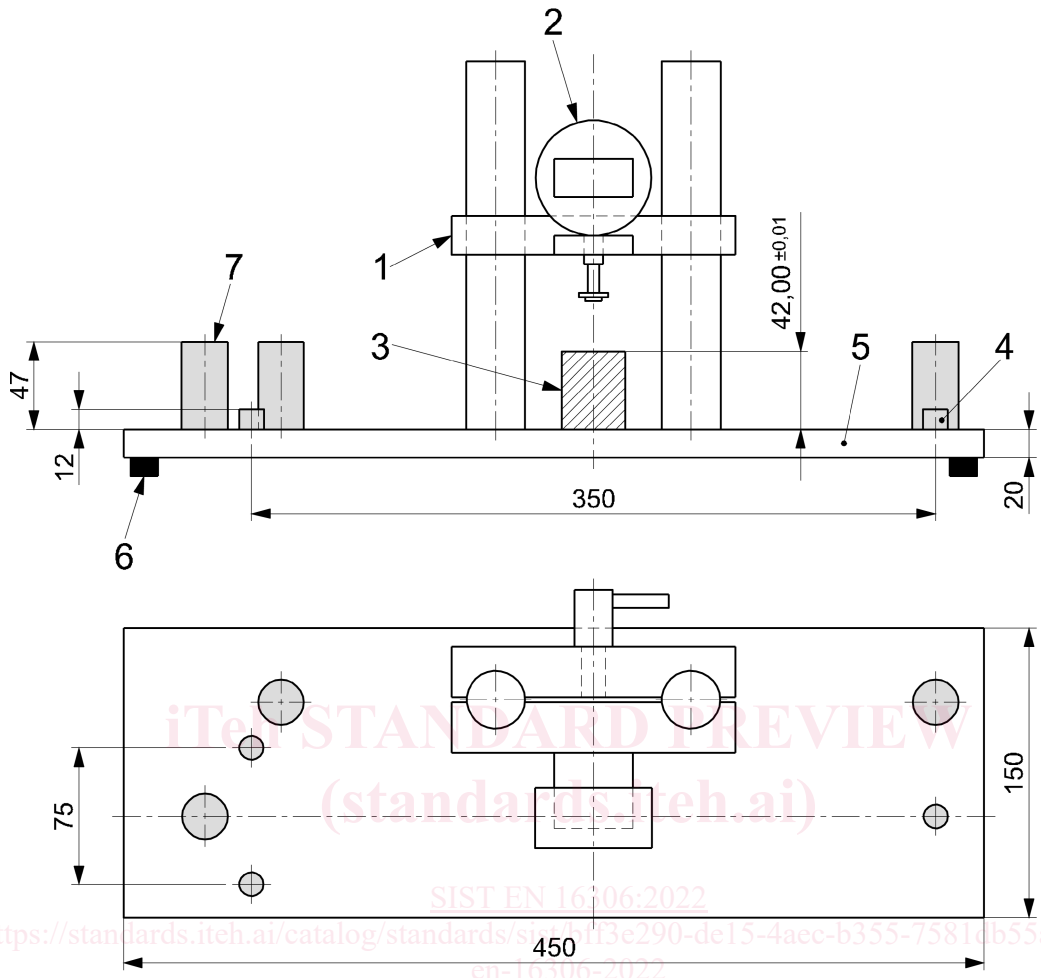


Key

1 black reference plate
2 thermocouple
3 test specimen

Figure 3 — Black reference plate (EN ISO 4892-1:2016) for T-measurements

Dimensions in millimetres



Key

1 stand
2 gauge
3 reference piece
4 support
5 steel plate (corrosion resistant)
6 rubber or polychloroprene studs
7 guide

Figure 4 — Schematic drawing of the bowing test rig

7 Preparation of specimens

7.1 Sampling

Sampling is not the responsibility of the test laboratory except where specially requested to undertake this.

At least 6 specimens are to be exposed to thermal cycling within the test chamber and a similar number of specimens from the same batch are to be used as references for measuring the flexural strength measurement of untreated material. Samples shall be chosen in order to be representative of the material to be tested. For identification testing, any foliation shall be taken into consideration; 6 specimens with faces perpendicular to and 6 specimens parallel to the foliation shall then be selected. For technological tests it is sufficient to select samples with a single, common orientation according to the use of the specimens.

For very heterogeneous marble types it has proven valuable to double the number of test specimens.

7.2 Test specimens

Test specimens shall be slabs with a length of (400 ± 5) mm, a width of (100 ± 5) mm and a thickness of (30 ± 2) mm. It is crucial that no other dimension is used. Altering the thickness influences the moisture and temperature gradient thus the recommended limits would no longer be valid. The surfaces of the specimen shall be sawn or honed (not polished). In the case of honed surfaces, these shall always be placed facing upwards. The specimens shall not be chemically treated in any way.

7.3 Reference marks on the specimens

To ensure that successive bowing measurements are done on the same measuring spot, on the same surface and similarly oriented specimens, make indelible marks on the specimens. Number the specimens in consecutive order.

7.4 Drying the specimen

The specimens are dried in a ventilated oven at 40 °C for one week, or until the change in weight is less than 0,1 % between two successive readings 24 hours apart, and then cooled to ambient temperature (20 ± 3) °C before start of the exposure.

8 Test procedure

8.1 Control measurements before cycling

After drying and cooling, a reference (H_0) height measurement is carried out at the point of the bowing measurement.

8.2 Procedure for bowing measurement

Only one specimen at a time shall be removed from the test chamber for measuring. All other samples shall remain in the test chamber until the measured sample has been returned and repositioned. Each specimen is gently placed on the three supporting points touching each of the three guide cylinders. The specimen shall be placed exactly in the same manner at each measurement. The pin of the gauge is gently lowered to the surface of the specimen and the reading is made. It is essential to the measuring process that the specimens, supporters, guides and gauge pin are clean. Water and dust shall be removed from the contact points before measuring each test specimen.