SLOVENSKI STANDARD
SIST EN 14579:2004

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Preskušanje naravnega kamna – Ugotavljanje hitrosti širjenja zvoka

Natural stone test methods - Determination of sound speed propagation

Prüfverfahren für Naturstein - Bestimmung der Geschwindigkeit der Schallausbreitung

Méthodes d'essai pour pierres naturelles - Détermination de la vitesse et propagation du son

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ICS:

73.020	Rudarstvo in kamnolomsko izkopavanje	Mining and quarrying
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EUROPEAN STANDARD

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English version

Natural stone test methods - Determination of sound speed propagation

Méthodes d'essai pour pierres naturelles - Détermination de la vitesse de propagation du son

Prüfverfahren für Naturstein - Bestimmung der Geschwindigkeit der Schallausbreitung

This European Standard was approved by CEN on 23 August 2004.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Contents

Foreword

This document (EN 14579:2004) 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of an identical text or by endorsement, at the latest by April 2005, and conflicting national standards shall be withdrawn at the latest by April 2005.

This standard is one of the series for tests on natural stone.

Test methods for natural stone consist of the following parts:

EN 1925, *Natural stone test methods – Determination of water absorption coefficient by capillarity*

EN 1926, *Natural stone test methods – Determination of compressive strength*

EN 1936, *Natural stone test methods – Determination of real density and apparent density, and of total and open porosity*

EN 12370, *Natural stone test methods – Determination of resistance to salt crystallisation*

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

EN 12407, *Natural stone test methods – Petrographic examination*

EN 13161, *Natural stone test methods – Determination of flexural strength under constant moment*

EN 13364, *Natural stone test methods - Determination of the breaking load at dowel hole*

EN 13373, *Natural stone test methods – Determination of geometric characteristics on units*

EN 13755, *Natural stone test methods – Determination of water absorption at atmospheric pressure*

EN 13919, *Natural stone test methods – Determination of resistance to ageing by SO_2 action in the presence of humidity*

EN 14066, *Natural stone test methods – Determination of resistance to ageing by thermal shock*

EN 14147, *Natural stone test methods – Determination of resistance to ageing by salt mist*

EN 14205, *Natural stone test methods - Determination of Knoop hardness*

EN 14231, *Natural stone test methods – Determination of the slip resistance by means of the pendulum tester*

EN 14157:2004, *Natural stone test methods – Determination of abrasion resistance*

EN 14158:2004, *Natural stone test methods – Determination of rupture energy*

EN 14579:2004, *Natural stone test methods – Determination of sound speed propagation*

prEN 14580:2002, *Natural stone test methods – Determination of the static elastic modulus*

prEN 14581:2002, *Natural stone test methods – Determination of linear thermal expansion coefficient*

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

1 Scope

This document specifies a method for the determination of the velocity of propagation of pulses of ultrasonic longitudinal waves in natural stone, both in laboratory and in situ.

2 Principle

A pulse of longitudinal vibrations is produced by an electro-acoustical transducer held in contact with one surface of the stone under test. After traversing a known path length in the stone, the pulse of vibrations is converted into an electrical signal by a second transducer and electronic timing circuits enable the transit time of the pulse to be measured.

3 Symbols and abbreviations

V pulse velocity, in km/s

L path length, in mm

T time taken by the pulse to transverse the length, in µs

4 Apparatus

4.1 General

4.1.1 The apparatus consists essentially of an electrical pulse generator, a pair of transducers, an amplifier and an electronic timing device for measuring the time interval elapsing between the onset of a pulse generated at the transmitting transducer and the onset of its arrival at the receiving transducer.

4.1.2 Two forms of electronic timing apparatus are available:

a) an oscilloscope on which the first front of the pulse is displayed in relation to a suitable time scale;

b) an interval timer with a direct reading digital display.

NOTE An oscilloscope provides the facility for examining the wave form, which can be advantageous in complex situations.

4.2 Performance requirements

The apparatus shall comply with the following performance requirements:

- to measure transit times in the calibration bar to an accuracy of ± 0,1 µs;

- to ensure a sharp pulse onset, that is the electronic excitation pulse applied to the transmitting transducer shall have a rise time of not greater than one-quarter of its natural period;

- the pulse repetition frequency shall be low enough to ensure that the onset of the received signal is free from interference by reverberations.

4.3 Transducers

The natural frequency of the transducers shall be within the range 20 to 150 kHz.

NOTE Frequencies as low as 10 kHz and as high as 200 kHz may sometimes be used. High frequency pulses have a well defined onset, but, as they pass through the natural stone, they become attenuated more rapidly than pulses of lower frequency. It is therefore preferable to use high frequency transducers (82 kHz to 200 kHz) for short path lengths (down to 50 mm) and low frequency transducers (10 kHz to 40 kHz) for long path lengths (up to a maximum of 15 m). Transducers with a frequency of 40 kHz to 82 kHz are found to be useful for most applications.

4.4 Apparatus for the determination of the arrival time of the pulse

The apparatus shall be capable of determining the time of arrival of the first front of the pulse, even though this may be of small amplitude compared with that of the first half wave of the pulse.

4.5 Other apparatus

A weighing instrument with an accuracy of 0,01 % of the mass to be weighed.

A ventilated oven capable of maintaining a temperature of (70 ± 5) °C.

5 Preparation of the specimens

5.1 Sampling

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

At least 6 specimens shall be selected from a homogeneous batch (see also 5.2.3)

5.2 Test specimens

5.2.1 General

As a standard reference the surface finish of the faces of the specimens shall be sawn or honed.

5.2.2 Dimensions

5.2.3 The test specimens shall be prisms of 300 mm x 75 mm x 50 mm with a tolerance of ± 2mm. Planes of anisotropy

If the stone shows planes of anisotropy (e.g. bedding, foliation) the specimens shall be prepared with the long axis either parallel or perpendicular to these planes.

5.2.4 Drying the specimens

The specimens shall be dried at a temperature of (70 ± 5) °C to constant mass. This is assumed to have been attained when the difference between two weighings at an interval of (24 ± 2) h is not greater than 0,1 % of the first of these two masses.

6 Test procedure

6.1 General

The apparatus shall be used within the operating conditions stated by the manufacturer.

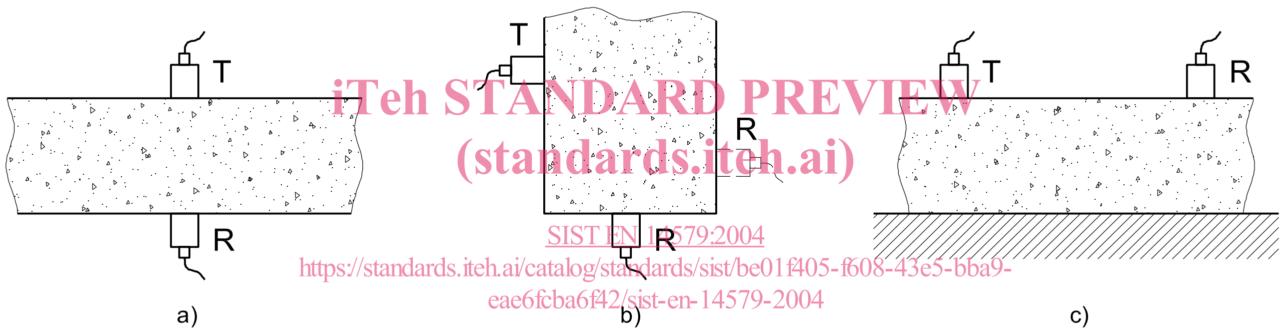
6.2 Determination of Pulse Velocity

6.2.1 Factors influencing pulse velocity measurements

In order to provide a measurement of pulse velocity which is reproducible, it is necessary to take into account various factors which can influence the measurements. These are set out in informative Annex B.

6.2.2 Transducer arrangement

Although the direction in which the maximum energy is propagated is at right angles to the face of the transmitting transducer, it is possible to detect pulses which have travelled through the natural stone in some other direction. It is therefore possible to make measurements of pulse velocity by placing the two transducers either on opposite face (direct transmission), or on adjacent faces (semi-direct transmission), or on the same face (indirect or surface transmission). (see Figure 1).



T = transmitter

R = receiver

a) direct transmission

b) semi-direct transmission

c) indirect or surface transmission

Figure 1 — Different transducer arrangements for the determination of pulse velocity

NOTE 1 It may be necessary to place the transducers on opposite faces but not directly opposite each other. Such arrangement shall be regarded as a semi-direct transmission. (see Figure 1.b).

NOTE 2 The indirect transmission arrangement is the least sensitive and should only be used, for in situ measurements when only a single face of the natural stone is accessible, or when it is more important to determine the strength of the layer near the surface than that of the body of the stone itself.

NOTE 3 The semi-direct transmission arrangement has a sensitivity intermediate between the other two arrangements and should only be used when the direct arrangement cannot be used.

6.2.3 Path length measurement

For direct transmission, the path length is the distance between the transducers measured with an accuracy of ± 1 %.

For semi-direct transmission, it is generally found to be sufficiently accurate to take the path length as the distance measured from centre to centre of the transducers faces. The accuracy of the measurement of the path length is dependent upon the size of the transducers compared with the centre to centre distance and it shall be estimated.

With indirect transmission, the path length is not measured, but a series of measurements is made with the transducers at different distances apart.

6.2.4 Coupling the transducer onto the stone

There shall be adequate acoustical coupling between the stone and the face of each transducer. For sufficiently smooth surface finishes a good acoustical contact is ensured by the use of a coupling medium such as petroleum jelly, grease, soft soap and kaolin/glycerol paste and by pressing the transducer against the stone surface.

Repeated readings of the transit time shall be made until a minimum value is obtained, so as to allow the layer of couplant to become thinly spread.

When the surface finish is very rough and uneven, the surface area shall be smoothed and levelled by grinding, or by the use of a quick-setting epoxy resin.

NOTE Special transducers are available for use on very rough surfaces

6.2.5 Measurement of the transit time

Using the electronic device the time interval indicated shall be recorded.

7 Expression of the results

For direct and semi-direct transmissions the pulse velocity shall be calculated from the formula:

$$V = \frac{L}{T}$$

where

V is the pulse velocity, in km/s

L is the path length, in mm

T is the time taken by the pulse to transverse the length, in μs

For indirect transmission, the velocity shall be calculated in accordance with normative Annex A.

The pulse velocity shall be expressed to the nearest 0,01 km/s.

NOTE Recommendations on the procedures for correlating test results to compressive strength are given in EN 12504-4.