SLOVENSKI STANDARD
SIST EN 1745:2020

01-december-2020

Nadomešča:
SIST EN 1745:2012

Zidovje in zidarski proizvodi - Metode za ugotavljanje toplotnih lastnosti

Masonry and masonry products - Methods for determining thermal properties

Mauerwerk und Mauerwerksprodukte - Verfahren zur Bestimmung von wärmeschutztechnischen Eigenschaften

Maçonnerie et éléments de maçonnerie - Méthodes pour la détermination des propriétés thermiques

Ta slovenski standard je istoveten z: **EN 1745:2020**

ICS:

91.080.30	Zidane konstrukcije	Masonry
91.120.10	Toplotna izolacija stavb	Thermal insulation of buildings

SIST EN 1745:2020 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1745

July 2020

ICS 91.080.30; 91.120.10

Supersedes EN 1745:2012

English Version

Masonry and masonry products - Methods for determining thermal properties

Maçonnerie et éléments de maçonnerie - Méthodes pour la détermination des propriétés thermiques

Mauerwerk und Mauerwerksprodukte - Verfahren zur Bestimmung von wärmeschutztechnischen Eigenschaften

This European Standard was approved by CEN on 17 May 2020.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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, Turkey and United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 1745:2020 E

Contents

Page

European foreword

This document (EN 1745:2020) has been prepared by Technical Committee CEN/TC 125 “Masonry”, 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 January 2021, and conflicting national standards shall be withdrawn at the latest by January 2021.

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 1745:2012.

The following is a list of significant technical changes since the last edition EN 1745:2012:

— replacement of Figure 1 by Tables 1 a and 1 b;

— editorial improvement;

— changes in the definitions 3.1.5 and 3.1.10;

— correction of term in Annex A;

— amendment heading of column in Annex A;

— addition of Annex G.

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, Turkey and the United Kingdom.

Introduction

This document provides methods for the determination of dry and design thermal conductivity and thermal resistance values of masonry products and masonry.

The following types of masonry unit are covered by this document:

— solid masonry units;

— masonry units with formed voids;

— composite masonry units.

Methods are described for the determination of the dry thermal conductivity of solid masonry units ($\lambda_{10,dry,unit}$) and of mortar ($\lambda_{10,dry,mor}$) and for the determination of equivalent dry thermal conductivity of masonry units with formed voids and composite masonry units ($\lambda_{10,dry,unit}$). Procedures are also described for the determination of the design thermal values of masonry units and masonry. The different methods are illustrated in Table 1.

The value in dry state is a characteristic of a masonry material, masonry unit or of masonry.

The determination of thermal values can be based on tabulated data, measurements, calculations or a combination of these.

Design thermal values may be determined according to procedures given in this European standard according to the intended application, environmental and climatic conditions, bearing in mind the purpose of this determination, such as:

— energy consumption;

— design of heating and cooling equipment;

— surface temperature determination;

— compliance with national building regulations;

— consideration of non-steady-state thermal conditions in buildings.

Table 1 a — Determination of thermal properties of masonry units and masonry

Overview of methods to determine $\lambda_{10,dry,unit}$			
Method (Clause)	**Masonry units**	**Determination of $\lambda_{10,dry,unit}$** [a] [b]	**Required parameters**
S1 (4.2.1)	solid	using tabulated value from Annex A for the $\lambda_{10,dry,mat}$ / net dry density relationship	Net dry density of unit/material [a]
S2 (4.2.2)	solid	based on determination of dry thermal conductivity by measurement and of the masonry unit material / dry density curve	Net dry density and thermal conductivity of unit/material [a]
S3 (4.2.3)	solid	based on determination of the thermal transmittance (U_{mas}) of masonry, then adjusting for the influence of the mortar	Net dry density and percentage area of units; thermal conductivity and percentage area of mortar
P1 (5.3.1.3)	with formed voids	based on determination of dry thermal conductivity of the masonry unit material, then using Annex B	Net dry density and thermal conductivity of unit/material and configuration of the units
P2 (5.3.1.4)	with formed voids	using tabulated values from Annex A, then using Annex B	Net dry density of unit/material and configuration of the units
P3 (5.3.2.2)	with formed voids and composite	by calculation according to 5.2, using dry thermal conductivity by measurement of the masonry unit material and any infill	Net dry density and thermal conductivity of unit/infill material and configuration of the units
P4 (5.3.2.3)	with formed voids and composite	by calculation according to 5.2 using tabulated thermal conductivity of the masonry unit material from Annex A and thermal conductivity of any infill material	Net dry density and thermal conductivity of unit/infill material and configuration of the units
P5 (5.3.3)	with formed voids and composite	based on determination of the thermal transmittance (U_{mas}) of masonry, then adjusting for the influence of the mortar	Gross dry density and percentage area of units, thermal conductivity and percentage area of mortar

[a] Methods S1 and S2 are also applicable for the determination of $\lambda_{10,dry,mor}$.

[b] If necessary, moisture correction according to Clause 6.

Table 1 b — Determination of thermal properties of masonry units and masonry

Overview of methods to determine $\lambda_{design,unit}$ [a] and $\lambda_{design,mas}$ [b]			
λ_{design} [a] [b] (Clause)	**Masonry units**	**Determination of $\lambda_{design,unit}$ [a] / $\lambda_{design,mas}$ [b]**	**Required parameters**
$\lambda_{design,unit}$ (6)	solid, with formed voids and composite	by applying moisture correction according to Clause 6 upon $\lambda_{10,dry,unit}$	Thermal conductivity in dry state and moisture conversion factor of unit
$\lambda_{design,mas}$ (7.2.1)	solid, with formed voids and composite	by using a simplified calculation based on $\lambda_{design,unit}$ and $\lambda_{design,mor}$	Design thermal conductivity of unit and mortar and percentage area of mortar joints
$\lambda_{design,mas}$ (7.2.2)	solid, with formed voids and composite	by numerical calculation based on $\lambda_{design,mat}$	Design thermal conductivity of materials and configuration
$\lambda_{design,mas}$ (7.3)	with formed voids	using of Annex B and application of the correction according to 6.3	Net dry density and thermal conductivity of unit/material and respective moisture conversion factors
S4/P6 $\lambda_{design,mas}$ (7.4)	solid, with formed voids and composite	by applying moisture correction according to Clause 6 onto the thermal transmittance (U_{mas}) of masonry	Thermal transmission of masonry and moisture conversion factor

[a] Or alternatively the design thermal resistance of the unit $R_{design,unit}$.

[b] Or alternatively the design thermal resistance of the masonry $R_{design,mas}$.

1 Scope

This document specifies methods for the determination of thermal properties of masonry and masonry products.

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 772-3, *Methods of test for masonry units — Part 3: Determination of net volume and percentage of voids of clay masonry units by hydrostatic weighing*

EN 772-4, *Methods of test for masonry units — Part 4: Determination of real and bulk density and of total and open porosity for natural stone masonry units*

EN 772-13, *Methods of test for masonry units — Part 13: Determination of net and gross dry density of masonry units (except for natural stone)*

EN 772-16, *Methods of test for masonry units — Part 16: Determination of dimensions*

EN 1015-10, *Methods of test for mortar for masonry — Part 10: Determination of dry bulk density of hardened mortar*

EN 1934, *Thermal performance of buildings — Determination of thermal resistance by hot box method using heat flow meter — Masonry*

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

EN 12664, *Thermal performances of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Dry and moist products of medium and low thermal resistance*

EN 12667, *Thermal performance of building materials and products- Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Products of high and medium thermal resistance*

EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation methods (ISO 6946)*

EN ISO 7345, *Thermal performance of buildings and building components — Physical quantities and definitions (ISO 7345)*

EN ISO 10211, *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations (ISO 10211)*

EN ISO 10456:2007,[1] *Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values (ISO 10456:2007)*

3 Terms, definitions and symbols

For the purposes of this document, the following terms, definitions and symbols and those given in EN ISO 7345 apply.

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

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

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

3.1 Terms and definitions

3.1.1
masonry
assemblage of masonry units laid in a specified pattern and joined together with masonry mortar

3.1.2
masonry product
masonry units, masonry mortars, rendering and plastering mortars

3.1.3
solid masonry unit
masonry unit containing no perforations except external indentations such as grip holes, grooves, etc.

3.1.4
masonry unit with formed voids
masonry unit with a system of intentionally formed voids

3.1.5
composite masonry unit
masonry unit incorporating additional material

3.1.6
thermal value
common term for either the thermal conductivity (W/(m K)) or the thermal resistance (m^2·K/W)

3.1.7
dry state
state after drying under conditions stated in the relevant standards

3.1.8
thermal value in dry state
value of a thermal property of a building material or product in a dry state determined according to this European Standard as a basis for the calculation of design thermal values

Note 1 to entry: The dry thermal value can be expressed as thermal conductivity or thermal resistance.

[1] As impacted by EN ISO 10456:2007/AC:2009.

3.1.9
design thermal value
value of a thermal property of a building material or product under specific external and internal conditions which can be considered as typical of the performance of that material or product when incorporated in a building component or building

3.1.10
equivalent thermal conductivity of masonry unit
value derived by dividing the width of a masonry unit with formed voids or a composite masonry unit by its thermal resistance excluding surface resistance

3.1.11
equivalent masonry thermal conductivity
value derived by dividing the thickness of a given masonry by its thermal resistance excluding surface resistance

3.1.12
reference conditions
set of conditions identifying a state of equilibrium selected as the base to which the thermal values of building materials and products are referred

3.2 Symbols

The order of the indices for thermal values is temperature, condition and subject.

Symbol	Quantity	Unit
$\lambda_{10,dry,mat}$	thermal conductivity at an average temperature of 10 °C in dry state for a masonry unit material and/or infill material	W/(m·K)
$\lambda_{10,dry,mas}$	thermal conductivity at an average temperature of 10 °C in dry state for the masonry	W/(m·K)
$\lambda_{10,dry,mor}$	thermal conductivity at an average temperature of 10 °C in dry state for the mortar	W/(m·K)
$\lambda_{10,dry,unit}$	thermal conductivity at an average temperature of 10 °C in dry state for the unit. For solid units the $\lambda_{10,dry,\ unit}$ is the same as $\lambda_{10,dry,\ mat}$ and for units with formed voids and composite units the $\lambda_{10,dry,\ unit}$ is the equivalent thermal conductivity.	W/(m·K)
$\lambda_{design,mas}$	design thermal conductivity for the masonry	W/(m·K)
$\lambda_{design,mor}$	design thermal conductivity for the mortar	W/(m·K)
$\lambda_{design,unit}$	design thermal conductivity for the unit	W/(m·K)
λ_g	equivalent thermal conductivity of voids	W/(m·K)
λ_i	individually determined thermal conductivity	W/(m·K)
R_g	thermal resistance of voids	m²·K/W
R_i	individually determined thermal resistance	m²·K/W
$R_{dry,mas}$	thermal resistance of masonry	m²·K/W
$R_{design,mas}$	design thermal resistance of masonry	m²·K/W
R_{si}, R_{se}	internal and external surface resistance	m²·K/W

$R_{tot,mas}$	total thermal resistance of masonry	m²·K/W
a_{mor}	percentage area of mortar joint in the measured masonry	%
a_{unit}	percentage area of units in the measured masonry	%
d	thickness of the masonry	m
T	Temperature	K
μ	water vapour resistance factor	
c_p	specific heat capacity	J/(kg·K)
l	length of a masonry unit	mm
w	width of a masonry unit	mm
h_{unit}	height of a masonry unit	mm
h_{mor}	thickness of a mortar joint	mm
F_m	moisture conversion factor	
f_u	moisture conversion coefficient by mass	kg/kg
f_ψ	moisture conversion coefficient by volume	m³/m³
u	moisture content mass by mass	kg/kg
ψ	moisture content volume by volume	m³/m³
$U_{10,dry,mas}$	thermal transmittance of the masonry at an average temperature of 10 °C in dry state	W/(m²·K)
U_{mas}	thermal transmittance of the masonry	W/(m²·K)
U_{mor}	thermal transmittance of the mortar	W/(m²·K)
U_{unit}	thermal transmittance of the units	W/(m²·K)
P	fractile of population	%
$\rho_{g,dry}$	gross dry density	kg/m³
$\rho_{n,dry}$	net dry density	kg/m³
v	percentage of voids	%

4 Determination of $\lambda_{10,dry,\ unit}$ –values for solid masonry units and $\lambda_{10,dry,mor}$ – values for mortars

4.1 General

$\lambda_{10,dry,unit}$ –values for solid masonry units and $\lambda_{10,dry,mor}$ –values for mortars are identical to the $\lambda_{10,dry,mat}$ – values. The $\lambda_{10,dry,mat}$ –values of solid masonry units and of mortars can be determined from tests carried out on samples of the material or from tables or graphs which relate $\lambda_{10,dry,mat}$ to density or from determining the thermal transmittance (U_{mas}) of masonry built from masonry units and mortar. In all cases the $\lambda_{10,dry,mat}$ –value is to be representative of the material.

NOTE For the determination of the $\lambda_{10,dry,unit}$ -value, $\lambda_{10,dry,mor}$ -value and $\lambda_{10,dry,mat}$ -value, with fractile X and confidence level Y, the basis is the corresponding gross dry density or net dry density and configuration.

4.2 $\lambda_{10,dry,\,mat}$ –values for solid masonry units and mortars

4.2.1 Method S1. Determination of $\lambda_{10,dry,unit}$ –values from tabulated $\lambda_{10,dry,mat}$ /net dry density relationship

Tabulated $\lambda_{10,dry,mat}$ –values for different materials used for masonry products are given in Annex A, differentiated by material and dry density. This annex also contains values for the water vapour resistance factor, the specific heat capacity and the moisture conversion coefficient.

These tabulated values are valid for materials where there is factory production control of the net dry density but no directly determined λ -values. $\lambda_{10,dry,mat}$ –values are given as 50 % and 90 % fractiles (P).

4.2.2 Method S2. Determination of $\lambda_{10,dry,unit}$ –values based on $\lambda_{10,dry,mat}$ /net dry density curve

4.2.2.1 General

To determine the $\lambda_{10,dry,mat}$ –value from a $\lambda_{10,dry,mat}$ /net dry density relationship the following procedure shall be used:

4.2.2.2 Test specimens

Test specimens shall be in accordance with the requirements of EN 12664. Care should be taken that the test specimens are representative of the masonry product itself.

NOTE An appropriate way to ensure this, is to cut specimens from masonry units.

4.2.2.3 Conditioning of specimens

Normally masonry materials are tested in a dry condition. It is also possible to carry out tests in a moist condition (e.g. conditioned to constant mass in an environment of (23 ± 2) °C and 50 % ± 5 % relative humidity), in which case the measured value has to be converted to the dry state following one of the procedures given in 6.2.

4.2.2.4 Test measurement

The reference test method is given in EN 12664. The test shall be carried out at a mean temperature of 10 °C.

Alternative test methods, which may require different test specimens and different conditioning methods, may be used, if the correlation between the reference test method and the alternative method can be given.

4.2.2.5 Establishing a product related $\lambda_{10,dry,mat}$ /net dry density-curve

Three items of information are necessary for this determination procedure:

1) the tabulated $\lambda_{10,dry,mat}$ /net dry density-correlation for the given material (see Annex A);

2) the product net dry density range, which can be derived either from the production history or from the net dry density tolerances which are given in the relevant product standards;

3) at least three individual test measurements of the net dry density and λ_i, on material which is representative for the current material produced. The measurements of net dry density and λ shall be carried out on the same specimens. The three tests have to be carried out on specimens from different production batches to represent the manufactured product net dry density range. These three measurements are used to determine the distance of the individual $\lambda_{10,dry,mat}$ /net dry density-curve, for a defined production, from the tabulated $\lambda_{10,dry,mat}$ /net dry density curve.

Determine the λ_I –value as described in 4.2.2.1 to 4.2.2.3 and calculate the arithmetic mean value of the 3 λ_i –results.

Measure the net dry density of each of the three samples following the procedure described in EN 772-4, EN 1936 or EN 772-13 or EN 1015-10 and calculate the arithmetic mean value of the 3 results.

Then use the following procedure.

Through the point A representing mean thermal conductivity and mean net dry density draw a λ/net dry density-curve parallel to the general $\lambda_{10,dry,mat}$ /net dry density-curve obtained from plotting the tabulated λ–value and net dry density-values for the product (material) given in Annex A.

Derive the mean λ-value of the product from the average net dry density. Derive the upper and lower limit values as the values that represent 90 % and 10 % of the manufactured product under consideration density range with a confidence level of 90 % according to EN ISO 10456.

Use the product related $\lambda_{10,dry,\ mat}$ /net dry density-curve to determine the $\lambda_{10,dry,mat}$ –value related to the mean net dry density the manufacturer is confident to achieve.

Express the $\lambda_{10,dry,unit}$ –values for solid masonry units or the $\lambda_{10,dry\ mor}$ –values for mortars as the mean $\lambda_{10,dry\ mat}$ –value together with the difference between the limit and the mean value.

Figure 1 shows this process in the form of a graph.