

Building components and building elements — Thermal resistance and thermal transmittance — Calculation method

The European Standard EN ISO 6946:1996, with the incorporation of amendment A1:2003, has the status of a British Standard

ICS 91.120.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/540, Energy performance of materials components and buildings, to Subcommittee B/540/1, European Standards for thermal insulation, upon which the following bodies were represented:

Association of Building Component Manufacturers
 Association for the Conservation of Energy
 Association of Lightweight Aggregate Manufacturers
 Autoclaved Aerated Concrete Products Association
 Brick Development Association
 British Rigid Urethane Foam Manufacturers' Association
 British Vermiculite Association
 Building Employers Confederation
 Cavity Foam Bureau
 Chartered Institution of Building Services Engineers
 Concrete Block Association
 Cork Industry Federation
 Department of the Environment (Building Research Establishment)
 Department of the Environment (Property and Buildings Directorate)
 Department of Trade and Industry (National Physical Laboratory)
 Eurisol (UK Mineral Wool Association)
 European Phenolic Foam Association
 European Phenolic Foam Association (UKSTC)
 Meteorological Office
 National House-Building Council
 Polyethylene Foam Insulation Association
 Thermal Insulation Contractors' Association
 Thermal Insulation Manufacturers and Suppliers' Association (TIMSA)
 Wood Wool Slab Manufacturers' Association

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National foreword

This British Standard has been prepared by Subcommittee B/540/1 and is the official English language version of EN ISO 6946:1996 *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*, including amendment A1:2003, published by the European Committee for Standardization (CEN) and the International Organization for Standardization (ISO).

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English version

Building components and building elements —
Thermal resistance and thermal transmittance —
Calculation method
(includes amendment A1:2003)

(ISO 6946:1996 + A1:2003)

Composants et parois de bâtiments — Résistance
thermique et coefficient de transmission
thermique — Méthode de calcul
(inclut l'amendement A1:2003)
(ISO 6946:1996 + A1:2003)

Bauteile — Wärmedurchlaßwiderstand und
Wärmedurchgangskoeffizient —
Berechnungsverfahren
(enthält Änderung A1:2003)
(ISO 6946:1996 + A1:2003)

This European Standard was approved by CEN on 1995-05-24 and amendment A1 was approved by CEN on 23 September 2002. 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.

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CEN

European Committee for Standardization
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Europäisches Komitee für Normung

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Foreword

The text of EN ISO 6946:1996 has been prepared by Technical Committee CEN/TC 89, Thermal performance of buildings and building components, the secretariat of which is held by SIS, in collaboration with Technical Committee ISO/TC 163, Thermal insulation.

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 February 1997, and conflicting national standards shall be withdrawn at the latest by December 1997.

NOTE Normative references to International Standards are listed in Annex ZA (normative).

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

Foreword to amendment A1

This document EN ISO 6946:1996/A1:2003 has been prepared by Technical Committee CEN/TC 89, Thermal performance of buildings and building components, the Secretariat of which is held by SIS, in collaboration with Technical Committee ISO/TC 163, Thermal performance and energy use in the built environment.

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 November 2003, and conflicting national standards shall be withdrawn at the latest by November 2003.

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, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

The thermal transmittance calculated according to this standard is suitable for determining heat flow through building components that are within the scope of this standard.

For most purposes heat flows can be calculated with the following temperatures:

- internal: dry resultant temperature;
- external: air temperature.

1 Scope

This standard gives the method of calculation of the thermal resistance and thermal transmittance of building components and building elements, excluding doors, windows and other glazed units, components which involve heat transfer to the ground, and components through which air is designed to permeate.

The calculation method is based on the appropriate design thermal conductivities or design thermal resistances of the materials and products involved.

The method applies to components and elements consisting of thermally homogeneous layers (which can include air layers).

The standard also gives an approximate method that can be used for inhomogeneous layers, except cases where an insulating layer is bridged by metal.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 10456:—¹⁾, *Thermal insulation — Building materials and products — Determination of declared and design thermal values*.

ISO 7345:1987, *Thermal insulation — Physical quantities and definitions*.

3 Definitions and symbols

3.1 Definitions

For the purposes of this standard, the following definitions and those given in ISO 7345 apply.

3.1.1

building element

major part of a building such as a wall, floor or roof

3.1.2

building component

building element or a part of it

NOTE In this standard the word “component” is used to indicate both element and component.

3.1.3

design thermal value

design thermal conductivity or design thermal resistance

NOTE A given product can have more than one design value, for different applications or environmental conditions.

¹⁾ To be published.

3.1.4**design thermal conductivity**

value of thermal conductivity 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

3.1.5**design thermal resistance**

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

3.1.6**thermally homogeneous layer**

layer of constant thickness having thermal properties which are uniform or which may be regarded as being uniform

3.2**Symbols and units**

Symbol	Quantity	Unit
A	area	m^2
R	design thermal resistance	$\text{m}^2 \cdot \text{K/W}$
R_g	thermal resistance of airspace	$\text{m}^2 \cdot \text{K/W}$
R_{se}	external surface resistance	$\text{m}^2 \cdot \text{K/W}$
R_{si}	internal surface resistance	$\text{m}^2 \cdot \text{K/W}$
R_T	total thermal resistance (environment to environment)	$\text{m}^2 \cdot \text{K/W}$
R'_T	upper limit of total thermal resistance	$\text{m}^2 \cdot \text{K/W}$
R''_T	lower limit of total thermal resistance	$\text{m}^2 \cdot \text{K/W}$
R_u	thermal resistance of unheated space	$\text{m}^2 \cdot \text{K/W}$
U	thermal transmittance	$\text{W}/(\text{m}^2 \cdot \text{K})$
d	thickness	m
h	heat transfer coefficient	$\text{W}/(\text{m}^2 \cdot \text{K})$
λ	design thermal conductivity	$\text{W}/(\text{m} \cdot \text{K})$

4 Principles

The principle of the calculation method is to:

- obtain the thermal resistance of each thermally homogeneous part of the component;
- combine these individual resistances so as to obtain the total thermal resistance of the component, including (where appropriate) the effect of surface resistances.

Thermal resistances of individual parts are obtained according to **5.1**.

The values of surface resistance given in **5.2** are appropriate in most cases. Annex A gives detailed procedures for low-emissivity surfaces, specific external wind speeds, and non-planar surfaces.

Air layers may be regarded as thermally homogeneous for the purposes of this standard. Values of the thermal resistance of large air layers with high-emissivity surfaces are given in **5.3**, and Annex B gives procedures for other cases.

The resistances of the layers are combined as follows:

- a) for components consisting of thermally homogeneous layers, obtain the total thermal resistance according to 6.1 and the thermal transmittance according to Clause 7;
- b) for components having one or more thermally inhomogeneous layers, obtain the total thermal resistance according to 6.2 and the thermal transmittance according to Clause 7;
- c) for components containing a tapered layer, obtain the thermal transmittance and/or the total thermal resistance according to Annex C.

Finally, corrections are applied to the thermal transmittance if appropriate according to Annex D, to allow for the effects of air gaps in insulation, mechanical fasteners penetrating an insulation layer, and precipitation on inverted roofs.

The thermal transmittance so calculated applies between the environments on either side of the component concerned, for example internal and external environments, two internal environments in the case of an internal partition, internal environment and an unheated space. Simplified procedures are given in 5.4 for treating an unheated space as a thermal resistance.

5 Thermal resistances

5.1 Thermal resistance of homogeneous layers

Design thermal values can be given as either design thermal conductivity or design thermal resistance. If thermal conductivity is given, obtain the thermal resistance of the layer from:

$$R = \frac{d}{\lambda} \quad (1)$$

where

- d is the thickness of the material layer in the component;
- λ is the design thermal conductivity of the material, either calculated according to ISO/DIS 10456.2 or obtained from tabulated values.

NOTE The thickness d may be different from the nominal thickness (e.g. when a compressible product is installed in a compressed state, d is less than the nominal thickness). If relevant, d should also make appropriate allowance for thickness tolerances (e.g. when they are negative).

Thermal resistance values used in intermediate calculations shall be calculated to at least 3 decimal places.

5.2 Surface resistances

Use the values in Table 1 for plane surfaces in the absence of specific information on the boundary conditions. The values under "horizontal" apply to heat flow directions $\pm 30^\circ$ from the horizontal plane. For non-planar surfaces or for specific boundary conditions use the procedures in Annex A.

Table 1 — Surface resistances (in $\text{m}^2 \cdot \text{K/W}$)

	Direction of heat flow		
	Upwards	Horizontal	Downwards
R_{si}	0,10	0,13	0,17
R_{se}	0,04	0,04	0,04

NOTE The values in Table 1 are design values. For the purposes of declaration of the thermal transmittance of components and other cases where values independent of heat flow direction are required, it is recommended that the values for horizontal heat flow are used.