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Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values

Ponts thermiques dans les bâtiments — Coefficient linéique de transmission thermique — Méthodes simplifiées et valeurs par défaut

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

ISO 14683 was prepared by ISO Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 14683:2007), which has been technically revised.

The changes in the third edition are mostly editorial. The document has been re-drafted according to CEN/TS 16629:2014.

Introduction

This document is part of a series aimed at the international harmonization of the methodology for assessing the energy performance of buildings. Throughout, this series is referred to as a "set of EPB standards".

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

All EPB standards provide a certain flexibility with regard to the methods, the required input data and references to other EPB standards, by the introduction of a normative template in Annex A and Annex B with informative default choices.

For the correct use of this document, a normative template is given in Annex A to specify these choices. Informative default choices are provided in Annex B.

The main target groups for this document are architects, engineers and regulators.

Use by or for regulators: In case the document is used in the context of national or regional legal requirements, mandatory choices may be given at national or regional level for such specific applications. These choices (either the informative default choices from Annex B or choices adapted to national/regional needs, but in any case following the template of Annex A) can be made available as national annex or as separate (e.g. legal) document (national data sheet).

NOTE 1 So in this case:

— the regulators will specify the choices;

— the individual user will apply the document to assess the energy performance of a building, and thereby use the choices made by the regulators.

Topics addressed in this document can be subject to public regulation. Public regulation on the same topics can override the default values in Annex B. Public regulation on the same topics can even, for certain applications, override the use of this document. Legal requirements and choices are in general not published in standards but in legal documents. In order to avoid double publications and difficult updating of double documents, a national annex may refer to the legal texts where national choices have been made by public authorities. Different national annexes or national data sheets are possible, for different applications.

It is expected, if the default values, choices and references to other EPB standards in Annex B are not followed due to national regulations, policy or traditions, that:

— national or regional authorities prepare data sheets containing the choices and national or regional values, according to the model in Annex A. In this case a national annex (e.g. NA) is recommended, containing a reference to these data sheets;

— or, by default, the national standards body will consider the possibility to add or include a national annex in agreement with the template of Annex A, in accordance to the legal documents that give national or regional values and choices.

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the Technical Report (ISO/TR 52019-2) accompanying this document.

The subset of EPB standards prepared under the responsibility of ISO/TC 163/SC 2 cover *inter alia*:

— calculation procedures on the overall energy use and energy performance of buildings;

— calculation procedures on the internal temperature in buildings (e.g. in case of no space heating or cooling);

— indicators for partial EPB requirements related to thermal energy balance and fabric features;

— calculation methods covering the performance and thermal, hygrothermal, solar and visual characteristics of specific parts of the building and specific building elements and components, such as opaque envelope elements, ground floor, windows and facades.

ISO/TC 163/SC 2 cooperates with other technical committees for the details on appliances, technical building systems, indoor environment, etc.

This document provides the means (in part) to assess the contribution that building products and services make to energy conservation and to the overall energy performance of buildings.

This document deals with methods for assessing thermal bridges, which give rise to changes in heat flow rates and surface temperatures compared with those of the unbridged structure. These heat flow rates and temperatures can be precisely determined by numerical calculation in accordance with ISO 10211. However, for linear thermal bridges, it is often convenient to use simplified methods or tabulated values to obtain an estimate of their linear thermal transmittance.

The effect of repeating thermal bridges which are part of an otherwise uniform building element, such as wall ties penetrating a thermal insulation layer or mortar joints in lightweight blockwork, needs to be included in the calculation of the thermal transmittance of the building element concerned, in accordance with ISO 6946.

Although not covered by this document, thermal bridges can also give rise to low internal surface temperatures, with an associated risk of surface condensation or mould growth.

Table 1 shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

NOTE 2 In ISO/TR 52000-2, the same table can be found, with, for each module, the numbers of the relevant EPB standards and accompanying technical reports that are published or in preparation.

NOTE 3 The modules represent EPB standards, although one EPB standard could cover more than one module and one module could be covered by more than one EPB standard, for instance a simplified and a detailed method respectively. See also Clause 2 and Tables A.1 and B.1.

Table 1 — Position of this document (*in casu* M2–5) within the modular structure of the set of EPB standards

	Overarching		Building (as such)		Technical building systems									
Sub module	**Descriptions**		**Descriptions**		**Descriptions**	**Heating**	**Cooling**	**Ventilation**	**Humidification**	**Dehumidification**	**Domestic hot water**	**Lighting**	**Building automation and control**	**PV, wind, ..**
sub1		**M1**		**M2**		**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**
1	General		General		General									
2	Common terms and definitions; symbols, units and subscripts		Building energy needs		Needs								[a]	
3	Applications		(Free) Indoor conditions without systems		Maximum load and power									
4	Ways to express energy performance		Ways to express energy performance		Ways to express energy performance									
5	Building categories and building boundaries		Heat transfer by transmission	ISO 14683	Emission and control									
6	Building occupancy and operating conditions		Heat transfer by infiltration and ventilation		Distribution and control									
7	Aggregation of energy services and energy carriers		Internal heat gains		Storage and control									
8	Building zoning		Solar heat gains		Generation and control									
9	Calculated energy performance		Building dynamics (thermal mass)		Load dispatching and operating conditions									

[a] The shaded modules are not applicable.

Table 1 *(continued)*

	Overarching		Building (as such)		Technical building systems									
Sub module	**Descriptions**		**Descriptions**		**Descriptions**	**Heating**	**Cooling**	**Ventilation**	**Humidification**	**Dehumidification**	**Domestic hot water**	**Lighting**	**Building automation and control**	**PV, wind, ..**
sub1		**M1**		**M2**		**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**
10	Measured energy performance		Measured energy performance		Measured energy performance									
11	Inspection		Inspection		Inspection									
12	Ways to express indoor comfort				BMS									
13	External environment conditions													
14	Economic calculation													

[a] The shaded modules are not applicable.

Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values

1 Scope

This document deals with simplified methods for determining heat flows through linear thermal bridges which occur at junctions of building elements.

This document specifies requirements relating to thermal bridge catalogues and manual calculation methods.

Default values of linear thermal transmittance are given in Annex C.

NOTE Table 1 in the Introduction shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

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.

ISO 7345, *Thermal insulation — Physical quantities and definitions*

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

ISO 13370, *Thermal performance of buildings — Heat transfer via the ground — Calculation methods*

ISO 13789, *Energy performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation method*

ISO 52000-1:2017, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures*

NOTE 1 Default references to EPB standards other than ISO 52000-1 are identified by the EPB module code number and given in Annex A (normative template in Table A.1) and Annex B (informative default choice in Table B.1).

EXAMPLE EPB module code number: M5–5, or M5–5,1 (if module M5–5 is subdivided), or M5–5/1 (if reference to a specific clause of the standard covering M5–5).

NOTE 2 In this document, there are no choices in references to other EPB standards. NOTE 1 and the EXAMPLE above are kept to maintain uniformity between all EPB standards.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345 and the following 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 https://www.iso.org/obp/

3.1
linear thermal bridge
thermal bridge with a uniform cross section along one of the three orthogonal axes

3.2
point thermal bridge
localized thermal bridge whose influence can be represented by a point thermal transmittance

3.3
linear thermal transmittance
heat flow rate in the steady-state divided by length and by the temperature difference between the environments on either side of a thermal bridge

Note 1 to entry: The linear thermal transmittance is a quantity describing the influence of a linear thermal bridge on the total heat flow through the building envelope.

3.4
point thermal transmittance
heat flow rate in the steady-state divided by the temperature difference between the environments on either side of a thermal bridge

Note 1 to entry: The point thermal transmittance is a quantity describing the influence of a point thermal bridge on the total heat flow through the building envelope.

3.5
transmission heat transfer coefficient
heat flow rate due to thermal transmission through the fabric of a building, divided by the difference between the environment temperatures on either side of the construction

3.6
EPB standard
standard that complies with the requirements given in ISO 52000-1, CEN/TS 16628[4] and CEN/TS 16629[5]

Note 1 to entry: These three basic EPB documents were developed under a mandate given to CEN by the European Commission and the European Free Trade Association and support essential requirements of EU Directive 2010/31/EU on the energy performance of buildings. Several EPB standards and related documents are developed or revised under the same mandate.

[SOURCE: ISO 52000-1:2017, 3.5.14]

4 Symbols and subscripts

4.1 Symbols

For the purposes of this document, the symbols given in ISO 52000-1 and the following apply.

Symbol	Quantity	Unit
A	area	m^2
b	width	m
d	thickness	m
H	heat transfer coefficient	W/K
l	length	m
R	thermal resistance	$m^2 \cdot K/W$
U	thermal transmittance	$W/(m^2 \cdot K)$
θ	temperature	°C
λ	design thermal conductivity	$W/(m \cdot K)$

Symbol	Quantity	Unit
Φ	heat flow rate	W
Ψ	linear thermal transmittance	W/(m·K)
χ	point thermal transmittance	W/K

4.2 Subscripts

For the purposes of this document, the subscripts given in ISO 52000-1 and the following apply.

Subscript	Definition
a	adjacent
d	direct
e	external
g	ground
int	internal
oi	overall internal
se	external surface
si	internal surface
tr	transmission
u	unconditioned spaces

5 Description of the method

5.1 Output

The output of this document are linear and point thermal transmittances of thermal bridges.

5.2 General description

This document describes the method of calculation of linear and point thermal transmittance and provides default values.

5.3 Influence of thermal bridges on overall heat transfer

5.3.1 Transmission heat transfer coefficient

Between internal and external environments with temperatures θ_{int} and θ_e respectively, the transmission heat flow rate through the building envelope, Φ, is calculated using Formula (1):

$$\Phi = H_{tr} \cdot \left(\theta_{int} - \theta_e\right) \tag{1}$$

The transmission heat transfer coefficient, H_{tr}, is calculated using Formula (2):

$$H_{tr} = H_d + H_g + H_u + H_a \tag{2}$$

where

H_d is the direct heat transfer coefficient through the building envelope defined by Formula (3);

H_g is the ground heat transfer coefficient calculated in accordance with ISO 13370;

H_u is the heat transfer coefficient through unconditioned spaces calculated in accordance with ISO 13789;

H_a is the heat transfer coefficient to adjacent buildings calculated in accordance with ISO 13789.

5.3.2 Linear thermal transmittance

The calculation of the transmission heat transfer coefficient includes the contribution due to thermal bridges, according to Formula (3):

$$H_d = \sum_i A_i \cdot U_i + \sum_k l_k \cdot \Psi_k + \sum_j \chi_j \quad (3)$$

where

H_d is the direct heat transfer coefficient, in W/K;

A_i is the area of element i of the building envelope, in m^2;

U_i is the thermal transmittance of element i of the building envelope, in $W/(m^2 \cdot K)$;

l_k is the length of linear thermal bridge k, in m;

Ψ_k is the linear thermal transmittance of linear thermal bridge k, in W/(m·K);

χ_j is the point thermal transmittance of the point thermal bridge j, in W/K.

The influence of point thermal bridges (insofar as they result from the intersection of linear thermal bridges) can often be neglected and so the correction term involving point thermal bridges can be omitted from Formula (3). If, however, there are significant point thermal bridges, then the point thermal transmittances should be calculated in accordance with ISO 10211.

Linear thermal bridges are generally liable to occur at the following locations in a building envelope:

— at junctions between external elements (corners of walls, wall to roof, wall to floor);

— at junctions of internal walls with external walls and roofs;

— at junctions of intermediate floors with external walls;

— at columns in external walls (if not allowed for in the U-value of the wall);

— around windows and doors.

5.3.3 Internal and external dimensions

There are three dimension systems commonly in use:

— internal dimensions, measured between the finished internal faces of each room in a building (thus excluding the thickness of internal partitions);

— overall internal dimensions, measured between the finished internal faces of the external elements of the building (thus including the thickness of internal partitions);

— external dimensions, measured between the finished external faces of the external elements of the building.