INTERNATIONAL STANDARD

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Thermal bridges in building construction — Calculation of heat flows and surface temperatures —

Part 2:
Linear thermal bridges

Ponts thermique dans les bâtiments — Calcul des flux thermiques et des températures superficielles —

Partie 2: Ponts thermiques linéaires

Reference number
ISO 10211-2:2001(E)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 10211 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10211-2 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 163, *Thermal insulation*, Subcommittee SC 2, *Calculation methods*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

ISO 10211 consists of the following parts, under the general title *Thermal bridges in building construction — Calculation of heat flows and surface temperatures*:

— *Part 1: General calculation methods*

— *Part 2: Linear thermal bridges*

Annexes A and B of this part of ISO 10211 are for information only.

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Foreword

The text of EN ISO 10211-2:2001 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", subcommittee 2 "Calculation methods".

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of an identical text or by endorsement, at the latest by September 2001, and conflicting national standards shall be withdrawn at the latest by December 2001.

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

This standard consists of two parts. The title of part 1 is "Thermal bridges in building construction - Calculation of heat flows and surface temperatures - Part 1: General methods".

This standard is one of a series of standards on calculation methods for the design and evaluation of the thermal performance of buildings and building components.

Introduction

Part 1 of this standard gives general methods for the calculation of heat flows and surface temperatures of thermal bridges of arbitrary shape and with an arbitrary number of boundary conditions. This part deals with linear thermal bridges bounded by two different thermal environments. For the calculation of surface temperatures, a third boundary temperature applies only if the thermal bridge is in thermal contact with the ground.

A linear thermal bridge can be represented by its cross-section, which provides the basis for a two-dimensional geometrical model.

As the two-dimensional model is a simplification of the real construction, the calculation results are approximations of the results calculated with a three-dimensional model according to EN ISO 10211-1:1995. The errors due to this simplification are related to the length of the linear thermal bridge which is often not specified. The calculation methods given in part 2 are termed "Class B" methods in order to distinguish them from the "Class A" methods given in part 1.

Although similar calculation procedures are used, the procedures are not identical for the calculation of heat flows and of surface temperatures.

Part 2 of this standard lays down criteria which have to be satisfied in order that a calculation method for linear thermal bridges can be described as being "Class B".

Part 2 can be used for the calculation of the linear thermal transmittance of the linear thermal bridge.

Part 2 does not provide reliable results for the assessment of surface condensation. Although accurate internal surface temperatures can be calculated with a two dimensional model, the actual minimum surface temperature can be lower,as a result of other linear or point thermal bridges in the vicinity.

At the intersection of two or three linear thermal bridges a drop of the internal surface temperature occurs. A method to calculate the lower limiting value of the temperature factor at the intersection is given in annex B.

1 Scope

This part 2 of the standard gives the specifications for a two-dimensional geometrical model of a linear thermal bridge for the numerical calculation of:

- the linear thermal transmittance of the linear thermal bridge;
- the lower limit of the minimum surface temperatures.

These specifications include the geometrical boundaries and subdivisions of the model, the thermal boundary conditions and the thermal values and relationships to be used.

The standard is based upon the following assumptions:

- steady-state conditions apply;
- all physical properties are independent of temperature;
- there are no heat sources within the building element;
- only one internal thermal environment applies;
- one or two external thermal environments apply.

A second external thermal environment only applies when surface temperatures are calculated and the soil is a part of the geometrical model. In that case the temperature at the horizontal cut-off plane in the soil is the second external thermal environment.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 7345	Thermal insulation - Physical quantities and definitions (ISO7345:1987)
EN ISO 10211-1:1995	Thermal bridges in building construction - Heat flows and surface temperatures - Part 1: General calculation methods (ISO 10211-1:1995)

3 Terms, definitions, symbols and units

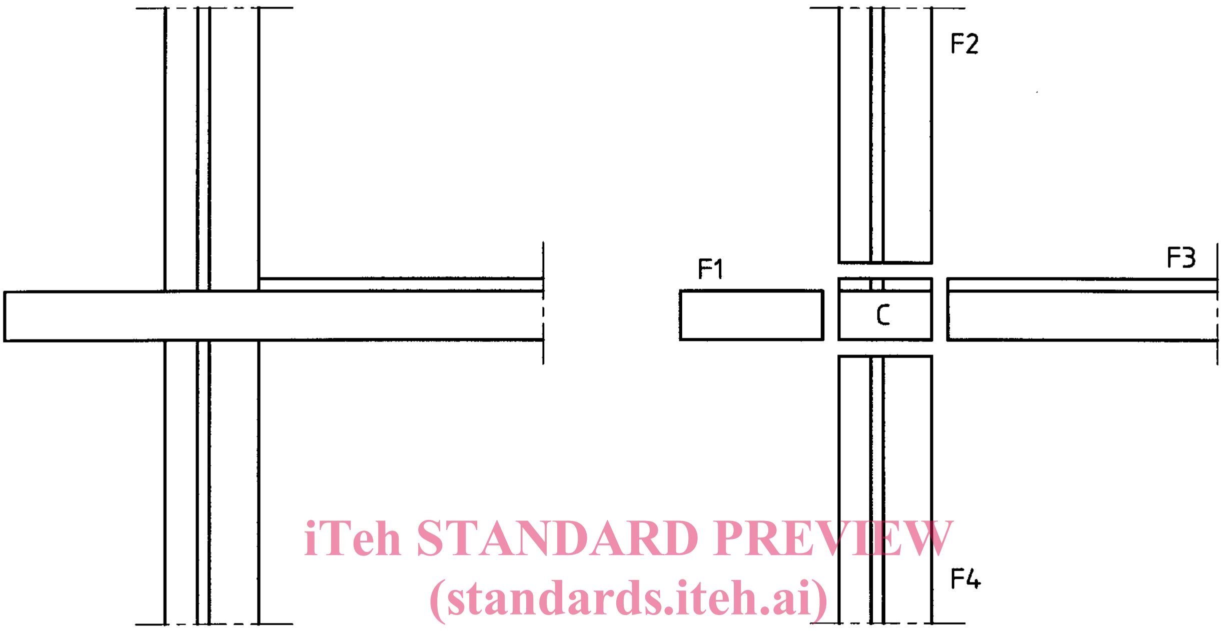
3.1 Terms and definitions

For the purposes of this standard the terms and definitions given in EN ISO 7345, EN ISO 10211-1:1995 and the following apply.

3.1.1
linear thermal bridge
thermal bridge with a uniform cross-section along one of the three orthogonal axes

3.1.2
2-D flanking element
part of a two-dimensional (2-D) geometrical model which, when considered in isolation, consists of plane, parallel material layers

3.1.3
2-D central element
part of a 2-D geometrical model which is not a 2-D flanking element



F1 to F4 have constant cross-sections. C is the remaining part.

Figure 1 - 2-D model with four flanking elements and a central element

3.2 Symbols and units

Symbol	Physical quantity	Unit
L^{2D}	linear thermal coupling coefficient	W/(m·K)
R_t	surface to surface thermal resistance	m²·K/W
R_{se}	external surface resistance	m²·K/W
R_{si}	internal surface resistance	m²·K/W
U	thermal transmittance	W/(m²·K)
b	ground floor width	m
f_{Rsi}^{3D}	temperature factor at the intersection of linear thermal bridges	-
f_{Rsi}^{2D}	temperature factor of a linear thermal bridge	-
f_{Rsi}^{1D}	temperature factor of a plane building element with uniform thermal resistance	-
g	temperature weighting factor	-
l	length	m
q	density of heat flow rate	W/m²
θ	Celsius temperature	°C
λ	thermal conductivity	W/(m·K)
ζ_{Rsi}	temperature difference ratio	-
Φ	heat flow rate	W
Ψ	linear thermal transmittance	W/(m·K)

Subscripts

e external
i internal
s surface
l length

Superscripts

1D refers to a one-dimensional geometrical model
2D refers to a two-dimensional geometrical model
3D refers to a three-dimensional geometrical model

4 Rules for modelling

4.1 Cut-off planes of the geometrical model

The geometrical model includes the 2-D central element, the 2-D flanking elements and, where appropriate, the subsoil. The geometrical model is delimited by cut-off planes.

Cut-off planes shall be positioned as follows:
- at least 1 m from the central element if there is no nearer symmetry plane (see Figure 2);
- at a symmetry plane if this is less than 1 m from the central element (see Figure 3);
- in the ground according to Table 1 (see Figure 4).

Dimensions in millimetres

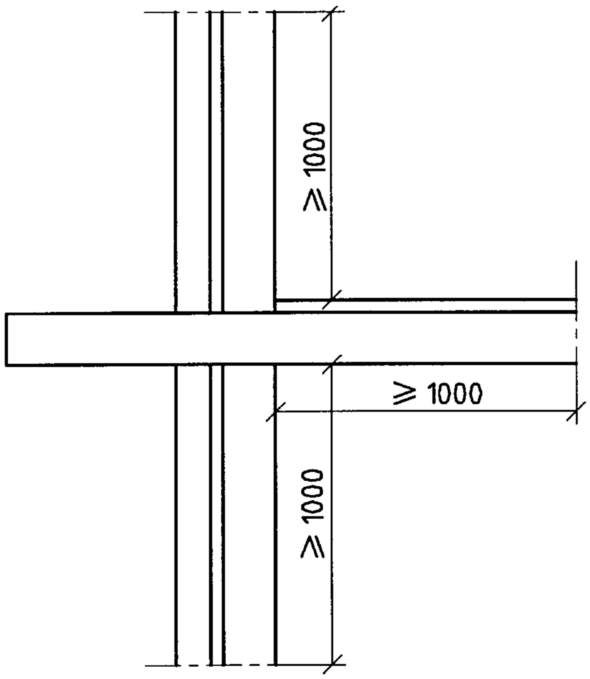


Figure 2 - Location of cut-off planes at least 1 m from the central element

Dimensions in millimetres

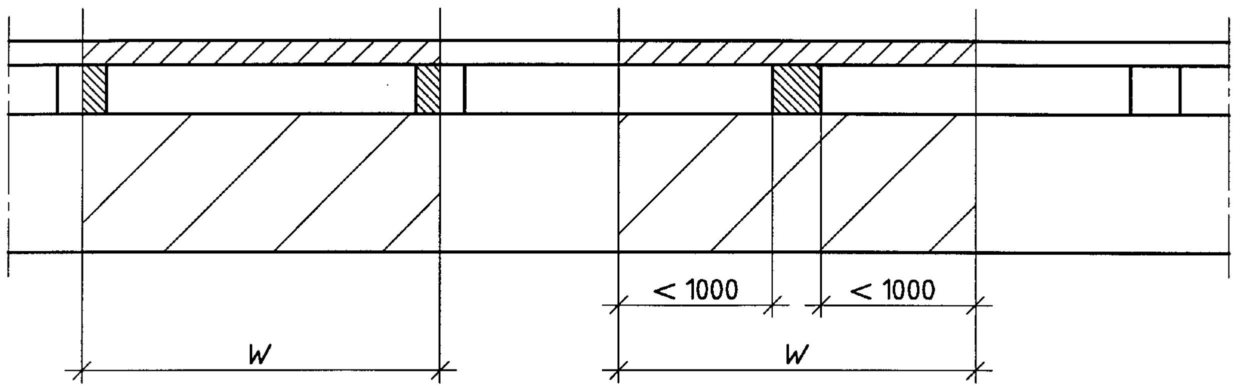


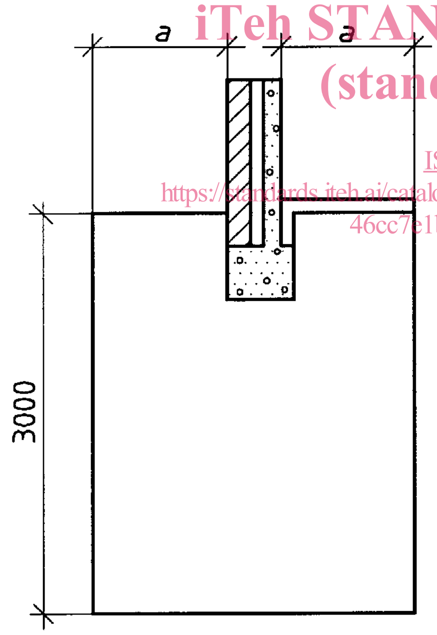
Figure 3 - Example of a construction with linear thermal bridges at fixed distances *W*, showing symmetry planes which can be used as cut-off planes

Table 1 - Location of cut-off planes in the subsoil
(foundations, ground floors, basements)

Direction	Distance to central element	
	Surface temperature calculations, see Figure 4a)	Heat flow calculations, see Figure 4b)
Horizontal inside the building	at least 1 m	0,5 *b* 1)
Horizontal outside the building	same distance as inside the building	2,5 *b* 1)
Vertical below ground level	3 m	2,5 *b* 1)
Vertical below floor level 2)	1 m	-

1) If the value of *b* is not given the default value *b* = 8 m shall be applied.
2) This value applies only if the level of the floor under consideration is more than 2 m below the ground surface.

Dimensions in millimetres



$a \geqslant 1000$

Figure 4a) - Soil dimensions for calculation of surface temperatures

Dimensions in metres

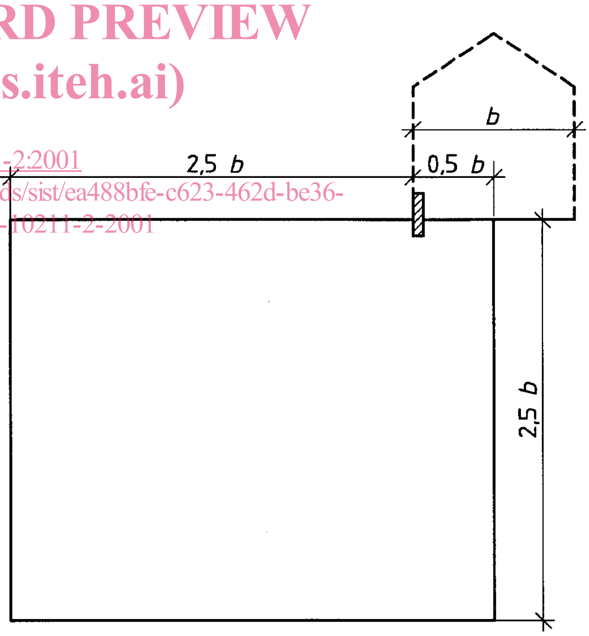


Figure 4b) - Soil dimensions for calculation of heat flow