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Thermal performance of curtain walling — Calculation of thermal transmittance

Performance thermique des façades-rideaux — Calcul du coefficient de transmission thermique

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 the member bodies casting a vote.

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.

ISO 12631 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 89, *Thermal performance of buildings and building components*, the secretariat of which is held by SIS, in collaboration with ISO Technical Committee TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Introduction

The design and construction of curtain wall systems is complex. This International Standard specifies a procedure for calculating the thermal transmittance of curtain wall structures.

Curtain walls often contain different kinds of materials, joined in different ways, and can exhibit numerous variations of geometrical shape. With such a complex structure, the likelihood of producing thermal bridges across the curtain wall envelope is quite high.

The results of calculations, carried out following the procedures specified in this International Standard, can be used for comparison of the thermal transmittance of different types of curtain wall or as part of the input data for calculating the heat used in a building. This International Standard is not suitable for determining whether or not condensation will occur on the structure surfaces nor within the structure itself.

Two methods are given in this International Standard:

— single assessment method (see 6.2);

— component assessment method (see 6.3).

Guidance on the use of these two methods is given in Annex A. Calculation examples for these two methods are given in Annex E and Annex F.

Testing according to ISO 12567-1:2010 is an alternative to this calculation method.

The thermal effects of connections to the main building structure as well as fixing lugs can be calculated according to ISO 10211:2007.

The thermal transmittance of the frame, U_f, is defined according to ISO 10077-2:2012 or EN 12412-2:2003 together with Annex A. The thermal transmittance of glazing units, U_g, is defined according to the documents listed in Table G.1 which does not include the edge effects. The thermal interaction of the frame and the filling element is included in the linear thermal transmittance Ψ which is derived using the procedures specified in ISO 10077-2:2012.

Thermal performance of curtain walling — Calculation of thermal transmittance

1 Scope

This International Standard specifies a method for calculating the thermal transmittance of curtain walls consisting of glazed and/or opaque panels fitted in, or connected to, frames.

The calculation includes:

- different types of glazing, e.g. glass or plastic; single or multiple glazing; with or without low emissivity coating; with cavities filled with air or other gases;
- frames (of any material) with or without thermal breaks;
- different types of opaque panels clad with metal, glass, ceramics or any other material.

Thermal bridge effects at the rebate or connection between the glazed area, the frame area and the panel area are included in the calculation.

The calculation does not include:

- effects of solar radiation;
- heat transfer caused by air leakage;
- calculation of condensation;
- effect of shutters;
- additional heat transfer at the corners and edges of the curtain walling;
- connections to the main building structure nor through fixing lugs;
- curtain wall systems with integrated heating.

2 Normative references

The following referenced documents are indispensable for the application 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 6946:2007, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*

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

ISO 10077-1:2006, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General*

ISO 10077-2:2012, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 2: Numerical method for frames*

ISO 10211:2007, *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations*

ISO 10291:1994, *Glass in building — Determination of steady-state U values (thermal transmittance) of multiple glazing - Guarded hot plate method*

ISO 10292:1994, *Glass in building — Calculation of steady-state U values (thermal transmittance) of multiple glazing*

ISO 10293:1997, *Glass in building — Determination of steady-state U values (thermal transmittance) of multiple glazing - Heat flow meter method*

ISO 12567-1:2010, *Thermal performance of windows and doors — Determination of thermal transmittance by hot box method — Part 1: Complete windows and doors*

EN 673:2011, *Glass in building — Determination of thermal transmittance (U value) — Calculation method*

EN 674:2011, *Glass in building — Determination of thermal transmittance (U value) — Guarded hot plate method*

EN 675:2011, *Glass in building — Determination of thermal transmittance (U value) — Heat flow meter method*

EN 12412-2:2003, *Thermal performance of windows, doors and shutters — Determination of thermal transmittance by hot-box method — Part 2: Frames*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345:1987, ISO 6946:2007 and Annex G apply.

NOTE Clause 4 includes descriptions of a number of geometrical characteristics of glazing units, frame sections and panels.

3.2 Symbols and units

Table 1 — Symbols and units

Symbol	Quantity	Unit
A	area	m^2
T	thermodynamic temperature	K
U	thermal transmittance	$W/(m^2 \cdot K)$
l	length	m
d	depth	m
Φ	heat flow rate	W
Ψ	linear thermal transmittance	$W/(m \cdot K)$
Δ	difference	
Σ	summation	
ε	emissivity	

3.3 Subscripts

cw curtain walling
d developed
e external
eq equivalent
f frame
f,g frame/glazing
FE filling element
g glazing
i internal
j joint
m mullion
m,f mullion/frame
m,g mullion/glazing
n normal
p panel (opaque)
s screw
t transom
t,f transom/frame
t,g transom/glazing
tot total
TJ thermal joint at a connection between two filling elements
W window

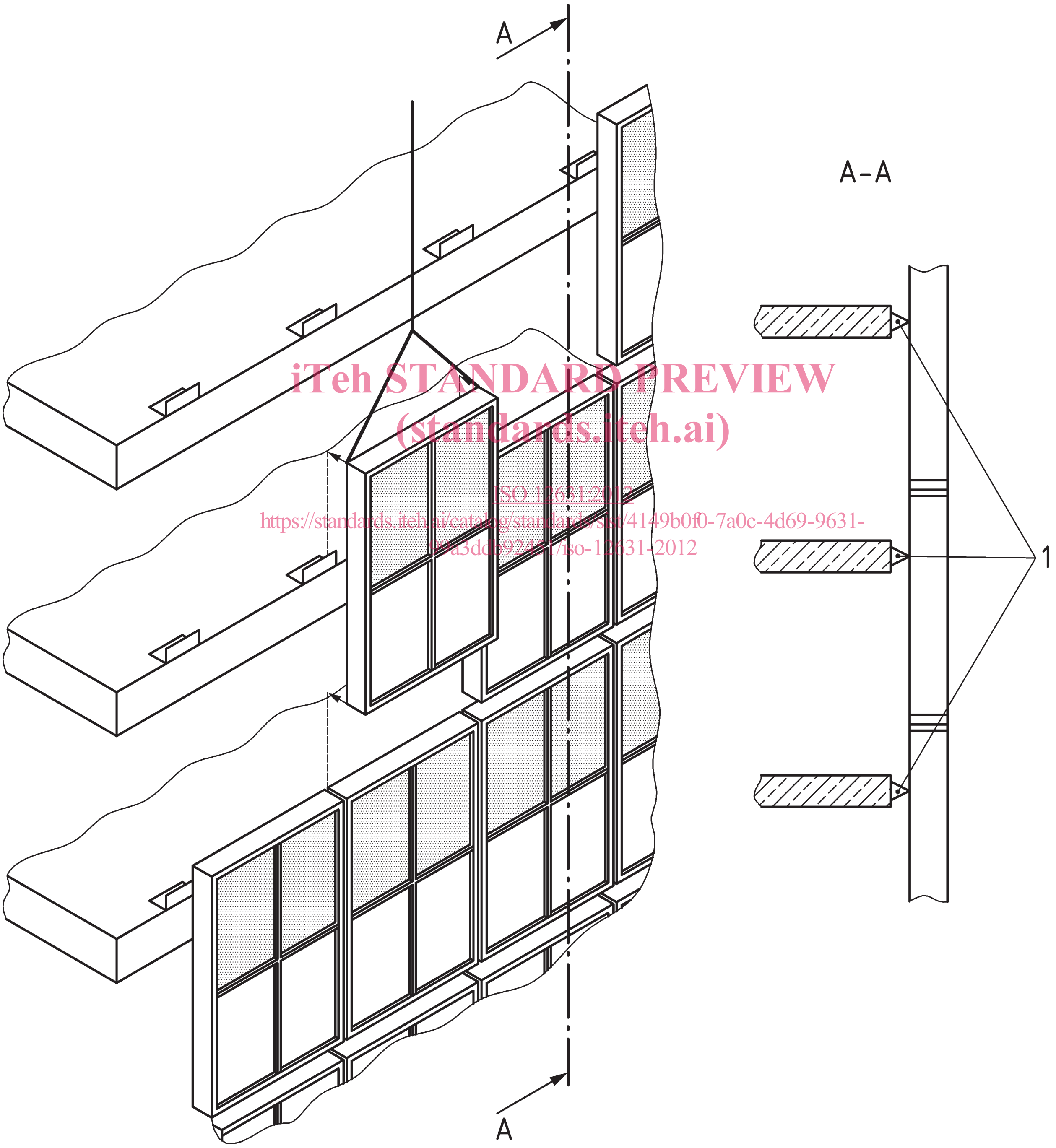
3.4 Superscripts

* definition of areas for length-related treatment of thermal joints (see 6.2.2.3)

4 Geometrical characteristics

4.1 Main principles

The main principles of curtain walling are shown in Figures 1 and 2.

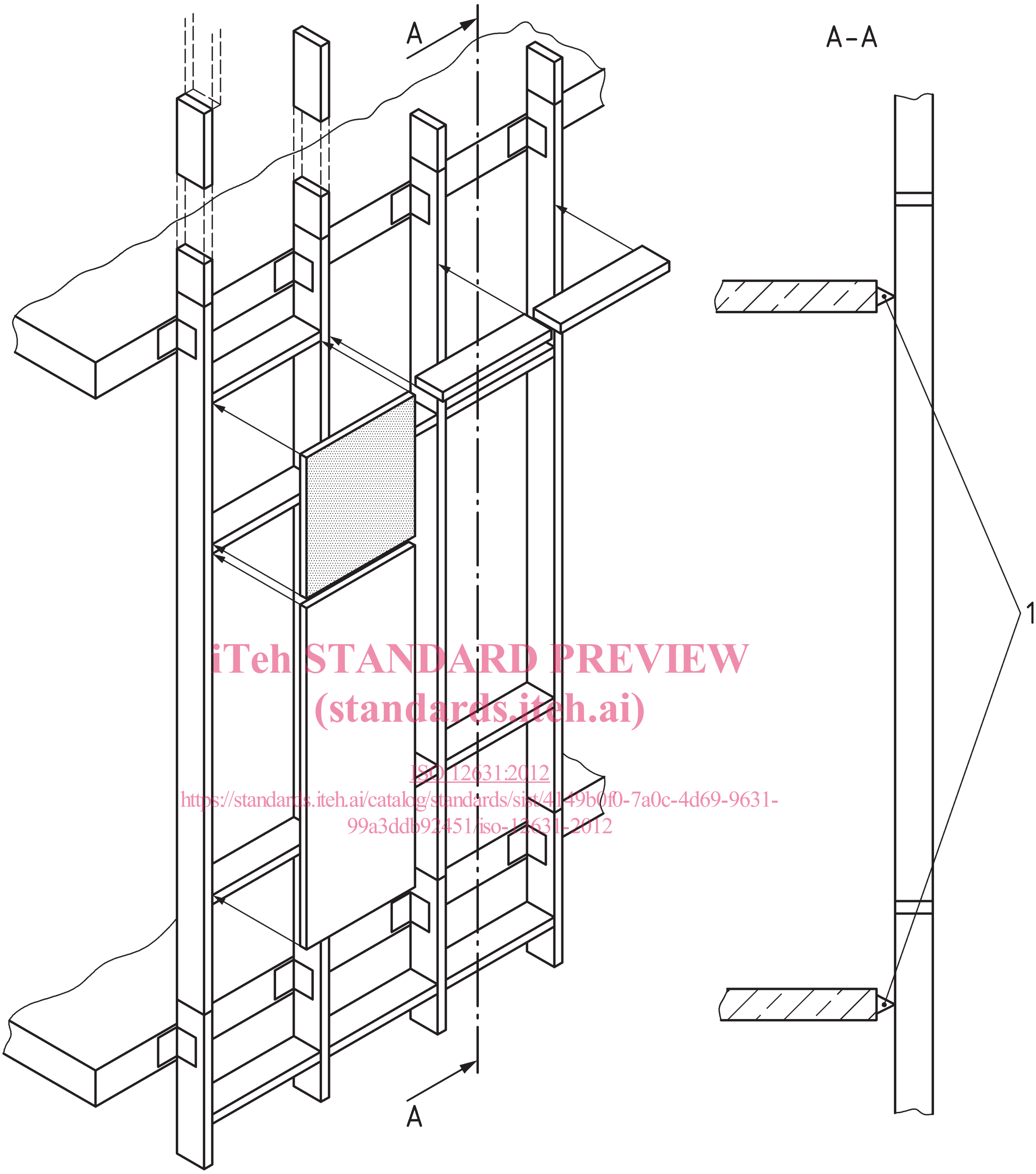


Key

1 structure fixing bracket

A-A vertical section

Figure 1 — Principle of curtain walling construction: unitised construction



Key

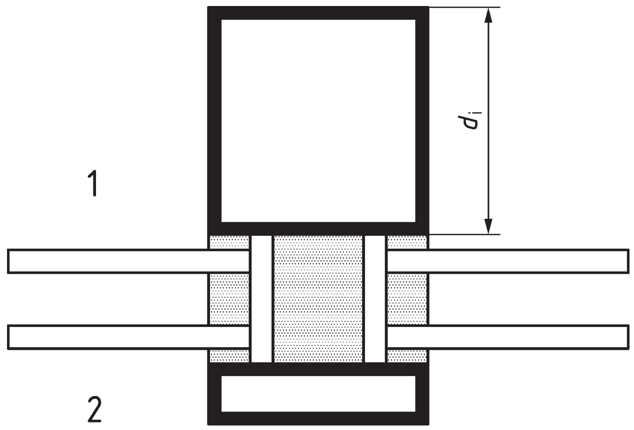
1 structure fixing bracket

A-A vertical section

Figure 2 — Principle of curtain walling construction: stick construction

4.2 Internal depth

The internal depth is defined as shown in Figure 3.



Key

1 internal

2 external

d_i internal depth of mullion or transom

Figure 3 — Internal and external developed area, internal depth

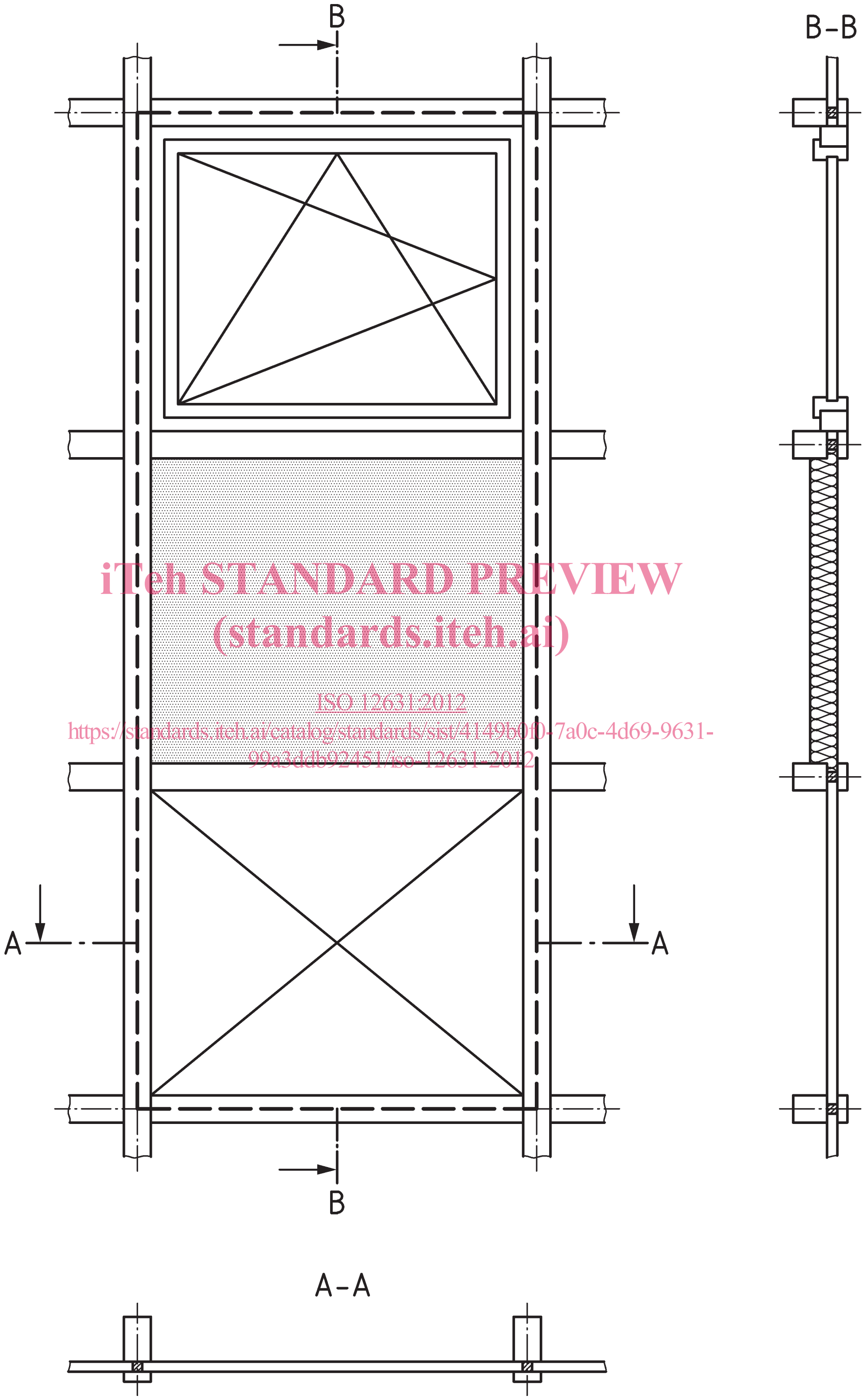
4.3 Boundaries of curtain wall structures

4.3.1 General

To evaluate the thermal transmittance of façades, representative reference areas should be defined. The following subclauses define the various areas.

4.3.2 Boundaries of a representative reference element

The boundaries of the representative reference element shall be chosen according to the principles shown in Figure 4.



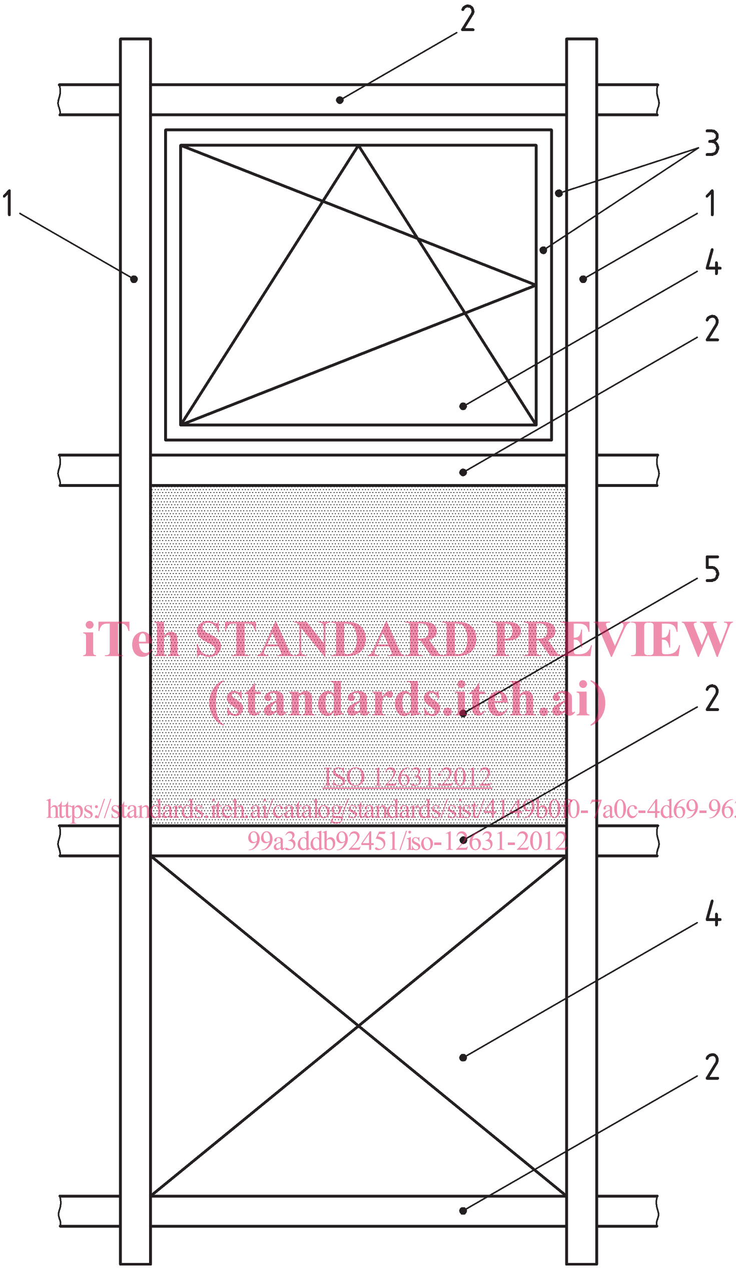
Key

— — — — Boundaries of the representative element

Figure 4 — Boundaries of a representative reference element of a façade

4.3.3 Curtain wall areas

The representative reference element is divided into areas of different thermal properties (sash, frame, mullion, transom, glazing units and panel sections) as shown in Figure 5.



Key
1 mullion
2 transom
3 sash and frame
4 glazing
5 panel

Figure 5 — Areas with different thermal properties

5 Cut-off planes and partitioning of thermal zones

5.1 Rules for thermal modelling

In most cases, the façade can be partitioned into several sections by using cut-off planes so that the thermal transmittance of the overall façade can be calculated as the area-weighted average of the thermal transmittance of each section. The necessary input data (thermal properties of each section) can be evaluated by measurement, two-dimensional finite element or finite difference software calculation or by tables or diagrams. In general there are two possibilities:

— the single assessment method (see 6.2);

— the component assessment method (see 6.3).

The partitioning of the façade shall be performed in such a way as to avoid any significant differences in calculation results of the façade treated as a whole and the heat flow rate through the partitioned façade. Appropriate partitioning into several geometrical parts is achieved by choosing suitable cut-off planes.

5.2 Cut-off planes of the geometrical model

The geometrical model includes central elements (glazing units, spandrel panels etc.) and thermal joints (mullion, transom, silicone joint etc.), which connect the different central elements. The geometrical model is delimited by cut-off planes.

Curtain walling often contains highly conductive elements (glass and metals) which implies that significant lateral heat flow is possible. Cut-off planes shall represent adiabatic boundaries, which can be either:

— a symmetry plane, or

— a plane where the heat flow through that plane is perpendicular to the plane of the curtain wall, i.e. no edge effect is present (e.g. at least 190 mm away from the edge of a double glazing unit).

Cut-off planes may be positioned only where there is a clear adiabatic situation (i.e. the heat flow is perpendicular to the plane). Figure 6 shows adiabatic lines (in the middle of the glass or panel far enough from the frame) where the heat flow will be perpendicular to the glass panes.

Cut-off planes do not necessarily fall at the same place as the geometrical boundaries of a unitised element (i.e. through the frame). The middle of a frame might not be an adiabatic boundary. This might be due to asymmetric geometrical shape of the frame, asymmetric material properties (e.g. different conductivity of sub-components at each side of the frame), or asymmetric connection of panels in a symmetric frame (e.g. a frame that connects a spandrel panel and a glazing unit, or two glazing units with different thermal properties).

6 Calculation of curtain wall transmittance

6.1 Methodologies

Two methods of calculating the thermal transmittance of curtain wall systems are specified: the single assessment method and the component assessment method.

The single assessment method (see 6.2) is based on detailed computer calculations of the heat transfer through a complete construction including mullions, transoms, and filling elements (e.g. glazing unit, opaque panel). The heat flow rate (between two adiabatic lines) is calculated by modelling each thermal joint between two filling elements (opaque panel and/or glazing unit) using two-dimensional or three-dimensional finite element analysis software. By area weighting the U-values of thermal joints and filling elements, the overall façade U-value can be calculated. This method can be used for any curtain walling system (i.e. unitised systems, stick systems, patent glazing, structural sealant glazing, rain screens, structural glazing).