



BSI Standards Publication

Metal profiles with thermal barrier — Mechanical performance — Requirements, proof and tests for assessment

National foreword

This British Standard is the UK implementation of EN 14024:2023. It supersedes BS EN 14024:2004, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/538/1, Windows and doors.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

Metal profiles with thermal barrier - Mechanical performance - Requirements, proof and tests for assessment

Profilés métalliques à rupture de pont thermique -
Performances mécaniques - Exigences, preuve et essais
pour évaluation

Metallprofile mit thermischer Trennung -
Mechanisches Leistungsverhalten - Anforderungen,
Nachweis und Prüfungen für die Beurteilung

This European Standard was approved by CEN on 12 June 2023.

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

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European foreword

This document (EN 14024:2023) has been prepared by Technical Committee CEN/TC 33 “Doors, windows, shutters, building hardware and curtain walling”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by January 2024, and conflicting national standards shall be withdrawn at the latest by January 2024.

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 14024:2004.

The main changes compared to the previous edition EN 14024:2004 are:

- new geometric design types have been introduced;
- the distinction between the two “Use categories” “W” and “CW” has been superseded by one category that includes both windows (W) and curtain walls (CW);
- revision of the clauses dealing with testing and test sequence;
- new Annex D dealing with simple products which typically do not need a static proof by calculation;
- inclusion of FEM analysis for specific non-symmetric profiles, as alternative validated method for static proof;
- Annex A: introduction of the semi-probabilistic approach in regard of static proof;
- Annex C: introduction of a full set of formulae to determine the maximal cross-section loads, contact shear strength and mid-span deformation for a simply supported beam loaded with a uniformly distributed load and subjected to a uniformly distributed temperature load.

Thermal barrier profiles are used in various fields of applications and demand a differing assessment of their mechanical performance depending on their intended use.

This document deals with the general field of application: profiles in windows, doors and façades.

In the design process, the safety aspect is part of national competency. For this reason, the definition of specific products that normally do not require tests or proof by calculation for the determination of mechanical properties, is a task of national specifications. This document applies when national specifications require tests or proof by calculation to determine the characteristic values of mechanical properties of the thermal barrier profile and to assess the suitability of the thermal barrier material.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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, Türkiye and the United Kingdom.

1 Scope

This document specifies requirements for assessment of the mechanical strength of metal profiles incorporating a thermal barrier having mechanical performance depending on their intended use.

It also specifies the tests to determine the characteristic values of mechanical properties of the thermal barrier profile and to assess the effect of different conditionings of the thermal barrier on the mechanical performance of the connection.

This document does not apply to thermal barriers which do not give a contribution to the mechanical resistance of the profiles.

This document is applicable to thermal barrier profiles designed mainly for windows, doors, screens and curtain walls.

This document does not apply to thermal barriers made only of metal profiles connected with metal pins or screws.

This current edition of EN 14024 will supersede EN 14024:2004. Differences in test procedures between the two versions will not lead to significant differences in test results. Therefore, existing test results according to EN 14024:2004 are considered as equivalent to new test results according to the current edition of EN 14024.

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 12519, *Windows and pedestrian doors — Terminology*

EN 14351-1, *Windows and doors — Product standard, performance characteristics — Part 1: Windows and external pedestrian doorsets*

EN 16759:2021, *Bonded glazing for doors, windows and curtain walling — Verification of mechanical performance of bonding*

EN ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps (ISO 4892-2)*

EN ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system (ISO 7500-1)*

EN ISO 22088-3, *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 3: Bent strip method (ISO 22088-3)*

EN ISO 22088-4, *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 4: Ball or pin impression method (ISO 22088-4)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply / the terms and definitions given in EN 12519 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 thermal barrier profile

profile composed of two or more metal sections connected by at least one thermally insulating (non-metallic) part

Note 1 to entry: The thermal barrier contributes to load transmission.

3.2 temperature categories

two temperature categories are defined and to be chosen according to the intended use (see Table 1)

Table 1 — Temperature categories and test temperature

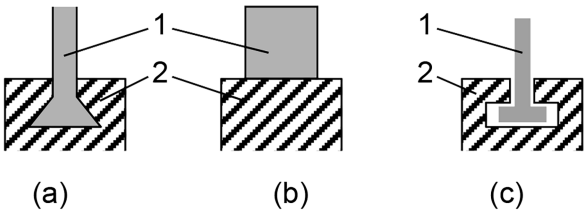
Temperature category	Low test temperature LT	High test temperature HT
TC1	$(-10 \pm 2) \text{ }^{\circ}\text{C}$	$(70 \pm 3) \text{ }^{\circ}\text{C}$
TC2	$(-20 \pm 2) \text{ }^{\circ}\text{C}$	$(80 \pm 3) \text{ }^{\circ}\text{C}$

Note 1 to entry: Temperature category TC2 includes Temperature category TC1.

Note 2 to entry: When specifically required (i.e. by the local climatic conditions or for specific application/project), voluntary tests can be carried out at adapted temperatures (LT and HT).

3.3 mechanical design systems

see Figure 1



- Key**
- 1 thermal barrier
 - 2 metal
 - (a) Type A system
 - (b) Type B system
 - (c) Type C system

Figure 1 — Schematic diagram of mechanical design systems

3.3.1

Type A system

system which is designed to transfer shear and in which shear failure will not reduce significantly the transverse tensile strength

3.3.2

Type B system

system which is designed to transfer shear and in which shear failure will negatively impair the transverse tensile strength

Note 1 to entry: E.g.: resin or foam poured into the gap between the two metal sections and hardened only by chemical reaction (Figure 2 a)) or flat strips of thermal barrier, only glued into the metal grooves (Figure 2 b)).

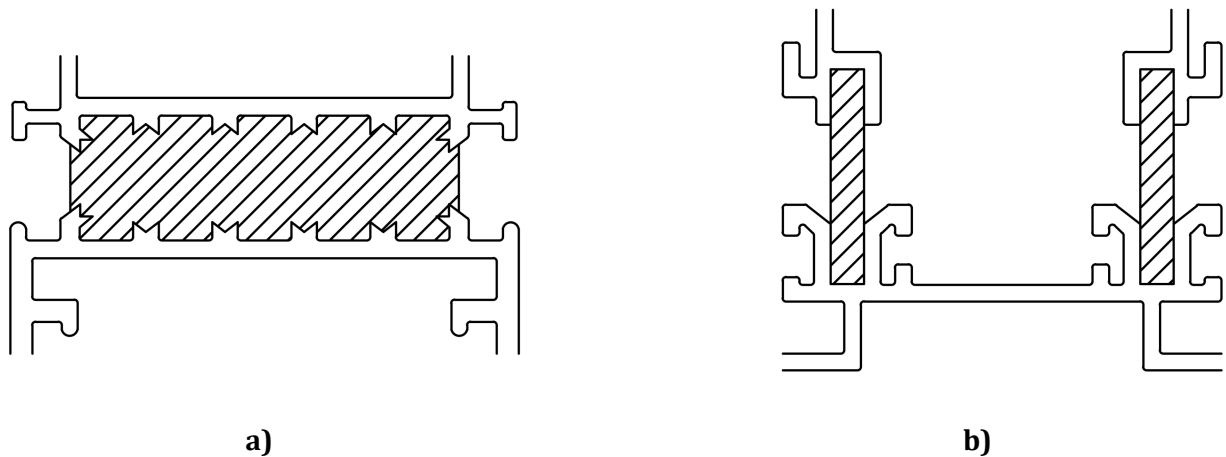


Figure 2 — Examples of mechanical design systems Type B

3.3.3

Type C system

system for which the shear transfer is not taken into account

3.4

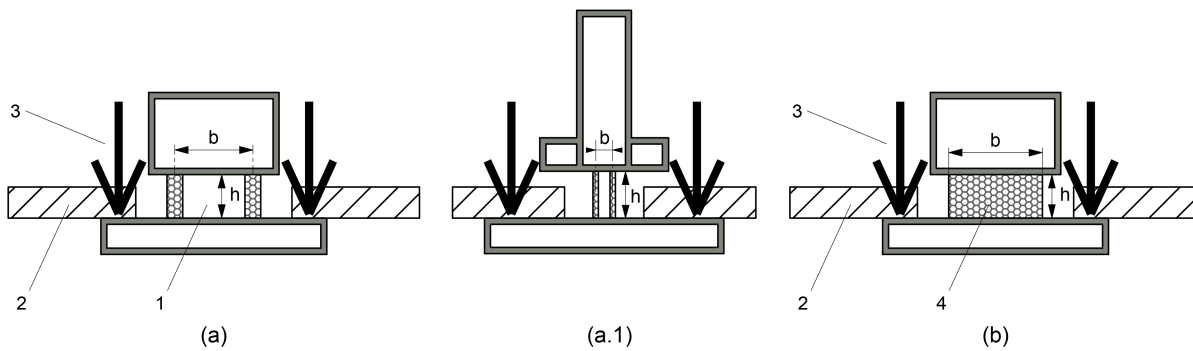
geometric design types

the following classification can be applied for thermal barrier profiles designed for windows, doors, curtain walls and their secondary parts

3.4.1

Type 1 profile

profile in which the thermal barrier is symmetrically loaded (see Figure 3), e.g. thermal barrier profile used in stick systems of curtain walls, symmetrically loaded (Figure 3 (a.1))



Key

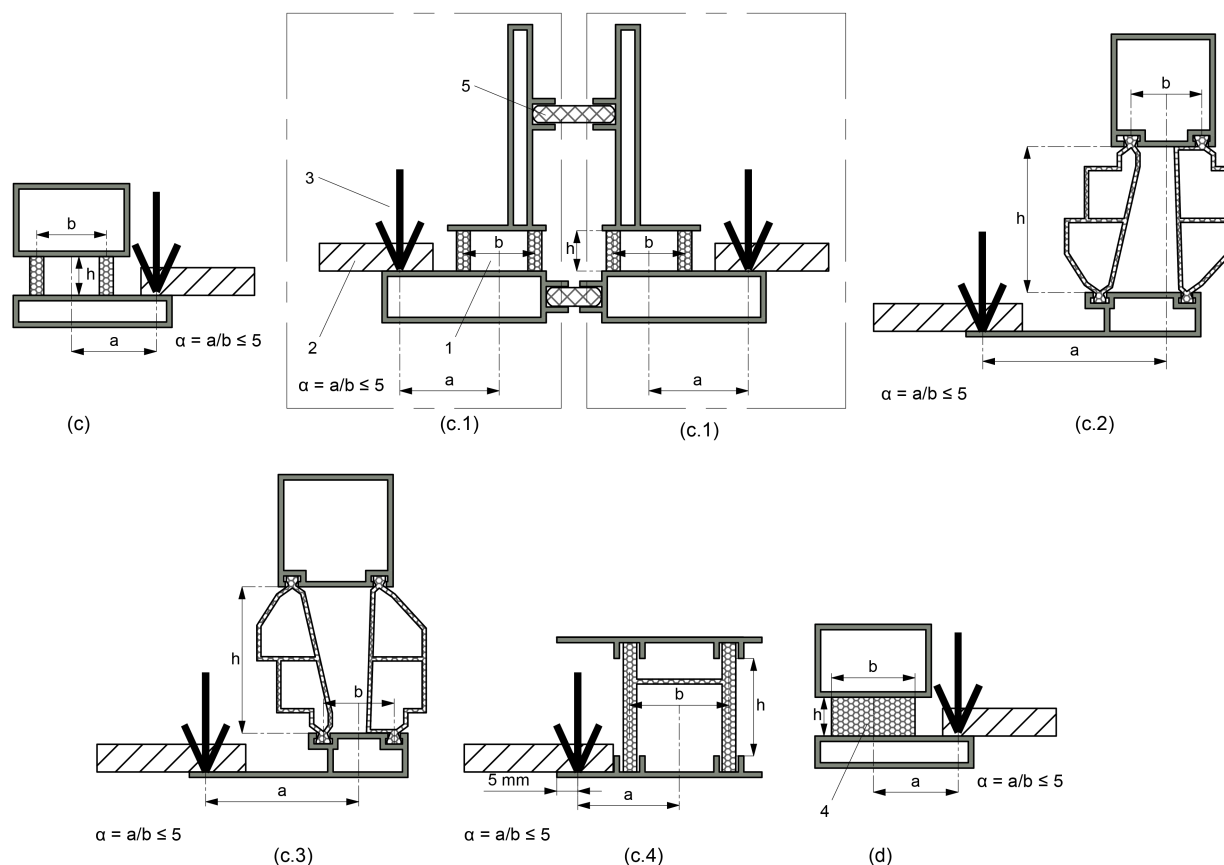
- 1 thermal barrier profile
- 2 glass pane
- 3 line load
- 4 mechanical design system type B

Figure 3 — Examples of geometric design type 1 (symmetrically loaded profile)

3.4.2

Type 2 profile

profile in which the thermal barrier is nearly symmetrically loaded, i.e. the eccentricity of the load $\alpha = a/b$ does not exceed the value of 5 (see Figure 4), e.g. thermal barrier profile used in unitized systems of curtain walls, nearly symmetrically loaded (Figure 4 (c.1))



Key

- 1 thermal barrier profile
- 2 glass pane
- 3 line load
- 4 mechanical design system type B
- 5 connection having no mechanical performances or no thermal barrier function (excluded from this document)

Figure 4 — Examples of geometric design type 2 (nearly symmetrically loaded profiles with eccentricity $\alpha = a/b \leq 5$)

Note 1 to entry: 5 mm is the reasonable distance, depending on the thermal barrier profile system, between the end of the profile and the central line of the groove (i.e. the foot of the gaskets).

3.4.3

Type 3 profile

profile in which the thermal barrier is asymmetrically loaded (see Figure 5), i.e. all profiles not covered by type 1 and type 2 with the resulting load parallel to the axis of the thermal barrier

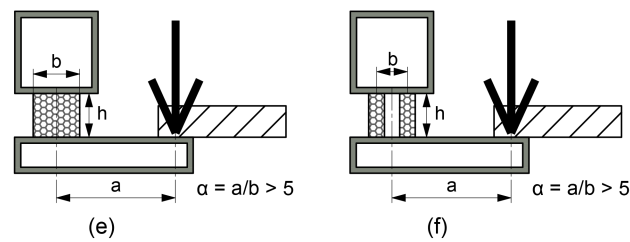


Figure 5 — Examples of geometric design type 3 (asymmetrically loaded profiles with eccentricity $\alpha = a/b > 5$)

3.4.4

Type 4 profile

profiles in which the resulting load is not parallel to the axis of the thermal barrier (e.g. non-symmetrically loaded profiles, see Figure 6). These geometric design types are not covered by this standard. The test method for some of these profiles are described in EN 16759:2021, Annex F. For non-symmetric profiles not covered by EN 16759, specific testing and/or a FEM analysis is required

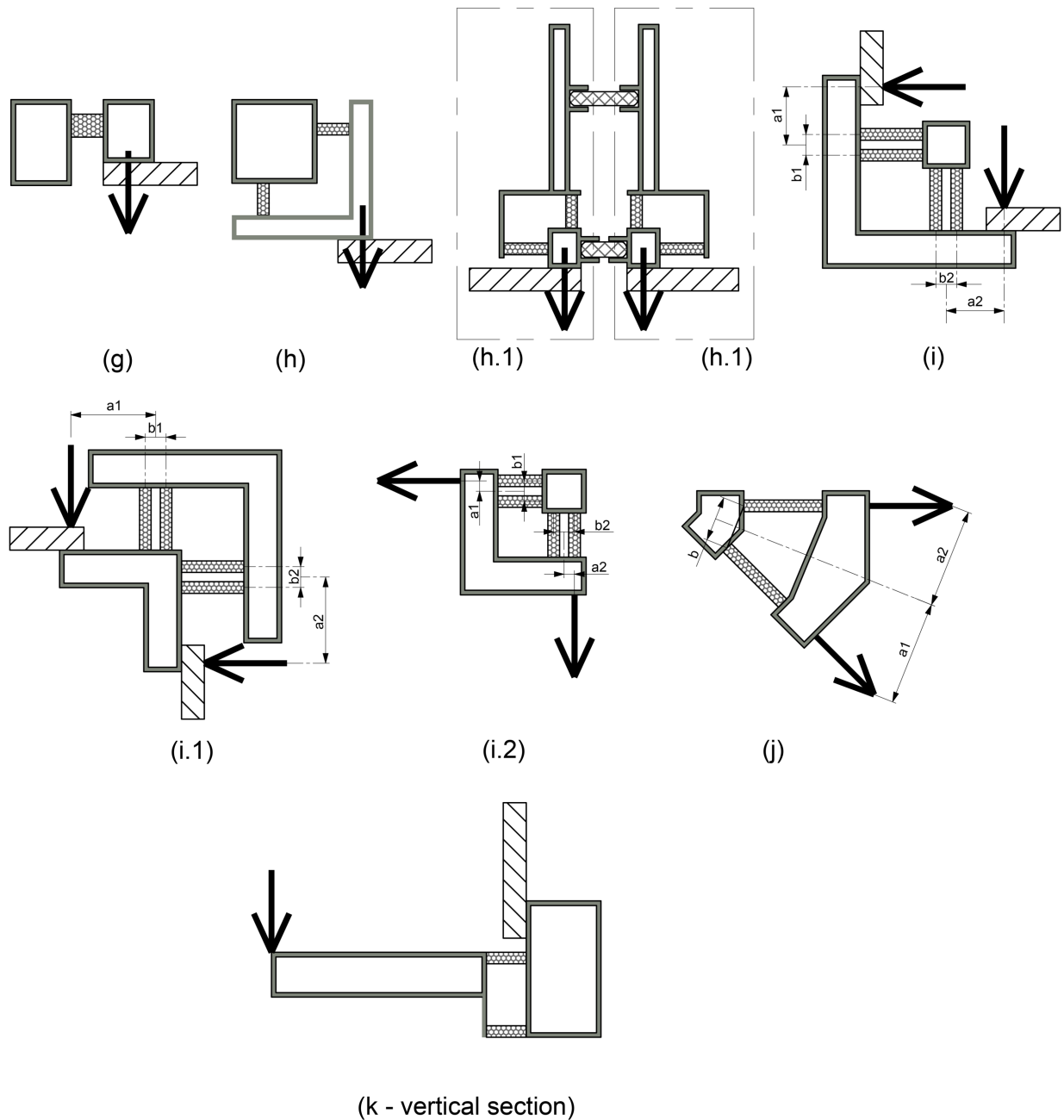


Figure 6 — Examples of geometric design type 4 (non-symmetrically loaded profiles)

For type 4, it is recommended to carry out a specific test simulating the real application of the load, since the behaviour of the profile depends on the way the profile is clamped and loaded.

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

A_1	Area of the metal section 1 [mm ²]
A_2	Area of the metal section 2 [mm ²]
A_o	Cross-section area of profile shell n°1
A_q	Parameter for the calculation of the normal stresses σ_q for a uniformly distributed load
A_T	Parameter for the calculation of the normal stresses σ_T for a uniformly distributed ΔT
A_u	Cross-section area of profile shell n°2
a	The lever arm of the acting moment measured from the centre line of (b) and the centre point of the load application area [mm]
b	The smallest dimension of the lever arm of the resistant moment of the thermal barrier [mm]
B_q	Parameter for the calculation of the maximal shear strength T_q for a simply supported beam with uniformly distributed load q
c	Elasticity constant [N/mm ²]
C	Measure of the effect of the elastic connection
C_d	Limiting design value of the relevant serviceability criterion
C_q	Parameter for the calculation of the mid-span deflection w_q for the uniformly distributed load
C_T	Parameter for the calculation of the mid-span deflection w_T for the uniformly distributed ΔT
E	Module of elasticity (i.e. Young module) [N/mm ²]
E_d	Effect of the action(s)
$E_{ULS;d}$	Design value of the effect of the action(s), expressed as calculated stress, caused by action(s) at the ultimate limit state
$E_{SLS;d}$	Design value of the effect of the action(s), expressed as calculated stress, caused by action(s) at the serviceability limit state
$E \{F_{SLS;d}\}$	Calculation of the effect of the serviceability limit state design value
$E \{F_{ULS;d}\}$	Calculation of the effect of the ultimate limit state design value
f	Remaining deformation after artificial ageing, method 2 [mm]
F	Force [N]
F_d	Design value of the action
$F_{SLS;d}$	Serviceability limit state design value of a single action or of a combination of actions

$F_{ULS;d}$	Ultimate limit state design value of a single action or of a combination of actions.
FEM	Numerical simulation analysis
G	Value of self-weight load
GC	Gravity centre of the compound profile
GC_O	Gravity centre of profile shell n°1
GC_u	Gravity centre of profile shell n°2
h	Initial height of the thermal barrier as the smallest distance between the metal sections in correspondence of the clamping point of the thermal barriers. See Figure 3, Figure 4 and Figure 5
I_1	Moment of inertia of the metal section 1
I_2	Moment of inertia of the metal section 2
I_{eff}	Effective moment of inertia [mm ⁴]
I_l	Moment of inertia of the loose compound
I_O	Second moment of area of profile shell n° 1
I_r	Moment of inertia of the rigid compound
I_u	Second moment of area of a profile shell n° 2
I_s	Rigid moment of inertia [mm ⁴]
l	Length of the test specimen [mm]
L	Span of the framing member [mm]
M_q	Maximal bending moment that for a simply supported beam with uniformly distributed load q
M_T	Maximal bending moment that for a simply supported beam with uniformly distributed temperature load
PA	Polyamide
PU	Polyurethanes
PPE	Polyphenylene ether
q	Uniformly distributed load
Q	Transverse tensile strength [N/mm]
$Q_{k,1}$	Value of the single action or dominant action
$Q_{k,i}$	Values of the actions which are not dominant
Q_{des}	Design transverse tensile strength [N/mm]
Q_q	Parameter for the calculation of the maximal shear strength T_q for a simply supported beam with uniformly distributed load q

R_C	Characteristic value of the resistance to the actions
R_d	Design value of the resistance to the actions
s	Standard deviation of the series under consideration
SLS	Service Limit State
ULS	Ultimate Limit State
T	Shear strength [N/mm]
T_q	Maximal shear strength for a simply supported beam with uniformly distributed load q
T_T	Maximal shear strength for a simply supported beam with uniformly distributed ΔT
TC1	Temperature category 1
TC2	Temperature category 2
t_m	Thickness of the metallic wall
t_b	Thickness of the thermal barrier
w_d	Allowable deflection
w_{max}	Maximum deflection calculated for the design load
w_q	Mid-span deflection for the uniformly distributed load
w_T	Mid-span deflection for the uniformly distributed ΔT
x	Coordinate related to the gravity centre of the both shells
x_o	Coordinate related to the gravity centre of the shell and the compound profile
x_u	Coordinate related to the gravity centre of the shell and the compound profile
z_{oo}	Coordinate related to the surface area above of profile shell n° 1
z_{ou}	Coordinate related to the surface area below of profile shell n° 1
z_{uo}	Coordinate related to the surface area above of profile shell n° 2
z_{uu}	Coordinate related to the surface area below of profile shell n° 2
Δh	Remaining deformation after artificial ageing, method 1 [mm]
ΔF	Increase of the load [N]
ΔT	Temperature differences [K]
$\Delta \delta$	Displacement [mm]
λ	Parameter depending on the geometry of the profile section, the elasticity constant c of the thermal barrier and the modulus of elasticity E of the metal and also on the span of the framing member L
α	Eccentricity of the load application, calculated as "a/b"

v	Compound part of the rigid moment of inertia
$\varphi_{c,s}$	Creep factor under shear load NOTE the corresponding symbol in accordance with EN 14024:2004 was: A_2
$\varphi_{c,t}$	Creep factor under transversal load
γ_G	Partial factor for permanent, also accounting for model uncertainties and dimensional variations
γ_m	Partial safety factor of the material
γ_M	Partial safety factor of the material that takes into account also the kind of connection and not only the material property (γ_m)
γ_Q	Partial factor for variable actions, also accounting for model uncertainties and dimensional variations
γ_{Rd}	Design factor for type B NOTE The corresponding symbol in accordance with EN 14024:2004 was: A_1
σ_{max}	Maximum stress calculated for the design load
σ_q	Normal stresses in the outer fibres of the two external metal profiles and in the contact area with the thermal barrier, for a simply supported beam with a uniformly distributed load q
σ_T	Normal stresses in the outer fibres of the two external metal profiles and in the contact area with the thermal barrier, for a simply supported beam subjected to an even temperature load ΔT
ψ	Combination factors for the actions
$\psi_{0,i}$	Combination factors for the actions which are not dominant
ψ_1	Partial factor for a frequent value of a variable action
ψ_2	Combination factor for a quasi-permanent value of a variable action
$\psi_{2,i}$	Combination factor for a quasi-permanent value of a variable action

For the purposes of this document, the following indexes apply.

c	Characteristic value which has a 95 % chance of being exceeded based on a normal distribution with 75 % confidence
d	Design value
HT	High temperature
LT	Low temperature
M1	After artificial ageing, method 1
M2	After artificial ageing, method 2
M3	After artificial ageing, method 3

Max.	Maximum
mean	Mean value
N	New, before artificial ageing
Req.	Required
RT	Room temperature

5 Requirements

5.1 General

Thermal barrier profiles shall be assessed through transverse tensile and shear tests, according to testing methods described in Clause 6. Values to be assessed for different profile types are specified in Table 2.

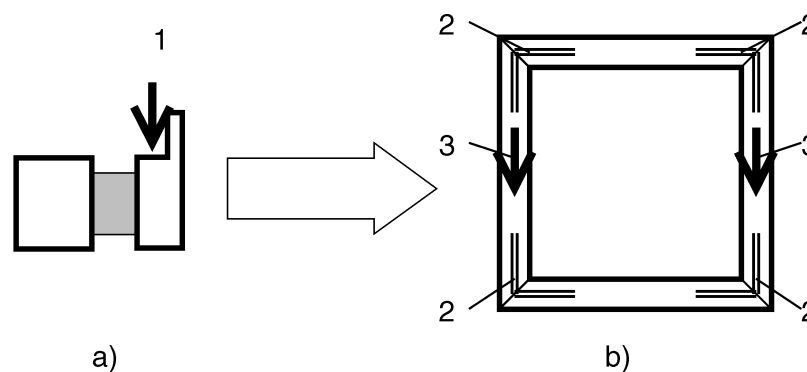
For assessing the shear related to the thermal barrier systems, three types A, B and C systems (see 3.3) shall be distinguished.

Because of the intrinsic robustness of type A system, shear and tensile strengths may be considered independently, whereas type B system requires the assessment of shear and tensile strengths together.

The transverse tensile strength of type A system and type C system shall be determined after shear failure. For type C system only the transverse tensile strength shall be determined, no shear strength and elasticity constant will be given.

This document doesn't cover thermal barrier supporting permanent loads except the following ones:

- a) the transversal tensile load created by conventional gaskets and glazing seals;
- b) for the type A and B systems mechanical designs, the vertical shear load created by the mechanical transfer of the infill panel self-weight from the horizontal profiles to the vertical ones (see Figure 7).

**Key**

- 1 self-weight of infill element
- 2 mechanical means (mechanical edge connection)
- 3 transferred self-weight
- a) horizontal profile section
- b) front view of a frame

Figure 7 — Transfer of the self-weight of the infill element to the vertical profile by mechanical means

For different and specific load cases not covered by EN 16759, validated numerical simulation analysis (FEM), other validated calculation methods, specific or direct testing may be required. All applied testing or calculation methods shall be based on reliable static theory or directly validated for the specific application.

5.2 Thermal barrier with mechanical functions

Thermal barrier composed of non-metallic materials, e.g. PA or PU based systems or improved synthetic materials, shall be tested in accordance with 6.2.

The aim of the test procedures is to assess the thermal barrier material independently of the shape of the thermal barrier and of the profile design, ensuring a material-related failure of the thermal barrier.

Materials used for the thermal barrier shall conform to the following requirements:

- a) the reduction of the characteristic value of transverse tensile strength after immersion in water (see 6.2.2) shall not exceed 30 % of the initial value;
- b) the reduction of the characteristic value of transverse tensile strength after exposure to humidity (see 6.2.3) shall not exceed 30 % of the initial value;
- c) the decrease of the characteristic value of transverse tensile strength during exposure to a sudden stress (see 6.2.4) shall not exceed 30 % of the initial value;
- d) determination of the creep factor under shear load (see 6.2.5).

If no results from previous tests are available, $\varphi_{C,S} = 1,2$ can be used as a reference value in case of a thermal barrier made of polyamide 66 with 25 % glass-fibres (PA 66 GF 25) and a density $\geq 0,9 \text{ g/cm}^3$, when the methodology of the connection follows B.2 Example 1.

In case of new methods of connecting the two metal parts with the thermal barrier, or in case of a new or another material of the thermal barrier, the aging coefficient $\varphi_{c,s}$ shall be determined by evaluation in accordance with 6.6.5;

- e) determination of the creep factor under transversal load (see 6.2.6).

If no results from previous tests are available, $\varphi_{c,t} = 1,5$ can be used as a reference value in case of a thermal barrier made of polyamide 66 with 25 % glass-fibres (PA 66 GF 25) and a density $\geq 0,9 \text{ g/cm}^3$, when the methodology of the connection follows B.2 Example 1.

In case of new methods of connecting the two metal parts with the thermal barrier, or in case of a new or another material of the thermal barrier, the creep factor $\varphi_{c,t}$ shall be determined by evaluation in accordance with 6.6.6;

- f) customary chemical media, which possibly have contact to the thermal barrier, like window and facade cleaning agents or cutting and drilling oils shall not cause additional or increased tensile cracks during storage in the agents (see 6.2.8);
- g) the reduction of the characteristic value of transverse tensile strength after exposure to UV radiation (see 6.2.7) should not exceed 30 % of the initial value.

NOTE Due to the current limited experience, this criterion is a recommendation and not a requirement.

The performance of the material used for the thermal barrier according to the above-mentioned requirements, shall be at least proven once before this material is used for a thermal barrier.

New or recurring tests are not required as long as the material and the production process of the thermal barrier remains the same type.

The material related tests are valid for any metal profile with thermal barrier provided B.2 (the first two bullets) Annex B are verified.

5.3 Mechanical resistance

Depending on the requirements specified by the design process (e.g. performances required to the thermal barrier profile, loads, etc.) and the geometry type of the thermal barrier system, the mechanical properties of the profile to be evaluated by testing are listed in Table 2.

The mechanical resistance of the profile shall be evaluated:

- when no previous test verifying the Annex B (B.2 and B.3) are available, or
- according the requirements related to the design process (i.e. cases where the geometry, loads or the complexity of the design require a complete and sophisticated analysis).

For simple application cases as specified D.2 the full range of test given in Table 2 is not required. Only use requirements according to product standard EN 14351-1 shall be assessed. This includes the evaluation of deflection at the serviceability limit state and an estimation of the product quality to avoid inconveniences over time.