

Thermal insulation and light weight fill products for civil engineering applications — Factory made products of extruded polystyrene foam (XPS) — Specification

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National foreword

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Produits isolants thermiques et de remblayage pour les applications de génie civil - Produits manufacturés en mousse de polystyrène extrudé (XPS) - Spécifications

Wärmedämmung und leichte Füllprodukte für Anwendungen im Tiefbau - Werkmäßig hergestellte Produkte aus extrudiertem Polystyrolschaum (XPS) - Spezifikation

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Contents

Page

Foreword.....	4
1 Scope	5
2 Normative references	5
3 Terms, definitions, symbols, units and abbreviated terms	6
3.1 Terms and definitions	6
3.2 Symbols, units and abbreviated terms.....	7
4 Requirements	9
4.1 General.....	9
4.2 For all applications	9
4.3 For specific applications.....	11
5 Test methods.....	17
5.1 Sampling	17
5.2 Conditioning.....	17
5.3 Testing	17
6 Designation code	20
7 Evaluation of conformity.....	21
8 Marking and labelling	22
Annex A (normative) Determination of the declared values of thermal resistance and thermal conductivity	23
A.1 Introduction	23
A.2 Input data	23
A.3 Declared values.....	23
Annex B (normative) Factory Production Control	25
Annex C (normative) Determination of the aged values of thermal resistance and thermal conductivity	29
C.1 Scope	29
C.2 Procedure for XPS foam without diffusion tight laminates.....	29
C.3 Procedure for XPS foam for use with diffusion tight facings on both sides.....	30
C.4 Calculation of aged value	31
C.5 Blowing agent	32
C.6 Product grouping.....	32
Annex D (normative) Determination of behaviour under cyclic square wave load.....	33
D.1 Scope	33
D.2 Definitions	33
D.3 Principle.....	34
D.4 Testing equipment.....	34
D.5 Test specimens	35
D.6 Procedure	35
D.7 Calculation and expression of results.....	37
D.8 Accuracy of measurement.....	38
D.9 Test report	38
Annex E (informative) Additional properties	39
E.1 General.....	39
E.2 Compressive modulus of elasticity	39
E.3 Determination of volume percentage of open and closed cells	39

E.4	Determination of shear strength	39
Annex ZA	(informative) Relationship between this European Standard and the Essential Requirements of EU Directive 89/106/EEC, EU Construction Products Directive	41
ZA.1	Scope and relevant characteristics	41
ZA.2	Procedures for the attestation of conformity of extruded polystyrene foam products	43
ZA.3	CE Marking and labelling	48
	Bibliography	50

Figures

Figure D.1	Required load cycle during the fatigue test	35
Figure D.2	Dimensions of the test specimen	36
Figure D.3	Test set-up	37
Figure ZA.1	Example CE marking information	49

Tables

Table 1	Tolerances of length, width, squareness and flatness	10
Table 2	Classes for thickness tolerances	10
Table 3	Levels for compressive stress at 10 % deformation or compressive strength	11
Table 4	Levels for deformation under specified compressive load and temperature conditions	12
Table 5	Levels for compressive stress at 2 % deformation or compressive strength	13
Table 6	Levels for compressive stress at 5 % deformation or compressive strength	13
Table 7	Levels for long term water absorption by total immersion	16
Table 8	Levels for long term water absorption by diffusion	16
Table 9	Levels for Freeze-thaw resistance	16
Table 10	Test methods, test specimens and conditions	18
Table A.1	Values of k for one sided 90 % tolerance interval with a confidence level of 90 %	24
Table B.1	Minimum product testing frequencies	25
Table B.2	Minimum product testing frequencies for the reaction to fire characteristics	27
Table E.1	Test methods, test specimens, conditions and minimum testing frequencies	40
Table ZA.1	Relevant clauses	42

Foreword

This document (EN 14934:2007) has been prepared by Technical Committee CEN/TC 88 “Thermal insulating materials and products”, the secretariat of which is held by DIN.

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 March 2008, and conflicting national standards shall be withdrawn at the latest by March 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

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1 Scope

This European Standard specifies the requirements for factory made products of extruded polystyrene foam which are used for frost insulation of roads, railways, trafficked areas, light weight fill for reduction of horizontal and vertical earth pressure and other civil engineering applications.

The products are manufactured in the form of boards, which are also available with special edge and surface treatment (tongue & grooves, shiplap etc.). The standard also covers multilayered insulation boards.

This standard describes product characteristics and includes procedures for testing, evaluation of conformity, marking and labelling.

The standard does not specify the required level of a given property to be achieved by a product to demonstrate fitness for purpose in a particular application. The classes and levels required for a given application are to be found in regulations or non-conflicting standards.

For applications where thermal resistance is required, products with a declared thermal resistance lower than $0,25 \text{ m}^2\cdot\text{K}/\text{W}$ or a declared thermal conductivity greater than $0,060 \text{ W}/(\text{m}\cdot\text{K})$ are not covered by this standard. This standard does not cover in situ insulation products and products intended to be used for insulation of buildings, of building equipment and industrial installations or products intended for acoustic insulation.

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.

EN 822, *Thermal insulating products for building applications — Determination of length and width*

EN 823, *Thermal insulating products for building applications — Determination of thickness*

EN 824, *Thermal insulating products for building applications — Determination of squareness*

EN 825, *Thermal insulating products for building applications — Determination of flatness*

EN 826, *Thermal insulating products for building applications — Determination of compression behaviour*

EN 1604, *Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions*

EN 1605, *Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions*

EN 1606, *Thermal insulating products for building applications — Determination of compressive creep*

EN 12086:1997, *Thermal insulating products for building applications — Determination of water vapour transmission properties*

EN 12087, *Thermal insulating products for building applications — Determination of long term water absorption by immersion*

EN 12088, *Thermal insulating products for building applications — Determination of long term water absorption by diffusion*

EN 12089, *Thermal insulating products for building applications — Determination of bending behaviour*

EN 12091, *Thermal insulating products for building applications — Determination of freeze-thaw resistance*

EN 12667, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Products of high and medium thermal resistance*

EN 12939, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Thick products of high and medium thermal resistance*

EN 13172:2001, *Thermal insulating products — Evaluation of conformity*

EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire test*

EN 13793, *Thermal insulating products for building applications — Determination of behaviour under cyclic loading*

EN 13823, *Reaction to fire tests for building products — Building products excluding floorings exposed to thermal attack by a single burning item*

EN ISO 1182, *Reaction to fire tests for building products — Non combustibility test (ISO 1182:2002)*

EN ISO 1716, *Reaction to fire tests for building products — Determination of the heat of combustion (ISO 1716:2002)*

EN ISO 9229:2007, *Thermal insulation — Vocabulary (ISO 9229:2007)*

EN ISO 11925-2, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 2: Single-flame source test (ISO 11925-2:2002)*

ISO 12491, *Statistical methods for quality control of building materials and components*

3 Terms, definitions, symbols, units and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1 Terms and definitions as given in EN ISO 9229:2007

3.1.1.1

extruded polystyrene foam

rigid cellular plastics insulation material expanded and extruded with or without a skin, from polystyrene or one of its copolymers and which has a closed cell structure

3.1.1.2

board

rigid or semi-rigid insulation product of rectangular shape and cross section in which the thickness is uniform and substantially smaller than the other dimensions

3.1.2 Additional definitions

3.1.2.1

level

given value which is the upper or lower limit of a requirement. The level is given by the declared value of the characteristic concerned

3.1.2.2

class

combination of two levels of the same property between which the performance shall fall

3.2 Symbols, units and abbreviated terms

Symbols and units used in this standard:

b	is the width	mm
d	is the thickness	mm
d_N	is the nominal thickness of the product	mm
d_s	is the thickness of test specimen	mm
D_i	is the relative compression after i number of cycles	%
$\Delta \varepsilon_b$	is the relative change in width	%
$\Delta \varepsilon_d$	is the relative change in thickness	%
$\Delta \varepsilon_l$	is the relative change in length	%
ε_{ct}	is the compressive creep	%
ε_t	is the total relative thickness reduction	%
$\varepsilon_{l,max}$	is the relative maximum deformation	%
ε_1	is the relative deformation after step A	%
ε_2	is the relative deformation after step B	%
k	is a factor related to the number of test results available	—
l	is the length	mm
$\lambda_{90/90}$	is the 90 % fractile with a confidence level of 90 % for the thermal conductivity	W/(m·K)
$\lambda_{90/90, 60d}$	is the 90 % fractile with a confidence level of 90 % for the thermal conductivity of foam at 60 days	W/(m·K)
$\lambda_{90/90>60d}$	is the 90 % fractile with a confidence level of 90 % for the thermal conductivity of foam older than 60 days	W/(m·K)
λ_D	is the declared thermal conductivity	W/(m·K)
λ_i	is one test result of thermal conductivity	W/(m·K)
λ_{mean}	is the mean thermal conductivity	W/(m·K)
$\lambda_{mean, a}$	is the mean thermal conductivity of aged values	W/(m·K)

$\lambda_{\text{mean}, 60\text{d}}$	is the mean thermal conductivity of values for 60 days old foam	W/(m·K)
$\lambda_{> 60\text{d}}$	is the measured value of the thermal conductivity of foam older than 60 days	W/(m·K)
μ	is the water vapour diffusion resistance factor	—
n	is the number of test results	—
$R_{90/90}$	is the 90 % fractile with a confidence level of 90 % for the thermal resistance	m ² ·K/W
$R_{90/90, 60\text{d}}$	is the 90 % fractile with a confidence level of 90 % for the thermal resistance of foam at 60 days	m ² ·K/W
$R_{90/90>60\text{d}}$	is the 90 % fractile with a confidence level of 90 % for the thermal resistance of foam older than 60 days	m ² ·K/W
R_D	is the declared thermal resistance	m ² ·K/W
R_i	is one test result of thermal resistance	m ² ·K/W
R_{mean}	is the mean thermal resistance	m ² ·K/W
S_b	is the deviation from squareness on length and width	mm/m
S_{max}	is the deviation from flatness	mm/m
s_R	is the estimate of the standard deviation of the thermal resistance	m ² ·K/W
s_λ	is the estimate of the standard deviation of the thermal conductivity	W/(m·K)
$s_{\lambda a}$	is the estimate of the standard deviation of the aged thermal conductivity	W/(m·K)
$s_{\lambda i}$	is the estimate of the standard deviation of the initial thermal conductivity within 90 days of production	W/(m·K) W/(m·K)
σ_2	is the compressive stress at 2 % deformation	kPa
σ_5	is the compressive stress at 5 % deformation	kPa
σ_{10}	is the compressive stress at 10 % deformation	kPa
σ_c	is the declared compressive stress	kPa
σ_i	is the compressive stress applied for resistance to cyclic compressive loading	kPa
σ_m	is the compressive strength	kPa
σ_b	is the bending strength	kPa
W_{dV}	is the water absorption by diffusion	% by volume
W_{it}	is the long term water absorption by total immersion	% by volume
W_V	is the water absorption by freeze-thaw after water absorption by diffusion	% by volume
Z	is the water vapour resistance	m ² ·h·Pa/mg
BS	is the symbol of the declared level for bending strength	
CC($i_1/i_2/y$) σ_c	is the symbol of the declared level for compressive creep	

CLR(i,z) σ_i	is the symbol of the declared level for resistance to cyclic compressive loading with sinus load application
CLRT(i,z) σ_i	is the symbol of the declared level for resistance to cyclic compressive loading with square wave load application
CS(10\Y)	is the symbol of the declared level for compressive stress at 10 % deformation or compressive strength
CS(5\Y)	is the symbol of the declared level for compressive stress at 5 % deformation or compressive strength
CS(2\Y)	is the symbol of the declared level for compressive stress at 2 % deformation or compressive strength
DLT(2)5	is the symbol of the declared level of deformation under specified compressive load and temperature at conditions set 2 with a maximum of 5 % deformation
DS(T+)	is the symbol of the declared value for dimensional stability at specified temperature
DS(TH)	is the symbol of the declared value for dimensional stability under specified temperature and humidity
FTC	is the symbol of the declared level for freeze-thaw resistance
MU	is the symbol of the declared level for water vapour diffusion resistance factor
T	is the symbol of the declared class for thickness tolerances
WD(V)	is the symbol of the declared level for water absorption by diffusion
WL(T)	is the symbol of the declared level for long term water absorption by total immersion
Z	is the symbol of the declared value for water vapour resistance

Abbreviated terms used in this standard:

XPS is extruded polystyrene foam

4 Requirements

4.1 General

Product properties shall be assessed in accordance with Clause 5. To comply with this standard, products shall meet the requirements of 4.2, and the requirements of 4.3 as appropriate.

NOTE Information on additional properties is given in Annex E.

One test result for a product property is the average of the measured values on the number of test specimens given in Table 10.

4.2 For all applications

4.2.1 Length, width, squareness, flatness

Length, l , and width, b , shall be determined in accordance with EN 822, the squareness on length and width, S_b , in accordance with EN 824, and the flatness, S_{max} , in accordance with EN 825. No test result shall deviate from the declared values by more than the tolerances given in Table 1.

Table 1 — Tolerances of length, width, squareness and flatness

Declared length or width	Tolerances		
	Length or width	Squareness on length and width	Flatness
mm	mm	S_b mm/m	S_{max} mm
less than 1 000	± 8	5	7,0
1 000 to 2 000	± 10	5	14,0
> 2 000 to 4 000	± 10	5	28,0
> 4 000	± 10	5	35,0

4.2.2 Thickness

Thickness, d , shall be determined in accordance with EN 823. No test result shall deviate from the nominal thickness, d_N , by more than the tolerances given in Table 2 for the labelled class.

Table 2 — Classes for thickness tolerances

Class	Tolerances mm		Thickness mm
T1	- 2	+ 2	< 50
	- 2	+ 3	$50 \leq d_N \leq 120$
	- 2	+ 8	> 120
T2	- 1,5	+ 1,5	< 50
	- 1,5	+ 1,5	$50 \leq d_N \leq 120$
	- 1,5	+ 1,5	> 120
T3	- 1	+ 1	< 50
	- 1	+ 1	$50 \leq d_N \leq 120$
	- 1	+ 1	> 120

4.2.3 Dimensional stability under specified temperature and humidity conditions

Dimensional stability under specified temperature and humidity conditions shall be determined in accordance with EN 1604. The test shall be carried out after storage for 48 h at $(23 \pm 2)^\circ\text{C}$ and $(90 \pm 5)\%$ relative humidity. The relative changes in length, $\Delta\epsilon_l$, in width, $\Delta\epsilon_b$, and in thickness, $\Delta\epsilon_d$, shall not exceed 2 %.

This test shall not be performed when the more severe test, described in 4.3.2.2 is used.

4.2.4 Compressive stress at 10 % deformation or compressive strength

The compressive stress at 10 % deformation, σ_{10} , or the compressive strength, σ_m , shall be determined in accordance with EN 826. No test result for either the compressive stress at 10 % deformation, σ_{10} , or the compressive strength, σ_m , whichever is the greatest, shall be lower than the values given in Table 3 for the declared level.

Table 3 — Levels for compressive stress at 10 % deformation or compressive strength

Level	Requirement kPa
CS(10\Y) 100	>100
CS(10\Y) 200	≥ 200
CS(10\Y) 250	≥ 250
CS(10\Y) 300	≥ 300
CS(10\Y) 350	≥ 350
CS(10\Y) 400	≥ 400
CS(10\Y) 450	≥ 450
CS(10\Y) 500	≥ 500
CS(10\Y) 600	≥ 600
CS(10\Y) 650	≥ 650
CS(10\Y) 700	≥ 700
CS(10\Y) 800	≥ 800
CS(10\Y) 900	≥ 900
CS(10\Y) 1000	≥ 1000

4.2.5 Reaction to fire

4.2.5.1 Reaction to fire classification

Reaction to fire classification (Euroclasses) shall be determined in accordance with EN 13501-1.

4.2.5.2 Continuous glowing combustion

Where subject to regulation, the continuous glowing combustion shall be declared. In the absence of a European test method which is under development, the existing relevant national test method applies.

4.3 For specific applications

4.3.1 General

If there is no requirement for a property described in 4.3 for a product in use, then the property does not need to be determined and declared by the manufacturer.

4.3.2 Dimensional stability under specified conditions

4.3.2.1 Dimensional stability at specified temperature

Dimensional stability at specified temperature shall be determined in accordance with EN 1604. The test shall be carried out after storage for 48 h at $(70 \pm 2) ^\circ\text{C}$. The relative changes in length, $\Delta\epsilon_l$, in width, $\Delta\epsilon_b$, and in thickness, $\Delta\epsilon_d$, shall not exceed 5 %.

4.3.2.2 Dimensional stability under specified temperature and humidity conditions

Dimensional stability under specified temperature and humidity conditions shall be determined in accordance with EN 1604. The test shall be carried out after storage for 48 h at $(70 \pm 2) ^\circ\text{C}$ and $(90 \pm 5) \%$ relative humidity. The relative changes in length, $\Delta\epsilon_l$, in width, $\Delta\epsilon_b$, and in thickness, $\Delta\epsilon_d$, shall not exceed 5 %.

4.3.2.3 Deformation under specified compressive load and temperature conditions

Deformation under specified compressive load and temperature conditions shall be determined in accordance with EN 1605. For the test condition the difference between the relevant deformation, ϵ_1 , after step A and, ϵ_2 , after step B as described in EN 1605 shall not exceed the value in percent given in Table 4 for the declared level.

Table 4 — Levels for deformation under specified compressive load and temperature conditions

Level	Test conditions	Requirement %
DLT(2) 5	load: 40 kPa temperature: $(70 \pm 1) ^\circ\text{C}$ time: $(168 \pm 1) \text{ h}$	≤ 5

4.3.3 Compressive stress at 2 % and 5 % deformation or compressive strength

The compressive stress at 2 % and/ or 5 % deformation, σ_2 , and/or, σ_5 , or the compressive strength, σ_m , shall be determined in accordance with EN 826. No test result for either the compressive stress at 2 % and/or 5 % deformation, σ_2 , and/ or, σ_5 , or the compressive strength, σ_m , whichever is the greatest, shall be lower than the values given in Table 5 and Table 6 for the declared level.

NOTE Although EN 826 does not specify the calculation of the compressive stress at 2 % and 5 % deformation, the calculation should be done in the same way.

Table 5 — Levels for compressive stress at 2 % deformation or compressive strength

Level	Requirement kPa
CS(2\Y) 100	> 100
CS(2\Y) 200	≥ 200
CS(2\Y) 250	≥ 250
CS(2\Y) 300	≥ 300
CS(2\Y) 350	≥ 350
CS(2\Y) 400	≥ 400
CS(2\Y) 450	≥ 450
CS(2\Y) 500	≥ 500
CS(2\Y) 600	≥ 600
CS(2\Y) 650	≥ 650
CS(2\Y) 700	≥ 700
CS(2\Y) 800	≥ 800
CS(2\Y) 900	≥ 900
CS(2\Y) 1 000	≥ 1.000

Table 6 — Levels for compressive stress at 5 % deformation or compressive strength

Level	Requirement kPa
CS(5\Y) 100	> 100
CS(5\Y) 200	≥ 200
CS(5\Y) 250	≥ 250
CS(5\Y) 300	≥ 300
CS(5\Y) 350	≥ 350
CS(5\Y) 400	≥ 400
CS(5\Y) 450	≥ 450
CS(5\Y) 500	≥ 500
CS(5\Y) 600	≥ 600
CS(5\Y) 650	≥ 650
CS(5\Y) 700	≥ 700
CS(5\Y) 800	≥ 800
CS(5\Y) 900	≥ 900
CS(5\Y) 1 000	≥ 1.000

4.3.4 Point load

The effects of foot traffic shall be assessed by means of determination of the compressive stress or the compressive strength in accordance with EN 826, see 4.2.4.

4.3.5 Compressive creep

Compressive creep, ε_{ct} , and total thickness reduction, ε_t , shall be determined after at least one hundred twenty two days of testing at a declared compressive stress, σ_c , given in steps of at least 1 kPa, and the results extrapolated thirty times, corresponding to ten years, to obtain the declared levels in accordance with EN 1606. Tests shall be done with samples that do not exceed the compressive stress or compressive strength according to the level of Table 3 by more than 10 %. Compressive creep shall be declared in levels, i_2 and the total thickness reduction shall be declared in levels, i_1 , with steps of 0,5% at the declared stress. No test result shall exceed the declared levels at the declared stress.

NOTE 1 For building applications a total thickness reduction, ε_t , of 2 % and an exploration time of 50 years are generally required.

NOTE 2 Examples for declaration of levels for compressive creep.

Level	Test time days	Extrapolation time years	Declared stress kPa	Requirement %
$CC(i_1/i_2/10)\sigma_c$	122	10	σ_c	$\varepsilon_t \leq i_1$ and $\varepsilon_{ct} \leq i_2$
$CC(i_1/i_2/25)\sigma_c$	304	25	σ_c	$\varepsilon_t \leq i_1$ and $\varepsilon_{ct} \leq i_2$
$CC(i_1/i_2/50)\sigma_c$	608	50	σ_c	$\varepsilon_t \leq i_1$ and $\varepsilon_{ct} \leq i_2$

NOTE 3 Referring to the designation code $CC(i_1/i_2/y)\sigma_c$, according to Clause 6, a declared level $CC(2/1.5/50)100$, for example, indicates a value not exceeding 1,5 % for compressive creep and 2 % for total thickness reduction after extrapolation at 50 years (i.e. 30 times six hundred eight days of testing) under a declared stress of 100 kPa.

4.3.6 Resistance to cyclic compressive loading

4.3.6.1 Resistance to cyclic compressive loading with square wave load application

The resistance to cycling compressive loading with square wave load application shall be determined in accordance with Annex D and shall be used specifically for railway applications. The relative compression, D_i , in %, shall be determined after a defined number of load cycles and the applied compressive stress, σ_i . The relative compression, D_i , shall be declared as level, i . No test result shall exceed the declared level of, D_i , after 2×10^6 load cycles at the declared stress.

NOTE For railway applications typically a relative compression, D_i , of 5 % after 2×10^6 load cycles at a compressive stress or compressive strength of 100 to 300 kPa are generally required.

4.3.6.2 Resistance to cyclic compressive loading with sinus load application

The resistance to cycling compressive loading with sinus load application shall be determined in accordance either with EN 13793. The relative deformation, $\varepsilon_{i,max}$, in percent shall be determined after a defined number of load cycles and the applied compressive stress, σ_i . The relative deformation, $\varepsilon_{i,max}$, shall be declared as level, i . No test result shall exceed the declared level at the declared number of load cycles and the declared stress.

4.3.7 Bending strength

Bending strength, σ_b , shall be determined in accordance with EN 12089.

XPS products may be tested in the extrusion direction or in the cross direction, depending on the application. No test result of, σ_b , shall be lower than the declared level, BS, chosen from the following levels: 300 kPa, 400 kPa, 500 kPa, 600 kPa, 700 kPa, 800 kPa, 900 kPa, 1 100 kPa, 1 300 kPa, 1 700 kPa, 1 900 kPa, 2 100 kPa, 2 300 kPa, 2 500 kPa, 3 000 kPa, 3 500 kPa, 4 000 kPa.

4.3.8 Thermal resistance and thermal conductivity

The thermal resistance and thermal conductivity shall be based upon measurements carried out in accordance with EN 12667 or EN 12939 for thick products. For light weight fill applications without thermal insulation requirements it is permitted to declare the maximum thermal conductivity value as defined in the Scope of this European Standard (0,060 W/(m·K)).

The thermal resistance and thermal conductivity shall be determined in accordance with Annex A and Annex C and declared by the manufacturer according to the following:

- the reference mean temperature shall be 10 °C;
- the measured values shall be expressed with three significant figures;
- the thermal resistance, λ_D , shall always be declared. The thermal conductivity, λ_D , shall be declared where possible;
- the declared thermal resistance, λ_D , and the declared thermal conductivity, λ_D , shall be given as limit values representing at least 90 % of the production, determined with a confidence level of 90 %;
- the value of thermal conductivity, $\lambda_{90/90}$, shall be rounded upwards to the nearest 0,001 W/(m·K) and declared as λ_D in levels with steps of 0,001 W/(m·K);
- the declared thermal resistance, λ_D , shall be calculated from the nominal thickness, d_N , and the corresponding thermal conductivity value, $\lambda_{90/90}$, unless measured directly;
- the value of thermal resistance, $R_{90/90}$, when calculated from the nominal thickness, d_N , and the corresponding thermal conductivity, $\lambda_{90/90}$, shall be rounded downwards to the nearest 0,05 m²·K/W, and declared as λ_D in levels with steps of 0,05 m²·K/W;
- the value of, $R_{90/90}$, for those products for which only the thermal resistance is measured directly, shall be rounded downwards to the nearest 0,05 m²·K/W and declared as λ_D in levels with steps of 0,05 m²·K/W.

4.3.9 Water absorption

4.3.9.1 Long term water absorption by immersion

Water absorption by total immersion, W_{lt} , shall be determined in accordance with EN 12087 method 2A. No test result shall be higher than the value given in Table 7, for the declared level.