BS EN 12524:2000

Building materials and products — Hygrothermal properties — Tabulated design values

The European Standard EN 12524:2000 has the status of a British Standard

ICS 91.100.01; 91.120.10

National foreword

This British Standard is the official English language version of EN 12524:2000.

The UK participation in its preparation was entrusted by Technical Committee B/540, Energy performance of materials, components and buildings, to Subcommittee B/540/1, European standards for thermal insulation, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 10, an inside back cover and a back cover.

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Building materials and products – Hygrothermal properties – Tabulated design values

Matériaux et produits pour le bâtiment – Propriétés hygrothermiques – Valeurs utiles tabulées

Baustoffe und -produkte – Wärme- und feuchteschutztechnische Eigenschaften – Tabellierte Bemessungswerte

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 89, Thermal performance of buildings and building components, the Secretariat of which is held by SIS.

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of an identical text or by endorsement, at the latest by October 2000, and conflicting national standards shall be withdrawn at the latest by December 2001.

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This standard is one of a series of standards for the evaluation of the thermal performance of building materials and products.

1 Scope

This standard gives design data in tabular form for heat and moisture transfer calculations, for thermally homogeneous materials and products commonly used in building construction.

It also gives data to enable the calculation and conversion of design thermal values for various environmental conditions.

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 these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN ISO 7345, Thermal insulation – Physical quantities and definitions (ISO 7345:1987).

EN ISO 9346, Thermal insulation – Mass transfer – Physical quantities and definitions (ISO 9346:1987).

EN ISO 10456, Thermal insulation – Building materials and products – Determination of declared and design thermal values (ISO 10456:1999).

3 Definitions, symbols and units

3.1 Definitions

For the purposes of this standard, the terms and definitions given in EN ISO 7345, EN ISO 9346 and the following apply.

3.1.1
declared thermal value
expected value of a thermal property of a building material or product
- assessed from measured data at reference conditions of temperature and humidity
- given for a stated fraction and confidence level
- corresponding to a reasonable expected service lifetime under normal conditions

[EN ISO 10456]

3.1.2
design thermal value
value of thermal property of a building material or product under specific external and internal conditions which may be considered as typical of the performance of that material or product when incorporated in a building component
[EN ISO 10456]

3.2 Symbols and units

Symbol	Quantity	Unit
c_p	specific heat capacity at constant pressure	J/(kg·K)
f_u	moisture conversion coefficient, mass by mass[1]	kg/kg
f_ψ	moisture conversion coefficient, volume by volume[2]	m^3/m^3
s_d	water vapour diffusion-equivalent air layer thickness	m
u	moisture content, mass by mass[2]	kg/kg
λ	thermal conductivity	W/(m·K)
ρ	density	kg/m^3
ψ	moisture content, volume by volume[3]	m^3/m^3
μ	water vapour resistance factor	–

4 Design thermal values

4.1 General

Design thermal values for building materials are used in heat and moisture transfer calculations.

[1] For conversion of thermal properties.
[2] Mass of evaporable water divided by dry mass of material.
[3] Volume of evaporable water divided by dry volume of material.

Design thermal values can be derived from declared thermal values by applying the conversion procedures in EN ISO 10456. This is normally the case for thermal insulation materials. The method of determination of the declared thermal value for an insulation material is specified in product standards. Design thermal values for masonry materials are usually derived from the thermal conductivity in the dry state using EN ISO 10456.

NOTE The thermal conductivity in the dry state for masonry materials is given in prEN 1745:1994, Masonry and masonry products – Methods for determining design thermal values.

4.2 Tabulated design thermal values

Table 1 gives design thermal values for materials in general in building applications. When appropriate, linear interpolation may be used.

For insulation materials and masonry materials, Table 2 gives the moisture content of materials and products in equilibrium with air at 23 °C and relative humidities of 50 % and 80 %, and moisture conversion coefficients taken from EN ISO 10456. Table 2 also gives the water vapour resistance factor and specific heat capacity for these materials.

Table 3 gives the water vapour diffusion-equivalent air layer thickness for thin layers.

Table 1 - Design thermal values for materials in general in building applications

Material group or application		Density ρ kg/m^3	Design thermal conductivity λ W/(m·K)	Specific heat capacity c_p J/(kg·K)	Water vapour resistance factor μ dry	wet
Asphalt		2 100	0,70	1 000	50 000	50 000
Bitumen	Pure	1 050	0,17	1 000	50 000	50 000
	Felt / sheet	1 100	0,23	1 000	50 000	50 000
Concrete [a]						
	Medium density	1 800	1,15	1 000	100	60
		2 000	1,35	1 000	100	60
		2 200	1,65	1 000	120	70
	High density	2 400	2,00	1 000	130	80
	Reinforced (with 1 % of steel)	2 300	2,3	1 000	130	80
	Reinforced (with 2 % of steel)	2 400	2,5	1 000	130	80
Floor coverings						
	Rubber	1 200	0,17	1 400	10 000	10 000
	Plastic	1 700	0,25	1 400	10 000	10 000
	Underlay, cellular rubber or plastic	270	0,10	1 400	10 000	10 000
	Underlay, felt	120	0,05	1 300	20	15
	Underlay, wool	200	0,06	1 300	20	15
	Underlay, cork	< 200	0,05	1 500	20	10
	Tiles, cork	> 400	0,065	1 500	40	20
	Carpet / textile flooring	200	0,06	1 300	5	5
	Linoleum	1 200	0,17	1 400	1 000	800
Gases						
	Air	1,23	0,025	1 008	1	1
	Carbon dioxide	1,95	0,014	820	1	1
	Argon	1,70	0,017	519	1	1
	Sulphur hexafluoride	6,36	0,013	614	1	1
	Krypton	3,56	0,0090	245	1	1
	Xenon	5,68	0,0054	160	1	1
Glass						
	Soda lime (incl. “float glass”)	2 500	1,00	750	∞	∞
	Quartz	2 200	1,40	750	∞	∞
	Glass mosaic	2 000	1,20	750	∞	∞
Water						
	Ice at −10 °C	920	2,30	2 000		
	Ice at 0 °C	900	2,20	2 000		
	Snow, freshly fallen (< 30 mm)	100	0,05	2 000		
	Snow, soft (30 mm to 70 mm)	200	0,12	2 000		
	Snow, slightly compacted (70 mm to 100 mm)	300	0,23	2 000		
	Snow, compacted (< 200 mm)	500	0,60	2 000		
	Water at 10 °C	1 000	0,60	4 190		
	Water at 40 °C	990	0,63	4 190		
	Water at 80 °C	970	0,67	4 190		
Metals						
	Aluminium alloys	2 800	160	880	∞	∞
	Bronze	8 700	65	380	∞	∞
	Brass	8 400	120	380	∞	∞
	Copper	8 900	380	380	∞	∞
	Iron, cast	7 500	50	450	∞	∞
	Lead	11 300	35	130	∞	∞
	Steel	7 800	50	450	∞	∞
	Stainless steel	7 900	17	460	∞	∞
	Zinc	7 200	110	380	∞	∞

Table 1 *(continued)*

Material group or application	Density ρ kg/m³	Design thermal conductivity λ W/(m·K)	Specific heat capacity c_p J/(kg·K)	Water vapour resistance factor μ dry	wet
Plastics, solid					
Acrylic	1 050	0,20	1 500	10 000	10 000
Polycarbonates	1 200	0,20	1 200	5 000	5 000
Polytetrafluoroethylene (PTFE)	2 200	0,25	1 000	10 000	10 000
Polyvinylchloride (PVC)	1 390	0,17	900	50 000	50 000
Polymethylmethacrylate (PMMA)	1 180	0,18	1 500	50 000	50 000
Polyacetate	1 410	0,30	1 400	100 000	100 000
Polyamide (nylon)	1 150	0,25	1 600	50 000	50 000
Polyamide 6.6 with 25 % glass fibre	1 450	0,30	1 600	50 000	50 000
Polyethylene / polythene, high density	980	0,50	1 800	100 000	100 000
Polyethylene / polythene, low density	920	0,33	2 200	100 000	100 000
Polystyrene	1 050	0,16	1 300	100 000	100 000
Polypropylene	910	0,22	1 800	10 000	10 000
Polypropylene with 25 % glass fibre	1 200	0,25	1 800	10 000	10 000
Polyurethane (PU)	1 200	0,25	1 800	6 000	6 000
Epoxy resin	1 200	0,20	1 400	10 000	10 000
Phenolic resin	1 300	0,30	1 700	100 000	100 000
Polyester resin	1 400	0,19	1 200	10 000	10 000
Rubber					
Natural	910	0,13	1 100	1 0000	10 000
Neoprene (polychloroprene)	1 240	0,23	2 140	1 0000	10 000
Butyl, (isobutene), solid / hot melt	1 200	0,24	1 400	200 000	200 000
Foam rubber	60 - 80	0,06	1 500	7 000	7 000
Hard rubber (ebonite), solid	1 200	0,17	1 400	∞	∞
Ethylene propylene diene monomer (EPDM)	1 150	0,25	1 000	6 000	6 000
Polyisobutylene	930	0,20	1 100	10 000	10 000
Polysulfide	1 700	0,40	1 000	10 000	10 000
Butadiene	980	0,25	1 000	100 000	100 000
Sealant materials, weather stripping and thermal breaks					
Silica gel (dessicant)	720	0,13	1 000	∞	∞
Silicone, pure	1 200	0,35	1 000	5 000	5 000
Silicone, filled	1 450	0,50	1 000	5 000	5 000
Silicone foam	750	0,12	1 000	10 000	10 000
Urethane / polyurethane (thermal break)	1 300	0,21	1 800	60	60
Polyvinylchloride (PVC) flexible, with 40 % softener	1 200	0,14	1 000	100 000	100 000
Elastomeric foam, flexible	60 - 80	0,05	1 500	10 000	10 000
Polyurethane (PU) foam	70	0,05	1 500	60	60
Polyethylene foam	70	0,05	2 300	100	100
Gypsum					
Gypsum	600	0,18	1 000	10	4
”	900	0,30	1 000	10	4
”	1 200	0,43	1 000	10	4
”	1 500	0,56	1 000	10	4
Gypsum plasterboard (b)	900	0,25	1 000	10	4
Plasters and renders					
Gypsum insulating plaster	600	0,18	1 000	10	6
Gypsum plastering	1 000	0,40	1 000	10	6
” ”	1 300	0,57	1 000	10	6
Gypsum, sand	1 600	0,80	1 000	10	6
Lime, sand	1 600	0,80	1 000	10	6
Cement, sand	1 800	1,00	1 000	10	6
Soils					
Clay or silt	1 200 – 1 800	1,5	1 670 – 2 500	50	50
Sand and gravel	1 700 – 2 200	2,0	910 – 1 180	50	50

Table 1 *(concluded)*

Material group or application		Density ρ kg/m^3	Design thermal conductivity λ W/(m·K)	Specific heat capacity c_p J/(kg·K)	Water vapour resistance factor μ dry	 wet
Stone	Natural, crystalline rock	2 800	3,5	1 000	10 000	10 000
	Natural, sedimentary rock	2 600	2,3	1 000	250	200
	Natural, sedimentary rock, light	1 500	0,85	1 000	30	20
	Natural, porous, e.g. lava	1 600	0,55	1 000	20	15
	Basalt	2 700 – 3 000	3,5	1 000	10 000	10 000
	Gneiss	2 400 – 2 700	3,5	1 000	10 000	10 000
	Granite	2 500 – 2 700	2,8	1 000	10 000	10 000
	Marble	2 800	3,5	1 000	10 000	10 000
	Slate	2 000 – 2 800	2,2	1 000	1 000	800
	Limestone, extra soft	1 600	0,85	1 000	30	20
	Limestone, soft	1 800	1,1	1 000	40	25
	Limestone, semi-hard	2 000	1,4	1 000	50	40
	Limestone, hard	2 200	1,7	1 000	200	150
	Limestone, extra hard	2 600	2,3	1 000	250	200
	Sandstone (silica)	2 600	2,3	1 000	40	30
	Natural pumice	400	0,12	1 000	8	6
	Artificial stone	1 750	1,3	1 000	50	40
Tiles (roofing)						
	Clay	2 000	1,0	800	40	30
	Concrete	2 100	1,5	1 000	100	60
Tiles (other)						
	Ceramic/porcelain	2 300	1,3	840		∞
	Plastic	1 000	0,20	1 000	10 000	10 000
Timber [(c)]						
		500	0,13	1 600	50	20
		700	0,18	1 600	200	50
Wood – based panels [(c)]						
	Plywood[(d)]	300	0,09	1 600	150	50
	“	500	0,13	1 600	200	70
	“	700	0,17	1 600	220	90
	“	1 000	0,24	1 600	250	110
	“					
	Cement-bonded particleboard	1 200	0,23	1 500	50	30
	Particleboard	300	0,10	1 700	50	10
	“	600	0,14	1 700	50	15
	“	900	0,18	1 700	50	20
	Oriented strand board (OSB)	650	0,13	1 700	50	30
	Fibreboard, including MDF[(e)]	250	0,07	1 700	5	2
	“	400	0,10	1 700	10	5
	“	600	0,14	1 700	20	12
	“	800	0,18	1 700	30	20

NOTE 1 For computational purposes the ∞ value may have to be replaced with an arbitrarily large value, e.g. 10^6.
NOTE 2 Water vapour resistance factors are given as dry cup and wet cup values, see prEN ISO 12572:1999, Hygrothermal performance of building materials and products – Determination of water vapour transmission properties.

(a) The density for concrete is the dry density.
(b) The thermal conductivity includes the effect of the paper liners.
(c) The density for timber and wood-based products is the density in equilibrium with 20 °C and 65 % relative humidity.
(d) As an interim measure and until sufficient significant data for solid wood panels (SWP) and laminated veneer lumber (LVL) are available, the values given for plywood may be used.
(e) MDF: Medium Density Fibreboard, dry process.

Table 2 - Moisture properties and specific heat capacity of thermal insulation materials and masonry materials

Material	Density	Moisture content1) at 23 °C, 50 % RH		Moisture content1) at 23 °C, 80 % RH		Moisture conversion coefficient		Water vapour resistance factor		Specific heat capacity
	ρ kg/m³	u kg/kg	ψ m³/m³	u kg/kg	ψ m³/m³	f_u	F_ψ	μ dry	wet	c_p J/(kg·K)
Expanded polystyrene	10 - 50		0		0		4	60	60	1 450
Extruded polystyrene foam	20 - 65		0		0		2,5	150	150	1 450
Polyurethane foam, rigid	28 - 55		0		0		3	60	60	1400
Mineral wool	10 - 200		0		0		4	1	1	1 030
Phenolic foam	20 - 50		0		0		5	50	50	1 400
Cellular glass	100 - 150	0		0		0		∞	∞	1 000
Perlite board	140 - 240	0,02		0,03		0,8		5	5	900
Expanded cork	90 - 140		0,008		0,011		6	10	5	1 560
Wood wool board	250 - 450		0,03		0,05		1,8	5	3	1 470
Wood fibreboard	150 - 250	0,1		0,16		1,5		10	5	1 400
Urea-formaldehyde foam	10 - 30	0,1		0,15		0,7		2	2	1 400
Spray applied polyurethane foam	30 - 50		0		0		3	60	60	1 400
Loose-fill mineral wool	15 - 60		0		0		4	1	1	1 030
Loose-fill cellulose fibre	20 - 60	0,11		0,18		0,5		2	2	1 600
Loose-fill expanded perlite	30 - 150	0,01		0,02		3		2	2	900
Loose-fill exfoliated vermiculite	30 - 150	0,01		0,02		2		3	2	1 080
Loose-fill expanded clay	200 - 400	0		0,001		4		2	2	1 000
Loose-fill expanded polystyrene beads	10 - 30		0		0		4	2	2	1 400
Fired clay	1 000- 2 400		0,007		0,012		10	16	10	1 000
Calcium silicate	900 - 2 200		0,012		0,024		10	20	15	1 000
Concrete with no other aggregate than pumice	500 - 1 300		0,02		0,035		4	50	40	1 000
Dense aggregate concrete and manufactured stone	1 600- 2 400		0,025		0,04		4	150	120	1 000
Concrete with polystyrene aggregates	500 - 800		0,015		0,025		5	120	60	1 000
Concrete with no other aggregate than expanded clay	400 - 700	0,02		0,03		2,6		6	4	1 000
Concrete with expanded clay as predominant aggregate	800 - 1 700	0,02		0,03		4		8	6	1 000
Concrete with more than 70 % expanded blastfurnace slag aggregate	1 100 - 1 700	0,02		0,04		4		30	20	1 000
Concrete with the predominant aggregate derived from pyropro-cessed colliery material	1 100 - 1 500	0,02		0,04		4		15	10	1 000
Autoclaved aerated concrete	300 - 1 000	0,026		0,045		4		10	6	1 000
Concrete with other lightweight aggregates	500 - 2 000		0,03		0,05		4	15	10	1 000
Mortar (masonry mortar and rendering mortar)	250 - 2 000		0,04		0,06		4	20	10	1 000

1) The values given are generally not exceeded.

Table 3 – Water vapour diffusion-equivalent air layer thickness (Water vapour resistance)

Product/material	Water vapour diffusion - equivalent air layer thickness s_d m
Polyethylene 0,15 mm	50
Polyethylene 0,25 mm	100
Polyester film 0,2 mm	50
PVC foil	30
Aluminium foil 0,05 mm	1 500
PE-foil (stapled) 0,15 mm	8
Bituminous paper 0,1 mm	2
Aluminium paper 0,4 mm	10
Breather membrane	0,2
Paint - emulsion	0,1
Paint - gloss	3
Vinyl wallpaper	2

NOTE The water vapour diffusion - equivalent air layer thickness of a product is expressed as the thickness of a motionless air layer with the same water vapour resistance as the product.
The thickness of the products in Table 3 is not normally measured and they can be regarded as infinitely thin products with a water vapour resistance. The table quotes nominal thickness values as an aid to the identification of the product.

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