# SLOVENSKI STANDARD
# SIST EN 12524:2001

**01-september-2001**

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**Gradbeni materiali in proizvodi - Higrotermalne lastnosti - Tabelirane raļ unske vrednosti**

Building materials and products - Hygrothermal properties - Tabulated design values

Baustoffe und -produkte - Wärme- und feuchteschutz-technische Eigenschaften - Tabellierte Bemessungswerte



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



**Ta slovenski standard je istoveten z:** **EN 12524:2000**

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**ICS:**

| | | |
|---|---|---|
| 91.100.01 | Gradbeni materiali na splošno | Construction materials in general |
| 91.120.10 | Toplotna izolacija stavb | Thermal insulation |

**SIST EN 12524:2001** **en**

# EUROPEAN STANDARD
# NORME EUROPÉENNE
# EUROPÄISCHE NORM

**EN 12524**

April 2000

ICS 91.100.01; 91.120.10

English version

# 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

This European Standard was approved by CEN on 11 March 2000.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

**Central Secretariat: rue de Stassart, 36 B-1050 Brussels**



Ref. No. EN 12524:2000 E

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of an identical text or by endorsement, at the latest by October 2000, and conflicting national standards shall be withdrawn at the latest by December 2001.



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 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 any 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 Building materials and products – Procedures for determining 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 can 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 |
| $f_\psi$ | 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 |
| $\lambda$ | thermal conductivity | W/(m·K) |
| $\rho$ | density | $kg/m^3$ |

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

| | | |
|---|---|---|
| $\psi$ | moisture content, volume by volume[3] | $m^3/m^3$ |
| $\mu$ | 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.

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.

[3] Volume of evaporable water divided by dry volume of material.

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

| Material group or application | | Density $\rho$ kg/m³ | Design thermal conductivity $\lambda$ W/(m·K) | Specific heat capacity $c_p$ J/(kg·K) | Water vapour resistance factor $\mu$ dry | wet |
|---|---|---|---|---|---|---|
| **Asphalt** | | 2100 | 0,70 | 1000 | 50000 | 50000 |
| **Bitumen** | Pure | 1050 | 0,17 | 1000 | 50000 | 50000 |
| | Felt / sheet | 1100 | 0,23 | 1000 | 50000 | 50000 |
| **Concrete** [a] | | | | | | |
| | Medium density | 1800 | 1,15 | 1000 | 100 | 60 |
| | | 2000 | 1,35 | 1000 | 100 | 60 |
| | | 2200 | 1,65 | 1000 | 120 | 70 |
| | High density | 2400 | 2,00 | 1000 | 130 | 80 |
| | Reinforced (with 1 % of steel) | 2300 | 2,3 | 1000 | 130 | 80 |
| | Reinforced (with 2 % of steel) | 2400 | 2,5 | 1000 | 130 | 80 |
| **Floor coverings** | | | | | | |
| | Rubber | 1200 | 0,17 | 1400 | 10000 | 10000 |
| | Plastic | 1700 | 0,25 | 1400 | 10000 | 10000 |
| | Underlay, cellular rubber or Plastic | 270 | 0,10 | 1400 | 10000 | 10000 |
| | Underlay, felt | 120 | 0,05 | 1300 | 20 | 15 |
| | Underlay, wool | 200 | 0,06 | 1300 | 20 | 15 |
| | Underlay, cork | <200 | 0,05 | 1500 | 20 | 10 |
| | Tiles, cork | >400 | 0,065 | 1500 | 40 | 20 |
| | Carpet / textile flooring | 200 | 0,06 | 1300 | 5 | 5 |
| | Linoleum | 1200 | 0,17 | 1400 | 1000 | 800 |
| **Gases** | | | | | | |
| | Air | 1,23 | 0,025 | 1008 | 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") | 2500 | 1,00 | 750 | ∞ | ∞ |
| | Quartz | 2200 | 1,40 | 750 | ∞ | ∞ |
| | Glass mosaic | 2000 | 1,20 | 750 | ∞ | ∞ |
| **Water** | | | | | | |
| | Ice at –10 °C | 920 | 2,30 | 2000 | | |
| | Ice at 0 °C | 900 | 2,20 | 2000 | | |
| | Snow, freshly fallen (< 30 mm) | 100 | 0,05 | 2000 | | |
| | Snow, soft (30…70 mm) | 200 | 0,12 | 2000 | | |
| | Snow, slightly compacted (70...100 mm) | 300 | 0,23 | 2000 | | |
| | Snow, compacted (< 200 mm) | 500 | 0,60 | 2000 | | |
| | Water at 10 °C | 1000 | 0,60 | 4190 | | |
| | Water at 40 °C | 990 | 0,63 | 4190 | | |
| | Water at 80 °C | 970 | 0,67 | 4190 | | |
| **Metals** | | | | | | |
| | Aluminium alloys | 2800 | 160 | 880 | ∞ | ∞ |
| | Bronze | 8700 | 65 | 380 | ∞ | ∞ |
| | Brass | 8400 | 120 | 380 | ∞ | ∞ |
| | Copper | 8900 | 380 | 380 | ∞ | ∞ |
| | Iron, cast | 7500 | 50 | 450 | ∞ | ∞ |
| | Lead | 11300 | 35 | 130 | ∞ | ∞ |
| | Steel | 7800 | 50 | 450 | ∞ | ∞ |
| | Stainless steel | 7900 | 17 | 460 | ∞ | ∞ |
| | Zinc | 7200 | 110 | 380 | ∞ | ∞ |

**Table 1** *(continued)*

| Material group or application | Density $\rho$ kg/m³ | Design thermal conductivity $\lambda$ W/(m·K) | Specific heat capacity $c_p$ J/(kg·K) | Water vapour resistance factor $\mu$ dry | wet |
|---|---|---|---|---|---|
| **Plastics, solid** | | | | | |
| Acrylic | 1050 | 0,20 | 1500 | 10000 | 10000 |
| Polycarbonates | 1200 | 0,20 | 1200 | 5000 | 5000 |
| Polytetrafluoroethylene (PTFE) | 2200 | 0,25 | 1000 | 10000 | 10000 |
| Polyvinylchloride (PVC) | 1390 | 0,17 | 900 | 50000 | 50000 |
| Polymethylmethacrylate (PMMA) | 1180 | 0,18 | 1500 | 50000 | 50000 |
| Polyacetate | 1410 | 0,30 | 1400 | 100000 | 100000 |
| Polyamide (nylon ) | 1150 | 0,25 | 1600 | 50000 | 50000 |
| Polyamide 6.6 with 25 % glass fibre | 1450 | 0,30 | 1600 | 50000 | 50000 |
| Polyethylene /polythene, high density | 980 | 0,50 | 1800 | 100000 | 100000 |
| Polyethylene/polythene, low density | 920 | 0,33 | 2200 | 100000 | 100000 |
| Polystyrene | 1050 | 0,16 | 1300 | 100000 | 100000 |
| Polypropylene | 910 | 0,22 | 1800 | 10000 | 10000 |
| Polypropylene with 25 % glass fibre | 1200 | 0,25 | 1800 | 10000 | 10000 |
| Polyurethane (PU) | 1200 | 0,25 | 1800 | 6000 | 6000 |
| Epoxy resin | 1200 | 0,20 | 1400 | 10000 | 10000 |
| Phenolic resin | 1300 | 0,30 | 1700 | 100000 | 100000 |
| Polyester resin | 1400 | 0,19 | 1200 | 10000 | 10000 |
| **Rubber** | | | | | |
| Natural | 910 | 0,13 | 1100 | 10000 | 10000 |
| Neoprene (polychloroprene) | 1240 | 0,23 | 2140 | 10000 | 10000 |
| Butyl, (isobutene), solid/hot melt | 1200 | 0,24 | 1400 | 200000 | 200000 |
| Foam rubber | 60 - 80 | 0,06 | 1500 | 7000 | 7000 |
| Hard rubber (ebonite), solid | 1200 | 0,17 | 1400 | ∞ | ∞ |
| Ethylene propylene diene monomer (EPDM ) | 1150 | 0,25 | 1000 | 6000 | 6000 |
| Polyisobutylene | 930 | 0,20 | 1100 | 10000 | 10000 |
| Polysulfide | 1700 | 0,40 | 1000 | 10000 | 10000 |
| Butadiene | 980 | 0,25 | 1000 | 100000 | 100000 |
| **Sealant materials, weather stripping and thermal breaks** | | | | | |
| Silica gel (dessicant) | 720 | 0,13 | 1000 | ∞ | ∞ |
| Silicone, pure | 1200 | 0,35 | 1000 | 5000 | 5000 |
| Silicone, filled | 1450 | 0,50 | 1000 | 5000 | 5000 |
| Silicone foam | 750 | 0,12 | 1000 | 10000 | 10000 |
| Urethane/polyurethane (thermal break) | 1300 | 0,21 | 1800 | 60 | 60 |
| Polyvinylchloride (PVC) flexible, with 40 % softener | 1200 | 0,14 | 1000 | 100000 | 100000 |
| Elastomeric foam, flexible | 60 - 80 | 0,05 | 1500 | 10000 | 10000 |
| Polyurethane (PU) foam | 70 | 0,05 | 1500 | 60 | 60 |
| Polyethylene foam | 70 | 0,05 | 2300 | 100 | 100 |
| **Gypsum** | | | | | |
| Gypsum | 600 | 0,18 | 1000 | 10 | 4 |
| " | 900 | 0,30 | 1000 | 10 | 4 |
| " | 1200 | 0,43 | 1000 | 10 | 4 |
| " | 1500 | 0,56 | 1000 | 10 | 4 |
| Gypsum plasterboard [b] | 900 | 0,25 | 1000 | 10 | 4 |
| **Plasters and renders** | | | | | |
| Gypsum insulating plaster | 600 | 0,18 | 1000 | 10 | 6 |
| Gypsum plastering | 1000 | 0,40 | 1000 | 10 | 6 |
| " " | 1300 | 0,57 | 1000 | 10 | 6 |
| Gypsum, sand | 1600 | 0,80 | 1000 | 10 | 6 |
| Lime, sand | 1600 | 0,80 | 1000 | 10 | 6 |
| Cement, sand | 1800 | 1,00 | 1000 | 10 | 6 |
| **Soils** | | | | | |
| Clay or silt | 1200 - 1800 | 1,5 | 1670 – 2500 | 50 | 50 |
| Sand and gravel | 1700 - 2200 | 2,0 | 910 – 1180 | 50 | 50 |

**Table 1** *(concluded)*

| Material group or application | | Density $\rho$ kg/m³ | Design thermal conductivity $\lambda$ W/(m·K) | Specific heat capacity $c_p$ J/(kg·K) | Water vapour resistance factor $\mu$ dry | wet |
|---|---|---|---|---|---|---|
| **Stone** | Natural, crystalline rock | 2800 | 3,5 | 1000 | 10000 | 10000 |
| | Natural, sedimentary rock | 2600 | 2,3 | 1000 | 250 | 200 |
| | Natural, sedimentary rock, light | 1500 | 0,85 | 1000 | 30 | 20 |
| | Natural, porous, e.g. lava | 1600 | 0,55 | 1000 | 20 | 15 |
| | Basalt | 2700 - 3000 | 3,5 | 1000 | 10000 | 10000 |
| | Gneiss | 2400 - 2700 | 3,5 | 1000 | 10000 | 10000 |
| | Granite | 2500 - 2700 | 2,8 | 1000 | 10000 | 10000 |
| | Marble | 2800 | 3,5 | 1000 | 10000 | 10000 |
| | Slate | 2000 - 2800 | 2,2 | 1000 | 1000 | 800 |
| | Limestone, extra soft | 1600 | 0,85 | 1000 | 30 | 20 |
| | Limestone, soft | 1800 | 1,1 | 1000 | 40 | 25 |
| | Limestone, semi-hard | 2000 | 1,4 | 1000 | 50 | 40 |
| | Limestone, hard | 2200 | 1,7 | 1000 | 200 | 150 |
| | Limestone, extra hard | 2600 | 2,3 | 1000 | 250 | 200 |
| | Sandstone (silica) | 2600 | 2,3 | 1000 | 40 | 30 |
| | Natural pumice | 400 | 0,12 | 1000 | 8 | 6 |
| | Artificial stone | 1750 | 1,3 | 1000 | 50 | 40 |
| **Tiles (roofing)** | | | | | | |
| | Clay | 2000 | 1,0 | 800 | 40 | 30 |
| | Concrete | 2100 | 1,5 | 1000 | 100 | 60 |
| **Tiles (other)** | | | | | | |
| | Ceramic/porcelain | 2300 | 1,3 | 840 | | ∞ |
| | Plastic | 1000 | 0,20 | 1000 | 10000 | 10000 |
| **Timber** [c] | | | | | | |
| | | 500 | 0,13 | 1600 | 50 | 20 |
| | | 700 | 0,18 | 1600 | 200 | 50 |
| **Wood–based panels** [c] | | | | | | |
| | Plywood[d] | 300 | 0,09 | 1600 | 150 | 50 |
| | " | 500 | 0,13 | 1600 | 200 | 70 |
| | " | 700 | 0,17 | 1600 | 220 | 90 |
| | " | 1000 | 0,24 | 1600 | 250 | 110 |
| | " | | | | | |
| | Cement-bonded particleboard | 1200 | 0,23 | 1500 | 50 | 30 |
| | Particleboard | 300 | 0,10 | 1700 | 50 | 10 |
| | " | 600 | 0,14 | 1700 | 50 | 15 |
| | " | 900 | 0,18 | 1700 | 50 | 20 |
| | Oriented strand board (OSB) | 650 | 0,13 | 1700 | 50 | 30 |
| | Fibreboard, including MDF[e] | 250 | 0,07 | 1700 | 5 | 2 |
| | " | 400 | 0,10 | 1700 | 10 | 5 |
| | " | 600 | 0,14 | 1700 | 20 | 12 |
| | " | 800 | 0,18 | 1700 | 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.