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EW_Exclusive_EPS_100

Exterior wall
created on 17.4.2023

Thermal protection

R_{tot} = 8,738 m²K/W

EnEV Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

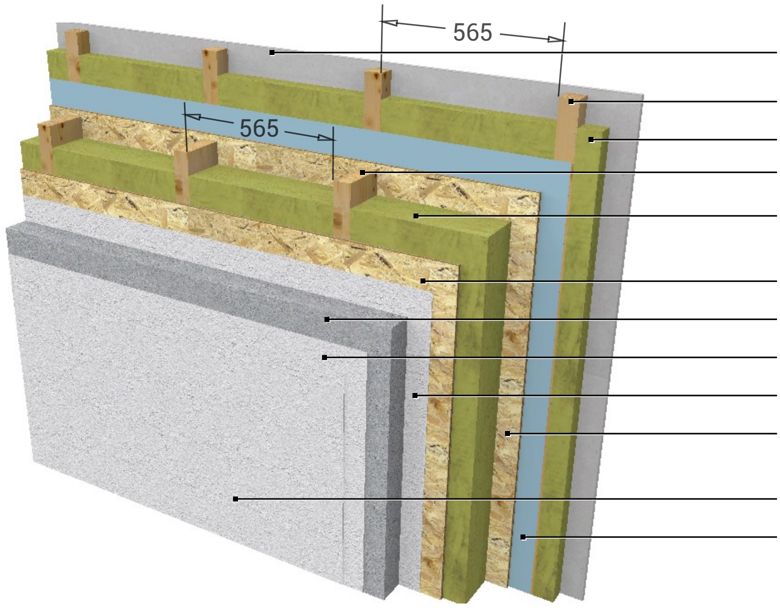
Drying reserve: 155 g/m²a
No condensate

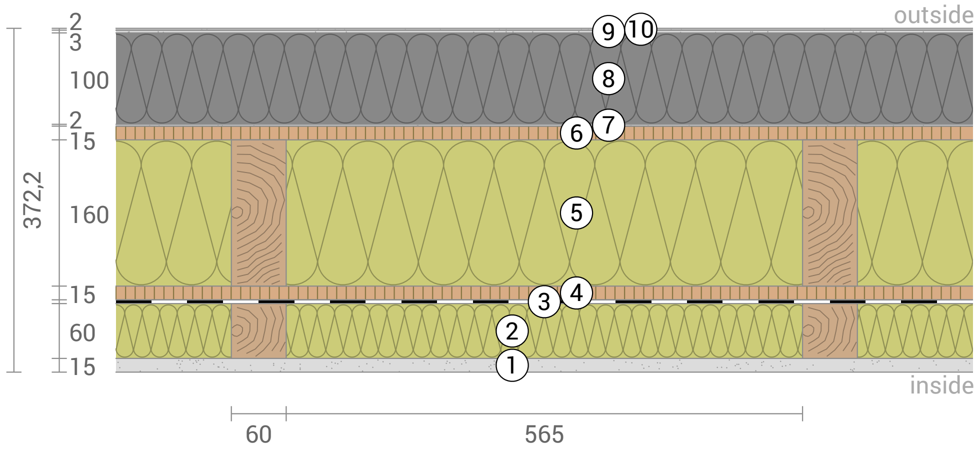
excellent insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 55 kJ/m²K

excellent insufficient





1. Gypsum fibre board (15 mm)
2. Stone wool (60 mm)
3. PE foil
4. OSB3 (15 mm)
5. Stone wool (160 mm)
6. OSB3 (15 mm)
7. Adhesive render (2 mm)
8. Graphite EPS (100 mm)
9. Armour render (3 mm)
10. External plaster (2 mm)

Inside air :	20,0°C / 50%			Thickness:	37,2 cm
Outside air:	-5,0°C / 80%	sd-value:	112,6 m	Weight:	66 kg/m²
Surface temperature.:	18,8°C / -4,9°C	Drying reserve:	155 g/m²a	Heat capacity:	87 kJ/m²K

☑ EnEV Bestand ☑ BEG Einzelmaßn. ☑ GEG 2020 Bestand ☑ GEG 2020 Neubau

*Comparison of the U-value with den Höchstwerten aus EnEV 2014 Anlage 3 Tabelle 1 (EnEV Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau)

EW_Exclusive_EPS_100, R_{tot}=8,738 m²K/W

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,130
1	Gypsum fibre board	1,50	0,320	0,047
2	Stone wool	6,00	0,035	1,714
	Instalation lath (9,6%)	6,00	0,130	0,462
3	PE foil	0,02	0,500	0,000
4	OSB3	1,50	0,130	0,115
5	Stone wool	16,00	0,035	4,571
	Structural timber (9,6%)	16,00	0,130	1,231
6	OSB3	1,50	0,130	0,115
7	Adhesive render	0,20	1,000	0,002
8	Graphite EPS	10,00	0,032	3,125
9	Armour render	0,30	1,000	0,003
10	External plaster	0,20	0,540	0,004
	Thermal contact resistance outside (Rse)			0,040

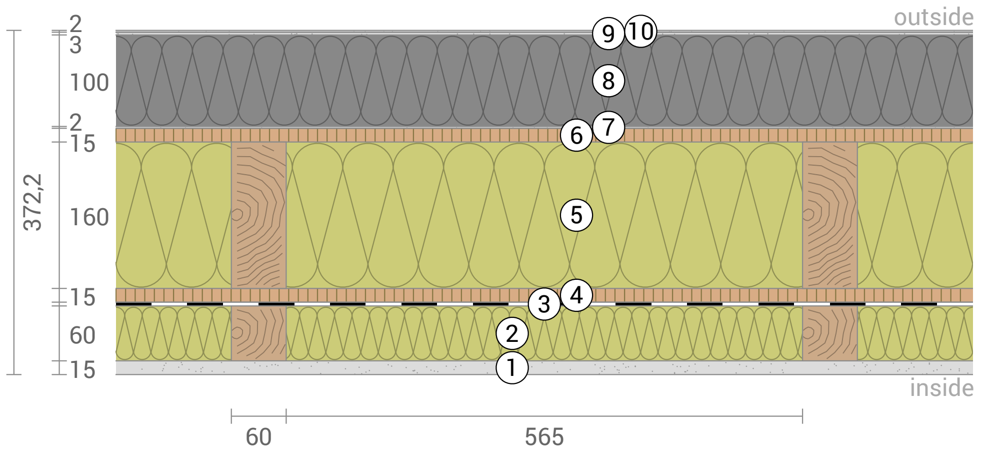
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction horizontally
Rse: heat flow direction horizontally, outside: Direct contact to outside air

Upper limit of thermal resistance $R_{tot;upper}$ = 9,106 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 8,568 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,063 (maximum allowed: 1,5)

The procedure may be used.

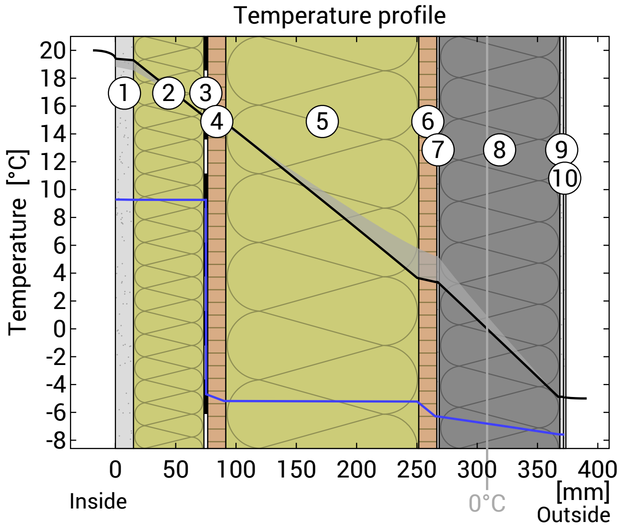
Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 8,837 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 3,0%

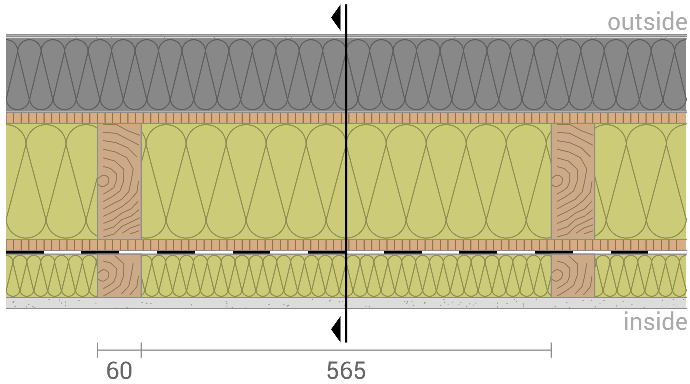
Heat transfer coefficient U = 1/R_{tot} = **0,11 W/(m²K)**



EW_Exclusive_EPS_100, R_{tot}=8,738 m²K/W

Temperature profile





① Gypsum fibre board (15 mm)
② Stone wool (60 mm)
③ PE foil
④ OSB3 (15 mm)
⑤ Stone wool (160 mm)
⑥ OSB3 (15 mm)
⑦ Adhesive render (2 mm)
⑧ Graphite EPS (100 mm)
⑨ Armour render (3 mm)
⑩ External plaster (2 mm)

Left: Temperature and dew-point temperature at the place marked in the right figure. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew point, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.
Right: The component, drawn to scale.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	18,8	20,0	
1	1,5 cm	Gypsum fibre board	0,320	0,047	18,6	19,4	17,3
2	6 cm	Stone wool	0,035	1,714	15,1	19,3	2,4
	6 cm	Instalation lath (9,6%)	0,130	0,462	15,3	18,7	2,6
3	0,02 cm	PE foil	0,500	0,000	15,1	15,3	0,2
4	1,5 cm	OSB3	0,130	0,115	14,6	15,3	9,3
5	16 cm	Stone wool	0,035	4,571	3,7	14,9	6,5
	16 cm	Structural timber (9,6%)	0,130	1,231	5,8	14,7	6,9
6	1,5 cm	OSB3	0,130	0,115	3,4	5,8	9,3
7	0,2 cm	Adhesive render	1,000	0,002	3,4	5,2	3,0
8	10 cm	Graphite EPS	0,032	3,125	-4,9	5,2	1,5
9	0,3 cm	Armour render	1,000	0,003	-4,9	-4,9	4,5
10	0,2 cm	External plaster	0,540	0,004	-4,9	-4,9	2,8
		Thermal contact resistance*		0,040	-5,0	-4,9	
	37,22 cm	Whole component		8,738			66,3

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max):	18,8°C	19,3°C	19,4°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,9°C

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EW_Exclusive_EPS_100, R_{tot}=8,738 m²K/W

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

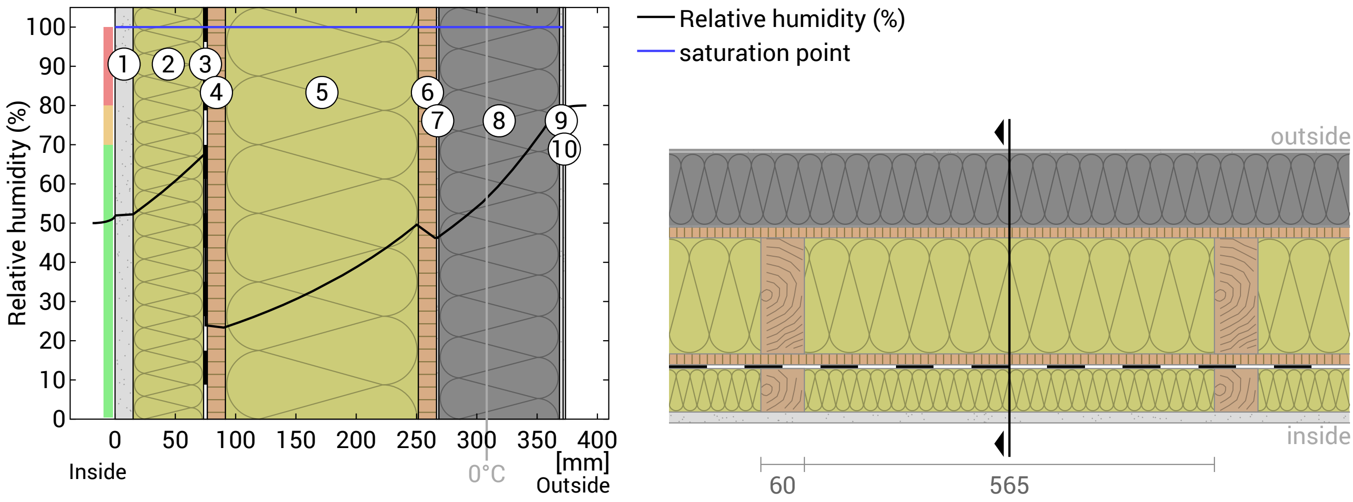
This component is free of condensate under the given climate conditions.

Drying reserve according to DIN 4108-3:2018: 155 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	Condensate [Gew.-%]	Weight [kg/m²]
1	1,5 cm	Gypsum fibre board	0,20	-		17,3
2	6 cm	Stone wool	0,06	-		2,4
	6 cm	Instalation lath (9,6%)	1,20	-	-	2,6
3	0,02 cm	PE foil	100,00	-		0,2
4	1,5 cm	OSB3	2,25	-	-	9,3
5	16 cm	Stone wool	0,16	-		6,5
	16 cm	Structural timber (9,6%)	3,20	-	-	6,9
6	1,5 cm	OSB3	4,50	-	-	9,3
7	0,2 cm	Adhesive render	0,04	-		3,0
8	10 cm	Graphite EPS	5,00	-		1,5
9	0,3 cm	Armour render	0,06	-		4,5
10	0,2 cm	External plaster	0,02	-		2,8
	37,22 cm	Whole component	112,59	0		66,3

Humidity

The temperature of the inside surface is 18,8 °C leading to a relative humidity on the surface of 54%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



① Gypsum fibre board (15 mm)
② Stone wool (60 mm)
③ PE foil
④ OSB3 (15 mm)
⑤ Stone wool (160 mm)
⑥ OSB3 (15 mm)
⑦ Adhesive render (2 mm)
⑧ Graphite EPS (100 mm)
⑨ Armour render (3 mm)
⑩ External plaster (2 mm)

Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

EW_Exclusive_EPS_100, R_{tot}=8,738 m²K/W

Moisture protection in accordance with DIN 4108-3:2018 Appendix A

This moisture proofing is only valid for **non-air-conditioned** residential buildings.

Please note the hints at the end of these moisture proofing calculations.

#		Material	λ [W/mK]	R [m²K/W]	sd [m]	ρ [kg/m³]
		Thermal contact resistance		0,250		
1	1,5 cm	Gypsum fibre board	0,320	0,047	0,2	1150
2	6 cm	Stone wool	0,035	1,714	0,06	45
3	0,02 cm	PE foil	0,500	0,000	100	900
4	1,5 cm	OSB3	0,130	0,115	2,25	620
5	16 cm	Stone wool	0,035	4,571	0,16	45
6	1,5 cm	OSB3	0,130	0,115	4,5	620
7	0,2 cm	Adhesive render	1,000	0,002	0,04	1500
8	10 cm	Graphite EPS	0,032	3,125	5	15
9	0,3 cm	Armour render	1,000	0,003	0,06	1500
10	0,2 cm	External plaster	0,540	0,004	0,02	1400
		Thermal contact resistance		0,040		

T [°C]	ps [Pa]	Σsd [m]
19,37	2249	0
19,26	2232	0,2
14,97	1700	0,26
14,96	1700	100
14,68	1670	103
3,23	770	103
2,94	754	107
2,94	754	107
-4,88	405	112
-4,89	405	112
-4,90	405	112

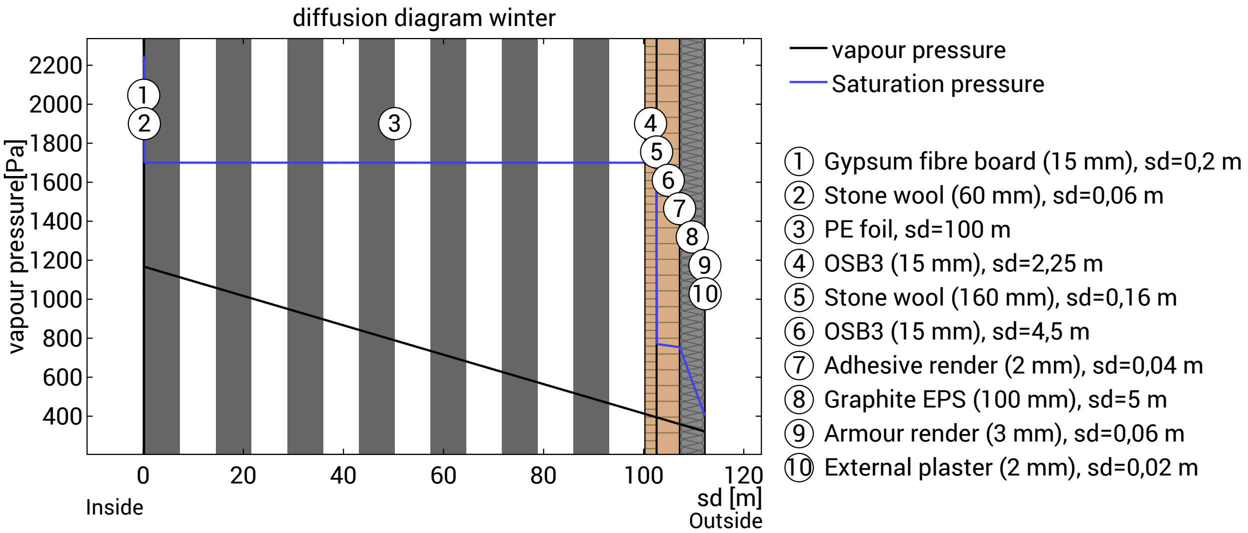
Temperature (T), vapor saturation pressure (ps), and the sum of the sd-values (Σsd) apply to the layer boundary.

Relative air humidity on the surface

The relative humidity on the interior surface is 52%. Requirements for the prevention of building material corrosion depend on material and coating and have not been investigated. ✓

Dew period (winter)

Boundary conditions	
Vapor pressure inside at 20°C and 50% humidity	pi = 1168 Pa
Vapor pressure outside at -5°C and 80% humidity	pe = 321 Pa
Duration of condensation period (90 days)	tc = 7776000 s
Water vapor diffusion coefficient in static air	δ0 = 2.0E-10 kg/(m*s*Pa)
sd-value (Whole component.)	sde = 112,29 m



The section under investigation is free of condensate under the given climate conditions. ✓

Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential:
sd=102,67 m; x=25,02 cm; ps=770 pa:
Layer boundary between Stone wool and OSB3

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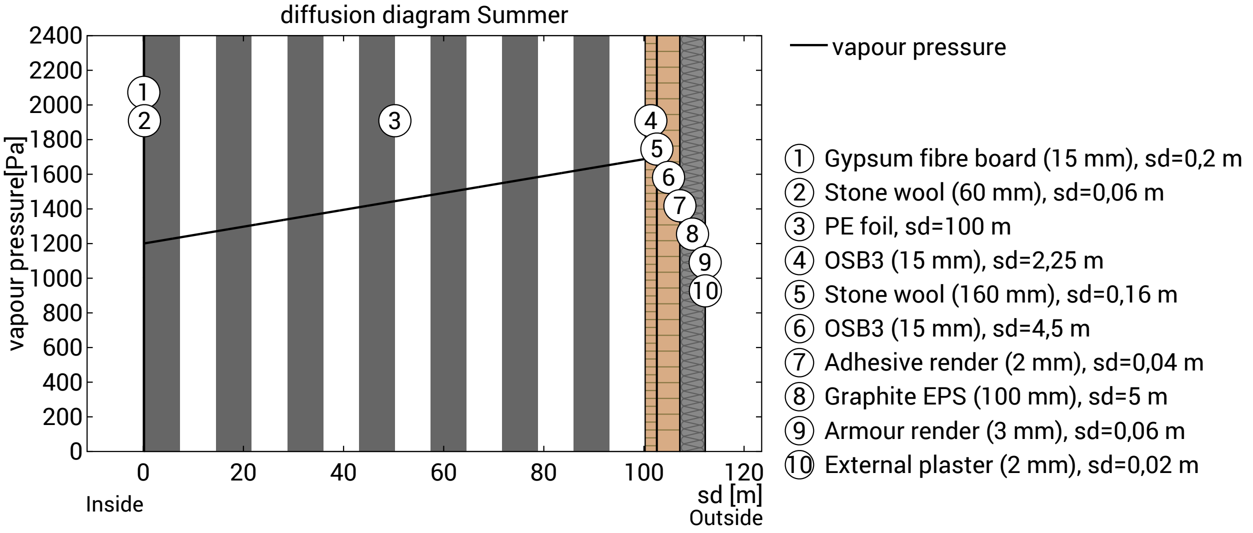
$M_{ev,Tauperiode} = t_c * \delta_0 * ((p_s-p_i)/sd^{ev} + (p_s-p_e)/(sd_e-sd_{ev}))$ = **0,067 kg/m²**

EW_Exclusive_EPS_100, R_{tot}=8,738 m²K/W

Evaporation period (summer)

Boundary conditions	
Interior vapor pressure	pi = 1200 Pa
Exterior vapor pressure	pe = 1200 Pa
Saturation vapour pressure in the condensation area	ps = 1700 Pa
Length of drying season (90 days)	tev = 7776000 s
sd-values remain unchanged.	



Condensate-free component: The maximum possible evaporation mass for the drying reserve is calculated. Consider the level that has the lowest evaporation potential in the dew period, at sd=102,67 m; x=25,02 cm:
Layer boundary between Stone wool and OSB3
Evaporation mass: Mev = δ0 * tev * [(ps-pi)/sd + (ps-pe)/(sde-sd)] = **0,09 kg/m²**

Drying reserve (DIN 68800-2)

Dew-water-free component: The evaporation potential of the dew period is also taken into account.
Drying reserve: Mr = (Mev + Mev,Tauperiode) * 1000 = **155 g/m²/a**
Minimum requested for walls and ceilings: 100 g/m²/a

✓

Evaluation according to DIN 4108-3

The component is permissible regarding the moisture protection.

Hints

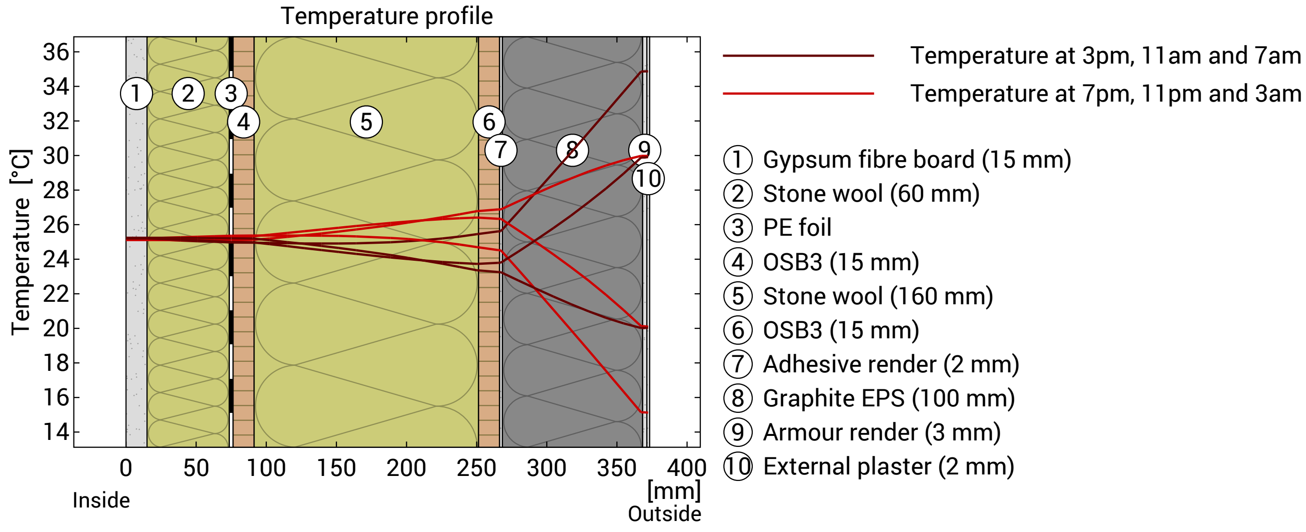
In the case of inhomogeneous constructions, such as skeleton-, stand- or frame constructions, as well as in wooden beam, rafter or half-timbered constructions or the like, the one-dimensional diffusion calculations are only to be demonstrated for the compartment area. Exceptional cases are special constructions in which, for example, The diffusion-inhibiting layer is also laid section-wise over the outer area. In these exceptional cases, the calculation performed here is invalid.

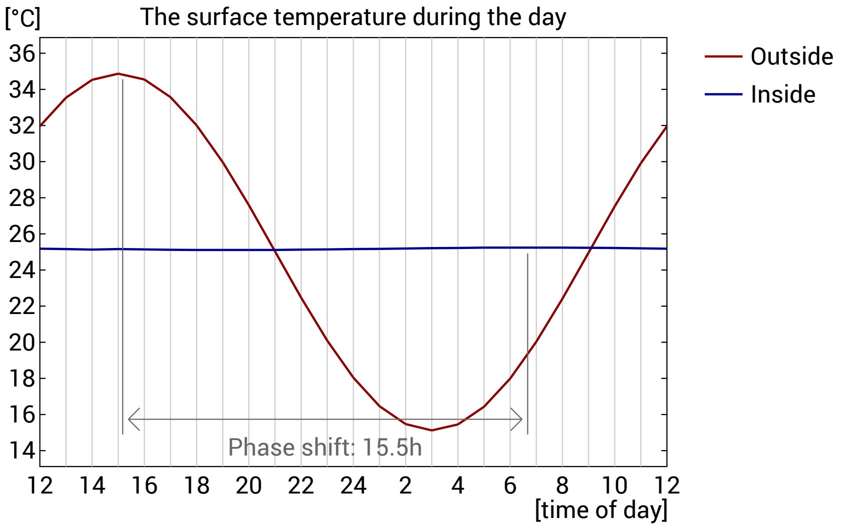
DIN 4108-3 describes in Section 5.3 components for which no moisture proofing is required as there is no risk of condensation water or the method is not suitable for the assessment. It is not possible to assess whether the component under test is underneath.

EW_Exclusive_EPS_100, R_{tot}=8,738 m²K/W

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	non relevant	Heat storage capacity (whole component):	87 kJ/m²K
Amplitude attenuation **	>100	Thermal capacity of inner layers:	55 kJ/m²K
TAV ***	0,007		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

Hints

There are no hints available for your calculation.

Floor construction

Thermal protection

U = 0,189 W/(m²K)

GEG 2020 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

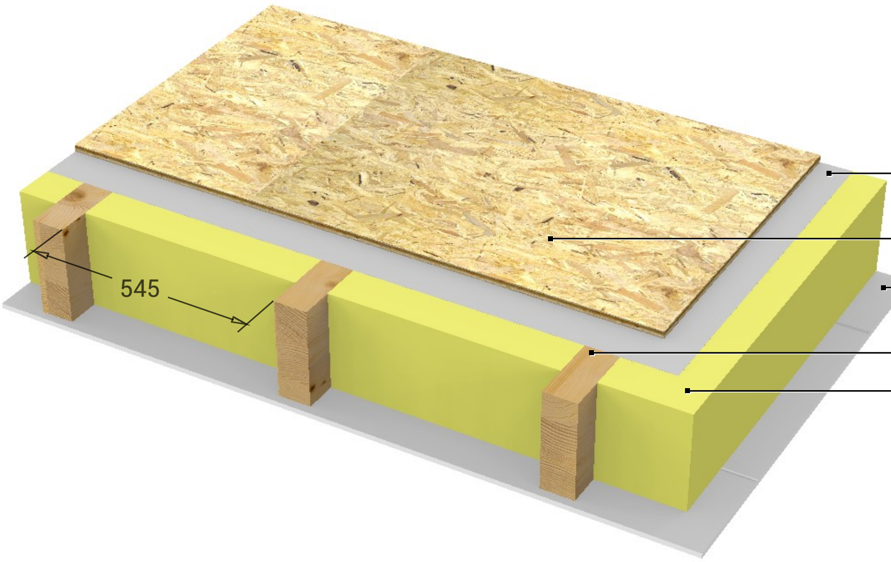
Drying reserve: 1311 g/m²a
No condensate

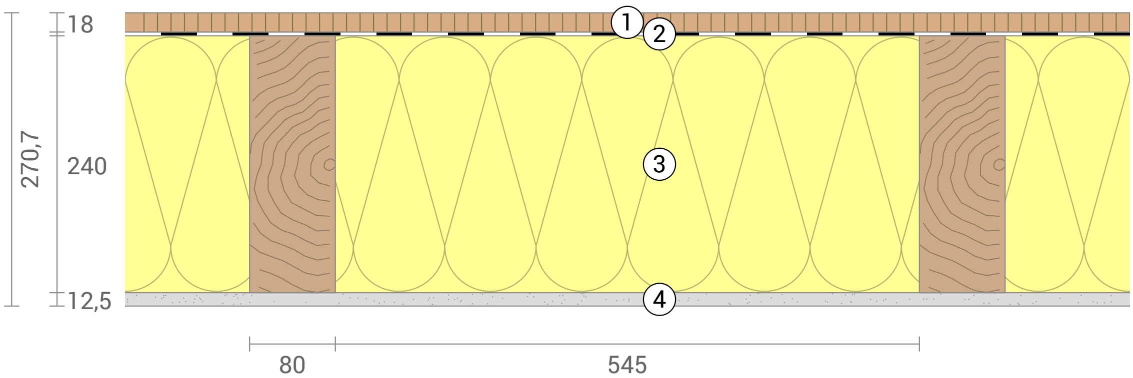
excellent insufficient

Heat protection

Temperature amplitude damping: 11
phase shift: 8,0 h
Thermal capacity inside: 32 kJ/m²K

excellent insufficient





1 OSB/3 (18 mm)
2 Vapour barier
3 Stone Wool Natur Bord FIT (240 mm)
4 Fermacell Powerpanel H2O (12,5 mm)

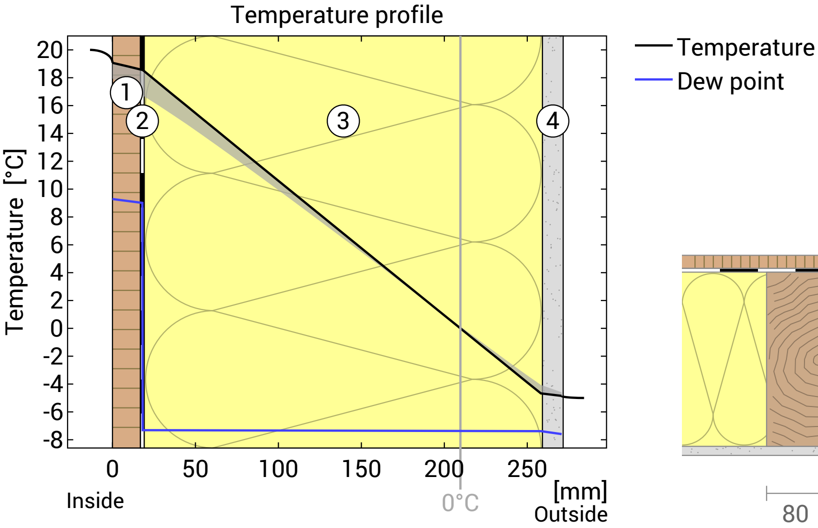
Inside air :	20,0°C / 50%			Thickness:	27,1 cm
Outside air:	-5,0°C / 80%	sd-value:	104,5 m	Weight:	43 kg/m²
Surface temperature.:	17,9°C / -4,8°C	Drying reserve:	1311 g/m²a	Heat capacity:	59 kJ/m²K

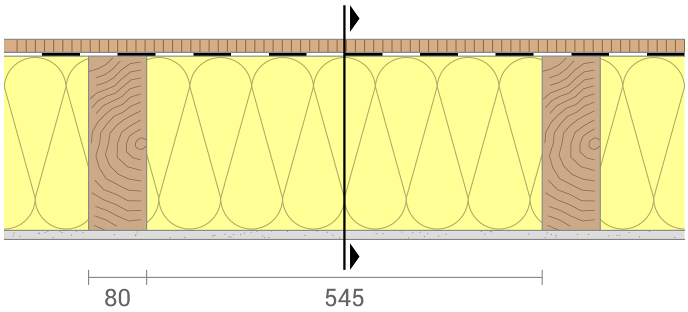
☑ GEG 2020 Bestand ☑ BEG Einzelmaßn. ☑ GEG 2020 Neubau ☑ DIN 4108

*Comparison of the U-value with den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau); den R-Werten aus DIN 4108-2 Tabelle 3

Floor construction, U=0,189 W/(m²K)

Temperature profile





① OSB/3 (18 mm)
② Vapour barier
③ Stone Wool Natur Bord FIT (240 mm)
④ Fermacell Powerpanel H2O (12,5 mm)

Left: Temperature and dew-point temperature at the place marked in the right figure. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew point, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.
Right: The component, drawn to scale.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,170	17,9	20,0	
1	1,8 cm	OSB/3	0,130	0,138	16,7	19,1	11,2
2	0,02 cm	Vapour barier	0,500	0,000	16,7	18,6	0,2
3	24 cm	Stone Wool Natur Bord FIT	0,038	6,316	-4,7	18,6	6,3
	24 cm	Structural timber (13%)	0,130	1,846	-4,1	17,2	12,9
4	1,25 cm	Fermacell Powerpanel H2O	0,250	0,050	-4,9	-4,1	12,5
		Thermal contact resistance*		0,040	-5,0	-4,6	
	27,07 cm	Whole component		5,304			43,0

*Thermal contact resistances according to DIN 6946 for the U-value calculation. Rsi=0,25 and Rse=0,04 according to DIN 4108-3 were used for moisture proofing and temperature profile.

Surface temperature inside (min / average / max):	17,9°C	18,8°C	19,1°C
Surface temperature outside (min / average / max):	-4,9°C	-4,8°C	-4,6°C

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

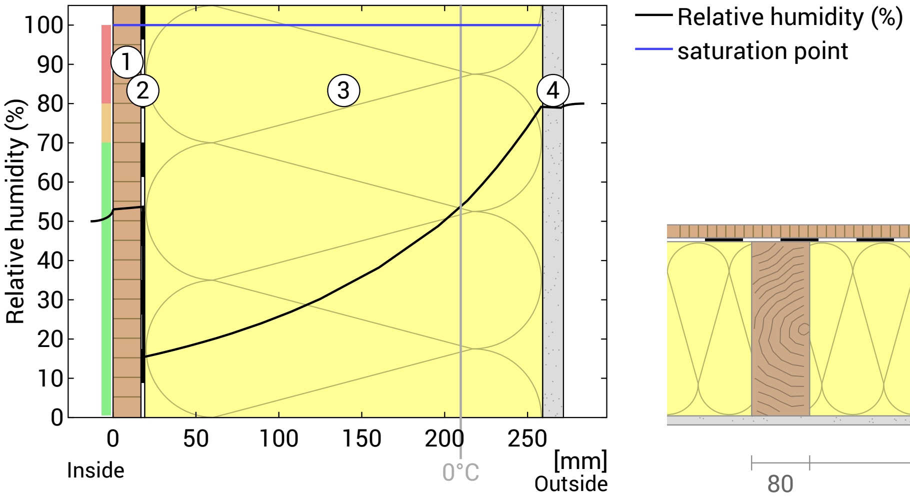
This component is free of condensate under the given climate conditions.

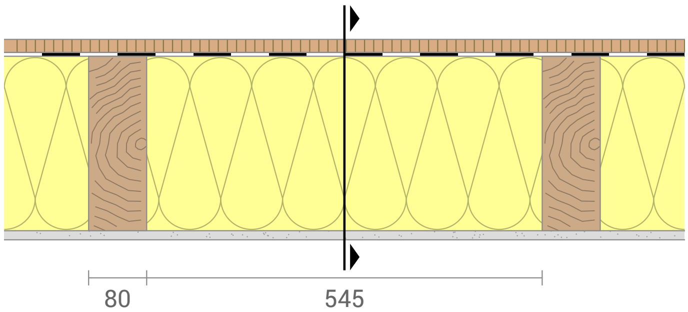
Drying reserve according to DIN 4108-3:2018: 1311 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	Condensate [Gew.-%]	Weight [kg/m²]
1	1,8 cm	OSB/3	2,70	-	-	11,2
2	0,02 cm	Vapour barier	100,00	-		0,2
3	24 cm	Stone Wool Natur Bord FIT	0,24	-		6,3
	24 cm	Structural timber (13%)	9,60	-	-	12,9
4	1,25 cm	Fermacell Powerpanel H2O	0,70	-		12,5
	27,07 cm	Whole component	104,49	0		43,0

Humidity

The temperature of the inside surface is 17,9 °C leading to a relative humidity on the surface of 57%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



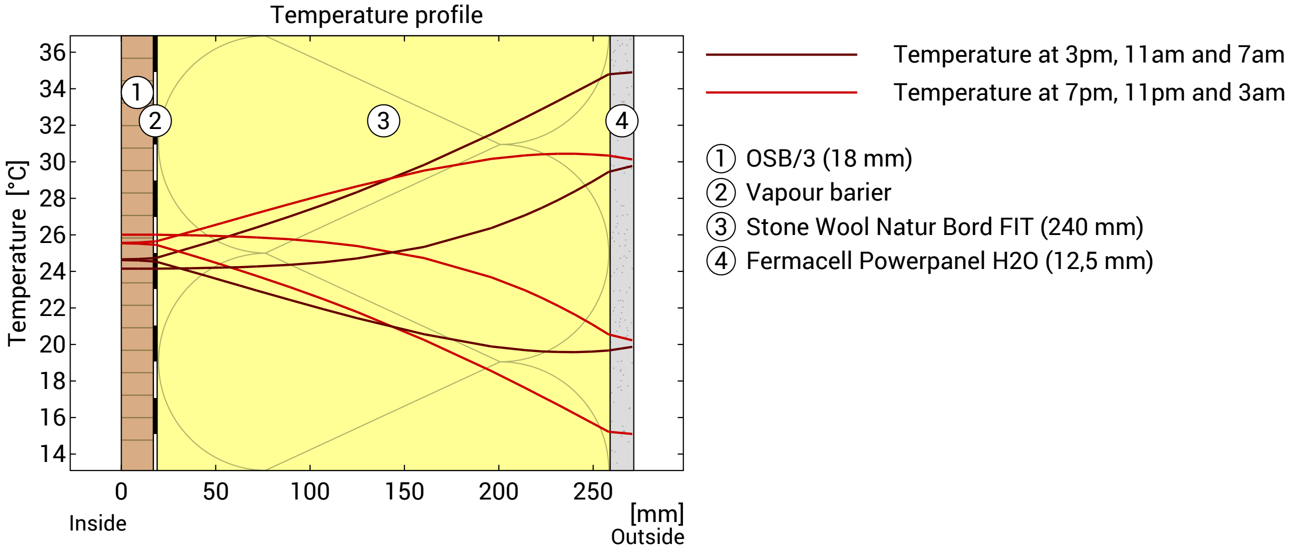


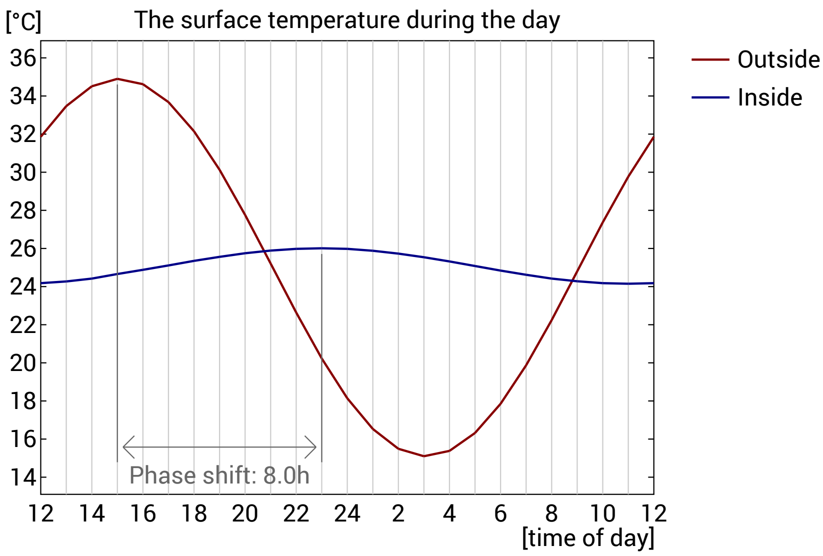
① OSB/3 (18 mm)
② Vapour barier
③ Stone Wool Natur Bord FIT (240 mm)
④ Fermacell Powerpanel H2O (12,5 mm)

Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	8,0 h	Heat storage capacity (whole component):	59 kJ/m²K
Amplitude attenuation **	10,6	Thermal capacity of inner layers:	32 kJ/m²K
TAV ***	0,094		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

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FR_Standard_R

Flat roof
created on 29.6.2023

Thermal protection

R_{tot} = 9,545 m²K/W

EnEV Bestand*: U<0,2 W/(m²K)

excellent insufficient

Moisture proofing

Drying reserve: 67 g/m²a
(leads to devaluation)

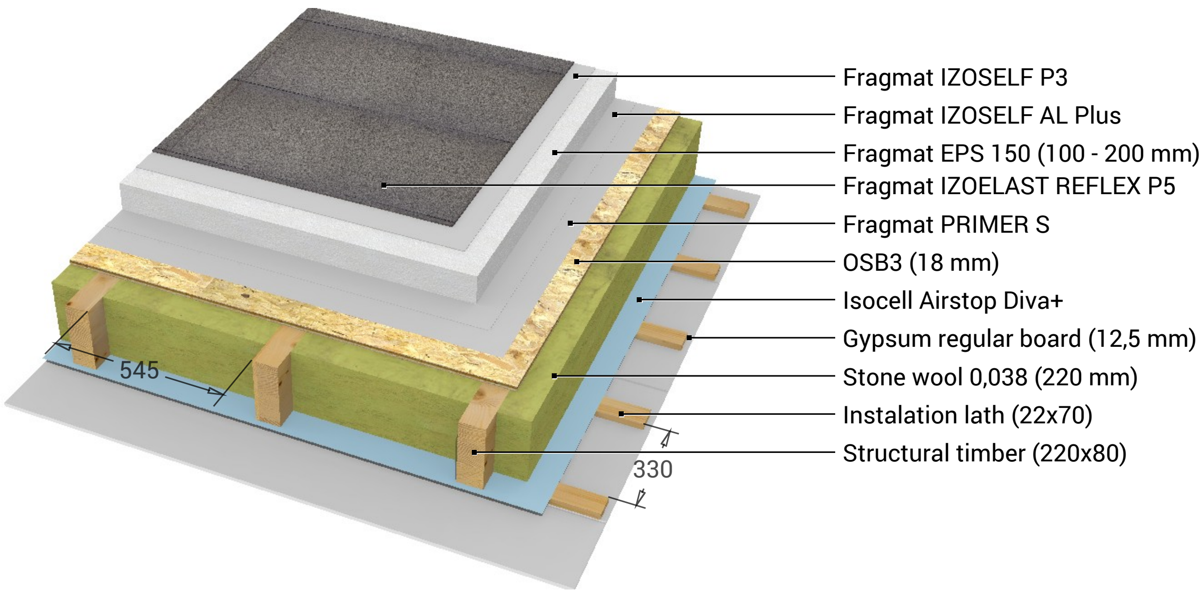
44 g/m² 36 Days +0,4%

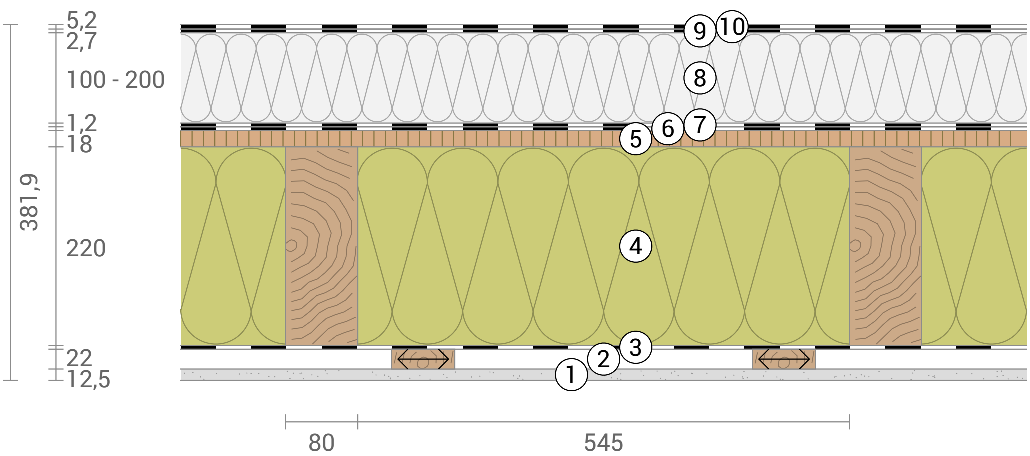
excellent insufficient

Heat protection

Temperature amplitude damping: 27
phase shift: 12,5 h
Thermal capacity inside: 35 kJ/m²K

excellent insufficient





1. Gypsum regular board (12,5 mm)
2. Instalation level (22 mm)
3. Isocell Airstop Diva+
4. Stone wool 0,038 (220 mm)
5. OSB3 (18 mm)
6. Fragmat PRIMER S
7. Fragmat IZOSELF AL Plus
8. Fragmat EPS 150 (100 - 200 mm)
9. Fragmat IZOSELF P3
10. Fragmat IZOELAST REFLEX P5

<-> Layers marked by arrows are perpendicular to the main axis.

Inside air :	20,0°C / 50%		Thickness:	38,2 cm
Outside air:	-5,0°C / 80%	sd-value: 1105,4 m	Weight:	55 kg/m²
Surface temperature.:	18,8°C / -4,9°C		Heat capacity:	70 kJ/m²K

☑ EnEV Bestand ☑ BEG Einzelmaßn. ☑ GEG 2020 Bestand ☑ GEG 2020 Neubau

*Comparison of the U-value with den Höchstwerten aus EnEV 2014 Anlage 3 Tabelle 1 (EnEV Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau)

FR_Standard_R, R_{tot}=9,545 m²K/W

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,100
1	Gypsum regular board	1,25	0,250	0,050
2	Instalation level	2,20	0,138	0,160
	Instalation lath (18%)	2,20	0,130	0,169
3	Isocell Airstop Diva+	0,01	0,500	0,000
4	Stone wool 0,038	22,00	0,038	5,789
	Structural timber (13%)	22,00	0,130	1,692
5	OSB3	1,80	0,130	0,138
6	Fragmat PRIMER S	0,02	0,230	0,001
7	Fragmat IZOSELF AL Plus	0,12	0,230	0,005
8	Fragmat EPS 150	10 - 20	0,034	2,941
9	Fragmat IZOSELF P3	0,27	0,230	0,012
10	Fragmat IZOELAST REFLEX P5	0,52	0,230	0,023
	Thermal contact resistance outside (Rse)			0,040

Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction upwards
Rse: heat flow direction upwards, outside: Direct contact to outside air

Thermal transfer resistances of resting air layers were calculated as follows:
Layer 2.1: Thickness 2.2 cm, Width 33 cm, DIN EN ISO 6946 Table 8, heat flow direction upwards

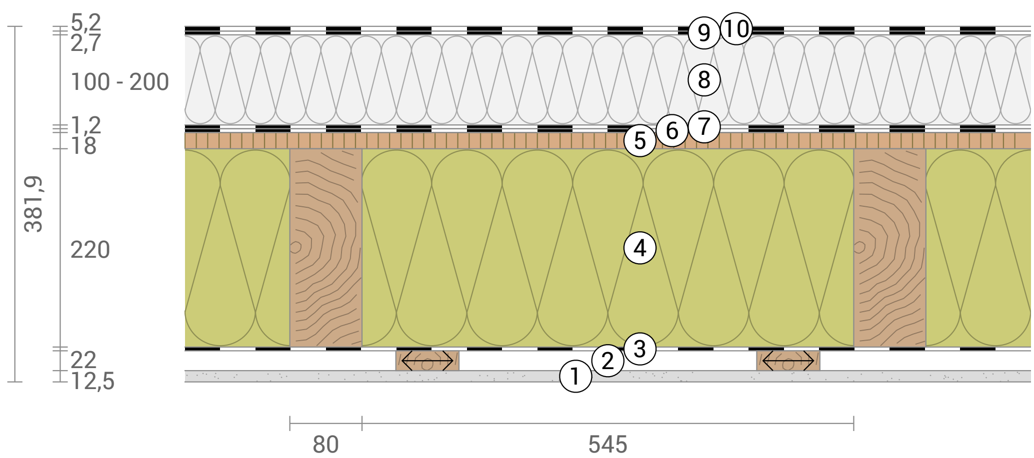
Upper limit of thermal resistance $R_{tot;upper}$ = 8,408 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 7,892 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,065 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 8,150 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 3,2%

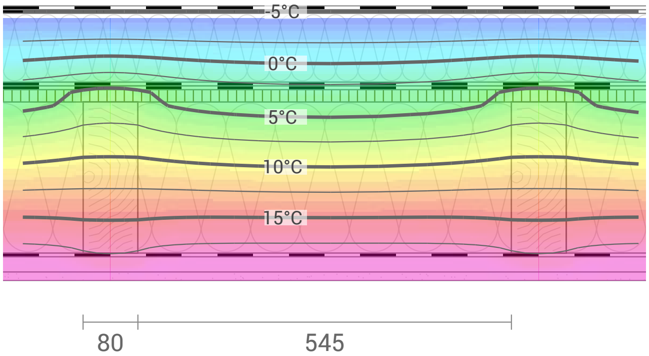
Consider sloped insulation in layer 8 (Rechteck, accor. appendix E):
with: d_2=100 mm; R_2 = 2,941 m²K/W

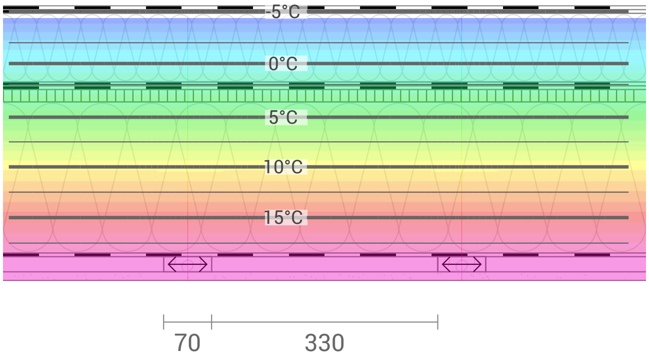
Heat transfer coefficient U = $1/R_2 * \ln(1+R_2/R_T)$ = **0,10 W/(m²K)**

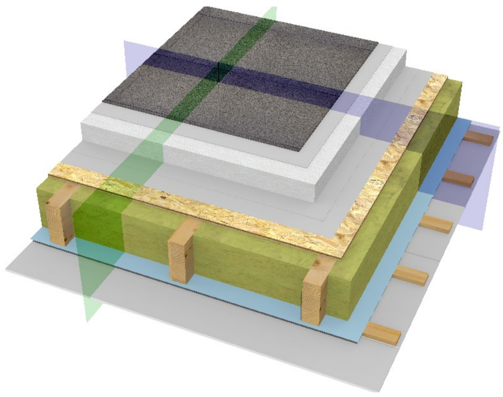


FR_Standard_R, R_{tot}=9,545 m²K/W

Temperature profile







Top left: Temperature profile in the blue section (see right illustration). Bottom left: Temperature profile in the green section.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	18,8	20,0	
1	1,25 cm	Gypsum regular board	0,250	0,050	18,6	19,4	8,5
2	2,2 cm	Instalation level	0,138	0,160	17,7	19,2	0,0
	2,2 cm	Instalation lath (18%)	0,130	0,169			1,7
3	0,01 cm	Isocell Airstop Diva+	0,500	0,000	17,7	18,8	0,1
4	22 cm	Stone wool 0,038	0,038	5,789	3,8	18,8	5,8
	22 cm	Structural timber (13%)	0,130	1,692	6,3	18,0	12,7
5	1,8 cm	OSB3	0,130	0,138	3,4	6,4	11,2
6	0,02 cm	Fragmat PRIMER S	0,230	0,001	3,4	5,7	0,2
7	0,12 cm	Fragmat IZOSELF AL Plus	0,230	0,005	3,4	5,7	1,3
8	10 cm	Fragmat EPS 150	0,034	2,941	-4,8	5,7	2,5
9	0,27 cm	Fragmat IZOSELF P3	0,230	0,012	-4,8	-4,7	3,8
10	0,52 cm	Fragmat IZOELAST REFLEX P5	0,230	0,023	-4,9	-4,8	7,3
		Thermal contact resistance*		0,040	-5,0	-4,9	
	38,19 cm	Whole component		9,545			55,0

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max):	18,8°C	19,2°C	19,4°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,9°C

STECO GROUP

FR_Standard_R, R_{tot}=9,545 m²K/W

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

Under these conditions, a total of 0,044 kg of condensation water per square meter is accumulated.This quantity dries in summer in 36 days (Drying season according to DIN 4108-3:2018-10).

Drying reserve according to Ubakus 2D-FE method: 67 g/(m²a)
At least required by DIN 68800-2: 250 g/(m²a)
The moisture protection of this component is therefore rated poorly.

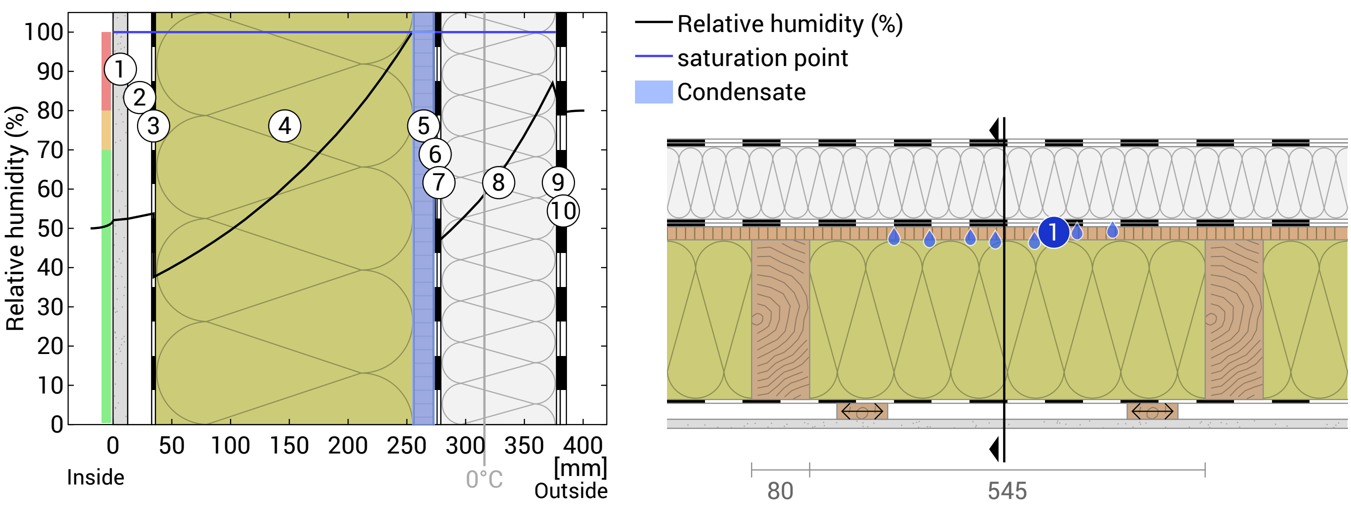
#		Material	sd-value [m]	Condensate [kg/m²]	Condensate [Gew.-%]	Weight [kg/m²]
1	1,25 cm	Gypsum regular board	0,05	-		8,5
2	2,2 cm	Instalation level	0,01	-		0,0
	2,2 cm	Instalation lath (18%)		-	-	1,7
3	0,01 cm	Isocell Airstop Diva+	12,03	-		0,1
4	22 cm	Stone wool 0,038	0,22	0,040		5,8
	22 cm	Structural timber (13%)	4,40	-	-	12,7
5	1,8 cm	OSB3	2,70	0,044	0,4	11,2
6	0,02 cm	Fragmat PRIMER S	2,00	-		0,2
7	0,12 cm	Fragmat IZOSELF AL Plus	1002	-		1,3
8	10 cm	Fragmat EPS 150	7,00	-		2,5
9	0,27 cm	Fragmat IZOSELF P3	27,00	-		3,8
10	0,52 cm	Fragmat IZOELAST REFLEX P5	52,00	-		7,3
	38,19 cm	Whole component	1.105,44	0,044		55,0

Condensation areas

(1) Condensate: 0,044 kg/m² Affected layers: OSB3, Stone wool 0,038, Fragmat PRIMER S

Humidity

The temperature of the inside surface is 18,8 °C leading to a relative humidity on the surface of 54%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



1. Gypsum regular board (12,5 mm)
2. Instalation level (22 mm)
3. Isocell Airstop Diva+
4. Stone wool 0,038 (220 mm)
5. OSB3 (18 mm)
6. Fragmat PRIMER S
7. Fragmat IZOSELF AL Plus
8. Fragmat EPS 150 (100 - 200 mm)
9. Fragmat IZOSELF P3
10. Fragmat IZOELAST REFLEX P5

Layers marked with <-> run parallel to the illustrated cutting plane and were not taken into account in the moisture protection calculation.
Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

STECO GROUP

FR_Standard_R, R_{tot}=9,545 m²K/W

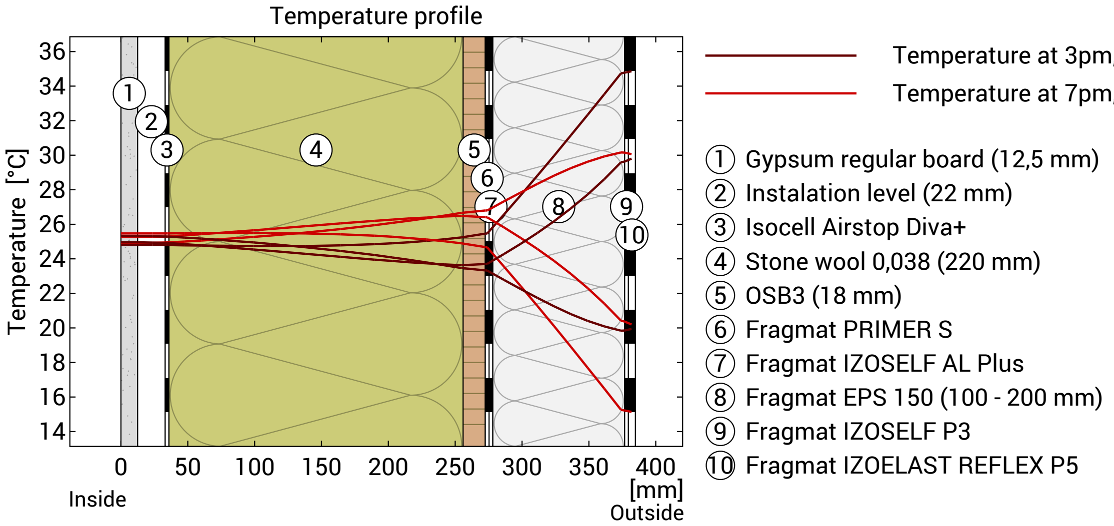
Moisture protection in accordance with DIN 4108-3:2018 Appendix A

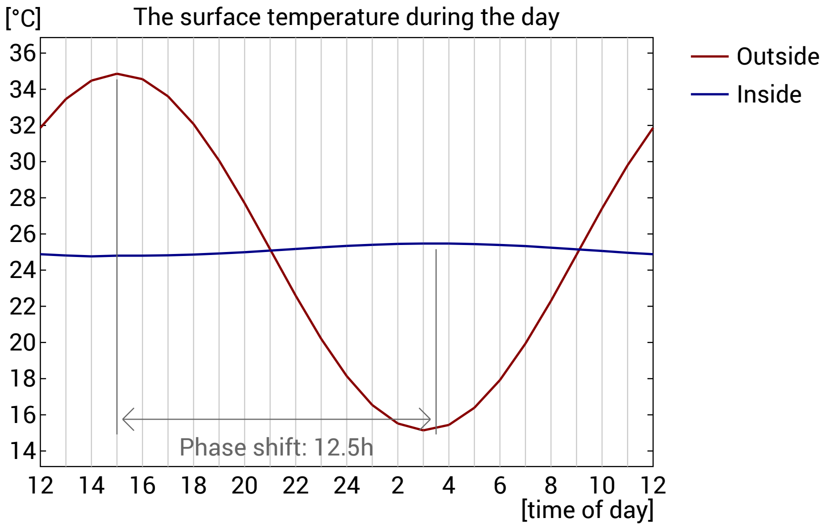
DIN 4108-3 may not be applied to insulated, non-ventilated wooden roof structures with metal roofing or with sealing on formwork or planking without ventilation of the waterproofing / underlay.

FR_Standard_R, R_{tot}=9,545 m²K/W

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	12,5 h	Heat storage capacity (whole component):	70 kJ/m²K
Amplitude attenuation **	26,7	Thermal capacity of inner layers:	35 kJ/m²K
TAV ***	0,037		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

FR_Standard_R, R_{tot}=9,545 m²K/W

Hints

Drying duration of roofs

If the roof is shaded, due to the roof pitch or orientation, if the sun is shining little or is in an unfavorable climatic zone, the drying of the dew water can take much longer than the calculated 36 days. In this case, have your component evaluated by a hygrothermal simulation program. Further information can be found in the article Außen dampfdichte Dächer.

Non-ventilated air layers

A stationary air layer is a cavity enclosed on all sides, which does not have any connections to the room or outside air. Two adjacent air layers are only calculated correctly if no air exchange is possible between the two layers, e.g. if the air layers are separated by a thin foil. Otherwise, the entire cavity must be modelled as a single layer.

An air layer as the most interiour or exterior layer of a building component, which thus has a connection to the room or outside air, is not considered a resting air layer. In this case, Ubakus tries to treat the air layer as a rear ventilation layer, room air or outside air. However, the calculation result may then contain significant uncertainties.

Resting air has a very low thermal conductivity. Above a certain layer thickness, however, convection occurs, which greatly reduces the insulation effect. If the layer thickness is more than 30 cm, the air layer can no longer be taken into account correctly.

If the air layer has openings to the outside air whose size exceeds 1,500 mm² per m length for vertical air layers or 1,500 mm² per m² surface for horizontal air layers, it is a rear ventilation layer. You will find rear ventilation levels in the building material menu under Various.

IW_Standard

internal wall
created on 29.6.2023

Thermal protection

R_{tot} = 1,898 m²K/W

Heated on both sides: No requirement*

excellent insufficient

Moisture proofing

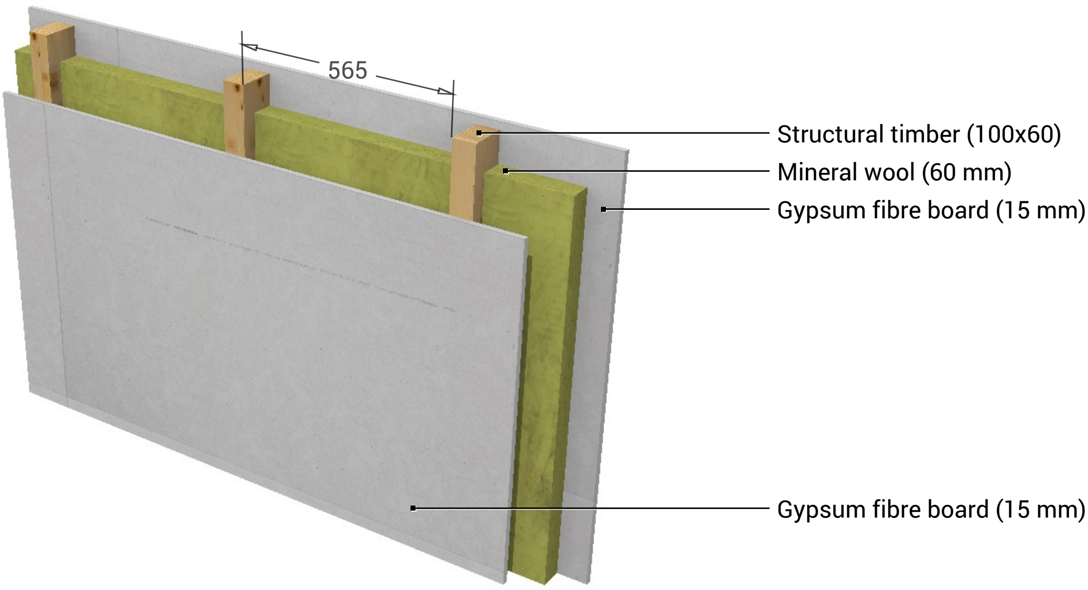
Drying reserve: 6326 g/m²a
No condensate

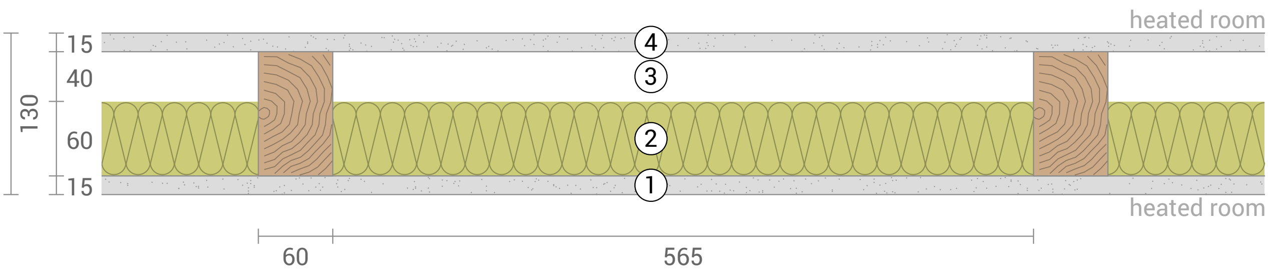
excellent insufficient

Heat protection

Temperature amplitude damping: 2,8
phase shift: 4,8 h
Thermal capacity inside: 21 kJ/m²K

excellent insufficient





1. Gypsum fibre board (15 mm)
2. Mineral wool (60 mm)
3. Instalation gap (40 mm)
4. Gypsum fibre board (15 mm)

Inside air :	20,0°C / 50%		Thickness:	13,0 cm
Inside air 2:	20,0°C / 50%	sd-value: 0,5 m	Weight:	40 kg/m²
Surface temperature.:	20,0°C / 20,0°C		Heat capacity:	47 kJ/m²K

☐ EnEV Bestand ☐ BEG Einzelmaßn. ☐ GEG 2020 Bestand ☐ GEG 2020 Neubau

*Comparison of the U-value with den Höchstwerten aus EnEV 2014 Anlage 3 Tabelle 1 (EnEV Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau)

IW_Standard, R_{tot}=1,898 m²K/W

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,130
1	Gypsum fibre board	1,50	0,320	0,047
2	Mineral wool	6,00	0,038	1,579
	Structural timber (Width: 6 cm)	10,00	0,130	0,769
3	Instalation gap	4,00	0,222	0,180
4	Gypsum fibre board	1,50	0,320	0,047
	Thermal contact resistance outside (Rse)			0,130

Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction horizontally
Rse: heat flow direction horizontally, outside: Heated room

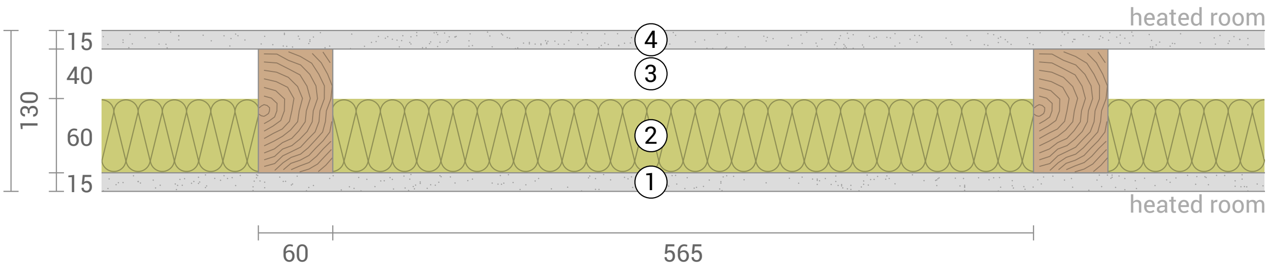
Thermal transfer resistances of resting air layers were calculated as follows:
Layer 3: Thickness 4 cm, Width 56.5 cm, DIN EN ISO 6946 Table 8, heat flow direction horizontally

Upper limit of thermal resistance $R_{tot;upper}$ = 1,948 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 1,822 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,069 (maximum allowed: 1,5)

The procedure may be used.

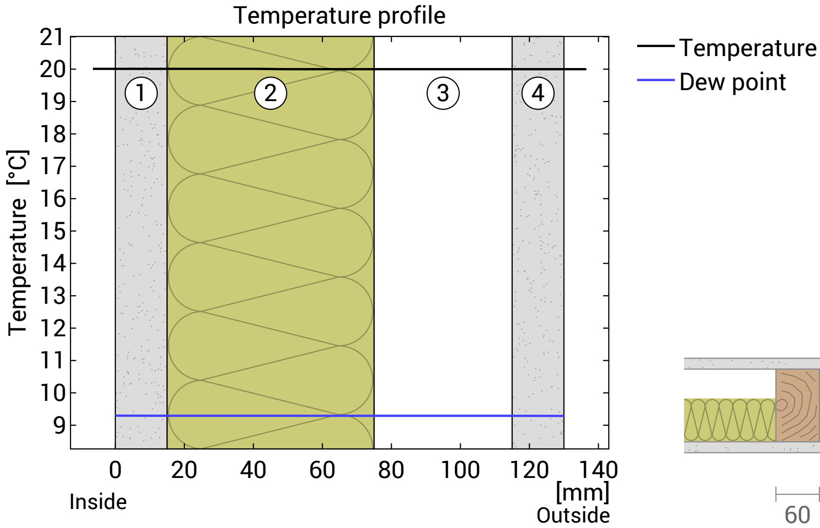
Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 1,885 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 3,3%

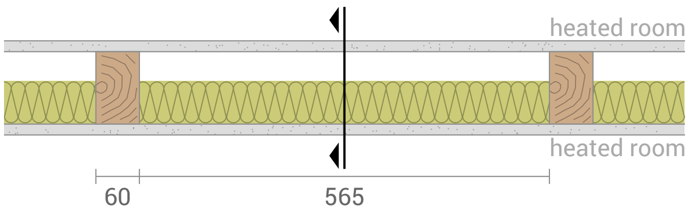
Heat transfer coefficient U = 1/R_{tot} = **0,53 W/(m²K)**



IW_Standard, R_{tot}=1,898 m²K/W

Temperature profile





① Gypsum fibre board (15 mm)
② Mineral wool (60 mm)
③ Instalation gap (40 mm)
④ Gypsum fibre board (15 mm)

Left: Temperature and dew-point temperature at the place marked in the right figure. The dew-point indicates the temperature, at which water vapour condensates. As long as the temperature of the component is everywhere above the dew point, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.
Right: The component, drawn to scale.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	20,0	20,0	
1	1,5 cm	Gypsum fibre board	0,320	0,047	20,0	20,0	17,3
2	6 cm	Mineral wool	0,038	1,579	20,0	20,0	1,6
	10 cm	Structural timber (Width: 6 cm)	0,130	0,769	20,0	20,0	4,3
3	4 cm	Instalation gap	0,222	0,180	20,0	20,0	0,0
4	1,5 cm	Gypsum fibre board	0,320	0,047	20,0	20,0	17,3
		Thermal contact resistance*		0,040	20,0	20,0	
	13 cm	Whole component		1,898			40,5

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max):	20,0°C	20,0°C	20,0°C
Surface temperature outside (min / average / max):	20,0°C	20,0°C	20,0°C

IW_Standard, R_{tot}=1,898 m²K/W

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20.01°C und 50% Humidity; outside: 20°C und 50% Humidity (Climate according to user input).

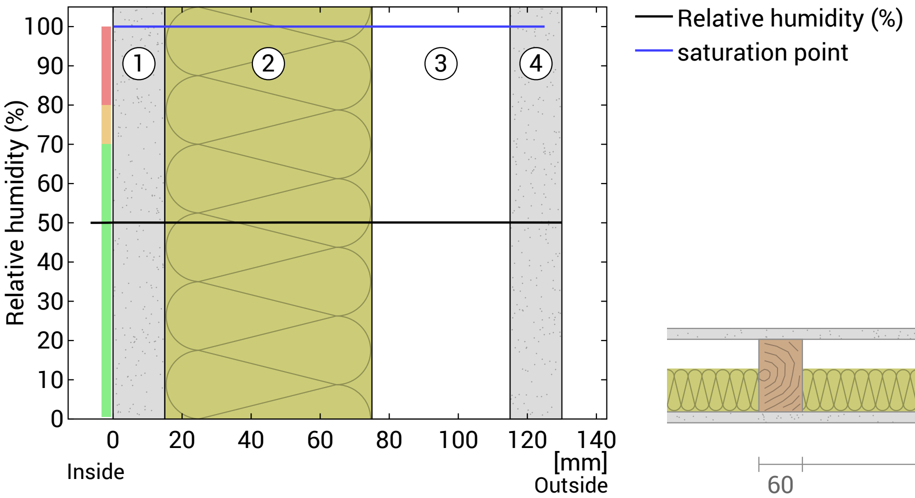
This component is free of condensate under the given climate conditions.

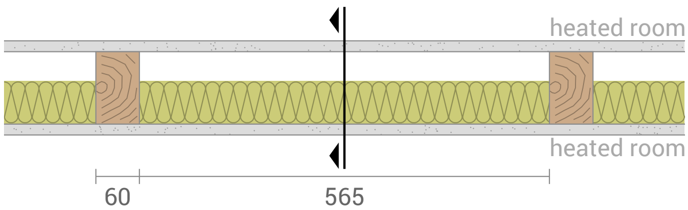
Drying reserve according to Ubakus 2D-FE method: 6326 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1,5 cm	Gypsum fibre board	0,20	-		17,3
2	6 cm	Mineral wool	0,06	-		1,6
	10 cm	Structural timber (Width: 6 cm)	5,00	-	-	4,3
3	4 cm	Instalation gap	0,01	-		0,0
4	1,5 cm	Gypsum fibre board	0,20	-		17,3
	13 cm	Whole component	0,50	0		40,5

Humidity

The temperature of the inside surface is 20,0 °C leading to a relative humidity on the surface of 50%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.





① Gypsum fibre board (15 mm)
② Mineral wool (60 mm)
③ Instalation gap (40 mm)
④ Gypsum fibre board (15 mm)

Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

Moisture protection in accordance with DIN 4108-3:2018 Appendix A

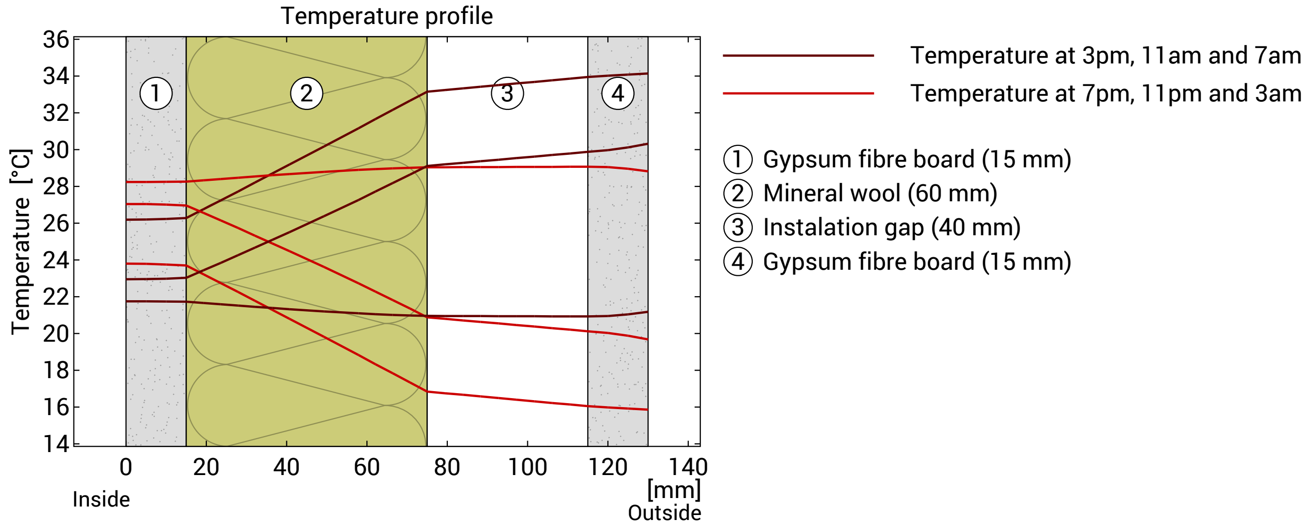
The temperatures and / or humidities you specify are not in accordance with DIN 4108-3. The following values are given by DIN 4108-3: 20°C / 50% humidity inside and -5°C / 80% humidity outside. Change the values in the input form to enable the calculation according to DIN 4108-3.

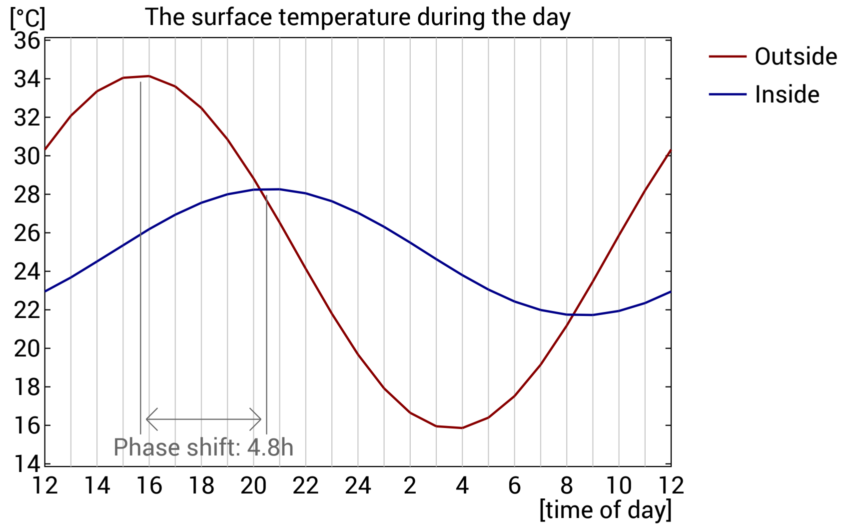
STECO GROUP

IW_Standard, R_{tot}=1,898 m²K/W

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	4,8 h	Heat storage capacity (whole component):	47 kJ/m²K
Amplitude attenuation **	2,8	Thermal capacity of inner layers:	21 kJ/m²K
TAV ***	0,358		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

IW_Standard, R_{tot}=1,898 m²K/W

Hints

Non-ventilated air layers

A stationary air layer is a cavity enclosed on all sides, which does not have any connections to the room or outside air. Two adjacent air layers are only calculated correctly if no air exchange is possible between the two layers, e.g. if the air layers are separated by a thin foil. Otherwise, the entire cavity must be modelled as a single layer.

An air layer as the most interiour or exterior layer of a building component, which thus has a connection to the room or outside air, is not considered a resting air layer. In this case, Ubakus tries to treat the air layer as a rear ventilation layer, room air or outside air. However, the calculation result may then contain significant uncertainties.

Resting air has a very low thermal conductivity. Above a certain layer thickness, however, convection occurs, which greatly reduces the insulation effect. If the layer thickness is more than 30 cm, the air layer can no longer be taken into account correctly.

If the air layer has openings to the outside air whose size exceeds 1,500 mm² per m length for vertical air layers or 1,500 mm² per m² surface for horizontal air layers, it is a rear ventilation layer. You will find rear ventilation levels in the building material menu under Various.

PR_Standard_T

Roof construction
created on 29.6.2023

Thermal protection

R_{tot} = 6,506 m²K/W

EnEV Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

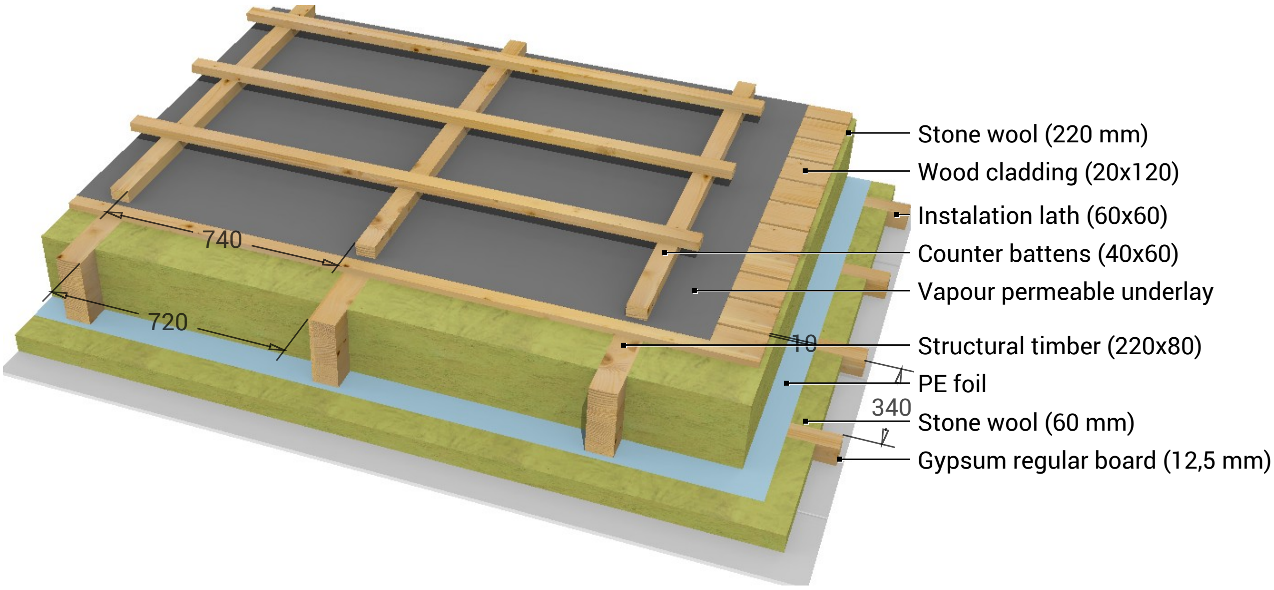
Drying reserve: 9089 g/m²a
No condensate

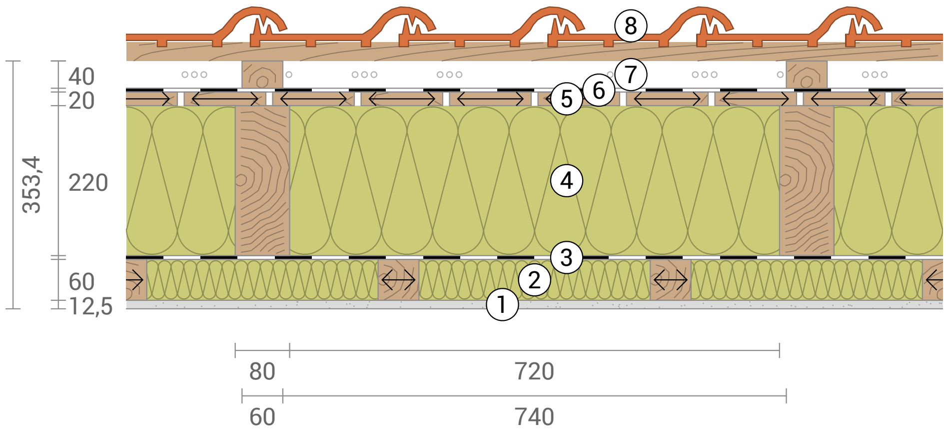
excellent insufficient

Heat protection

Temperature amplitude damping: 6,9
phase shift: 8,1 h
Thermal capacity inside: 18 kJ/m²K

excellent insufficient





1. Gypsum regular board (12,5 mm)
2. Stone wool (60 mm)
3. PE foil
4. Stone wool (220 mm)
5. Air gap (20 mm)
6. Vapour permeable underlay
7. Rear ventilated level (40 mm)
8. Roof lath with covering (103 mm)

<-> Layers marked by arrows are perpendicular to the main axis.

Inside air :	20,0°C / 50%			Thickness:	45,6 cm
Outside air:	-5,0°C / 80%	sd-value:	101,3 m	Weight:	91 kg/m²
Surface temperature.:	18,9°C / -4,9°C	Drying reserve:	9089 g/m²a	Heat capacity:	32 kJ/m²K

☑ EnEV Bestand ☐ BEG Einzelmaßn. ☑ GEG 2020 Bestand ☑ GEG 2020 Neubau

*Comparison of the U-value with den Höchstwerten aus EnEV 2014 Anlage 3 Tabelle 1 (EnEV Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; den Höchstwerten aus GEG 2020 Anlage 7 (GEG 2020 Bestand); 80% des U-Werts der Referenzausführung aus GEG 2020 Anlage 1 (GEG20 Neubau)

PR_Standard_T, R_{tot}=6,506 m²K/W

U-Value calculation according to DIN EN ISO 6946

#	Material	Dicke [cm]	λ [W/mK]	R [m²K/W]
	Thermal contact resistance inside (Rsi)			0,100
1	Gypsum regular board	1,25	0,250	0,050
2	Stone wool	6,00	0,038	1,579
	Instalation lath (15%)	6,00	0,130	0,462
3	PE foil	0,02	0,500	0,000
4	Stone wool	22,00	0,038	5,789
	Structural timber (10%)	22,00	0,130	1,692
5	Air gap	2,00	0,080	0,251
	Wood cladding (92%)	2,00	0,130	0,154
6	Vapour permeable underlay	0,07	0,500	0,001
	Thermal contact resistance outside (Rse)			0,100

Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction upwards
Rse: heat flow direction upwards, outside: Ventilation level

Thermal transfer resistances of resting air layers were calculated as follows:
Layer 5.1: Thickness 2 cm, Width 1 cm, DIN EN ISO 6946 Appendix D.4, heat flow direction 45° upwards, Temperature ca. -4°C, Emissionsgrad der Oberflächen: 0,9

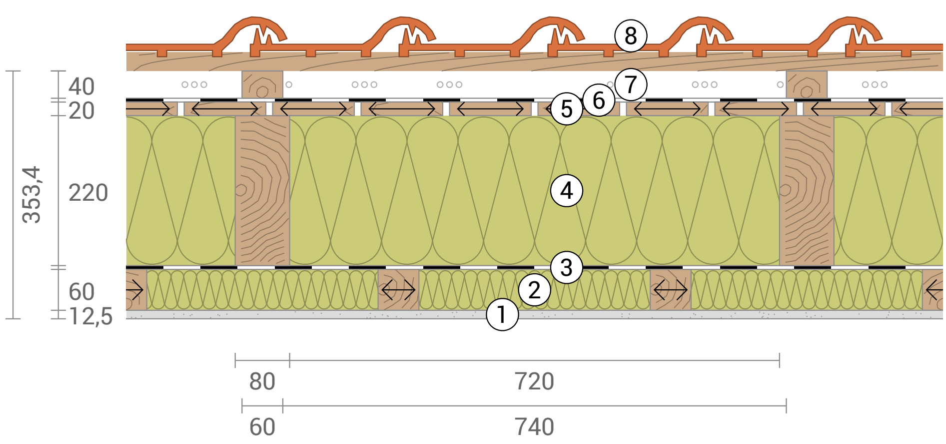
Upper limit of thermal resistance $R_{tot;upper}$ = 6,781 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 6,230 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,088 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 6,506 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 4,2%

Heat transfer coefficient U = 1/R_{tot} = **0,15 W/(m²K)**

This component includes several inhomogeneous layers of different overall width. For all the calculations it was assumed that the layer arrangement is repeated in width all 40 cm. This, however, is not true for at least layer 5 with a total width of 13 cm and can cause increased inaccuracy of the U-value.



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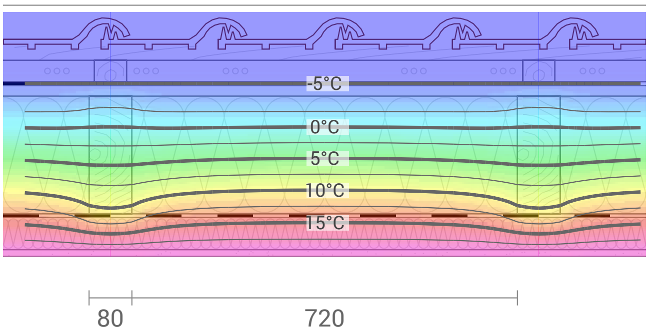
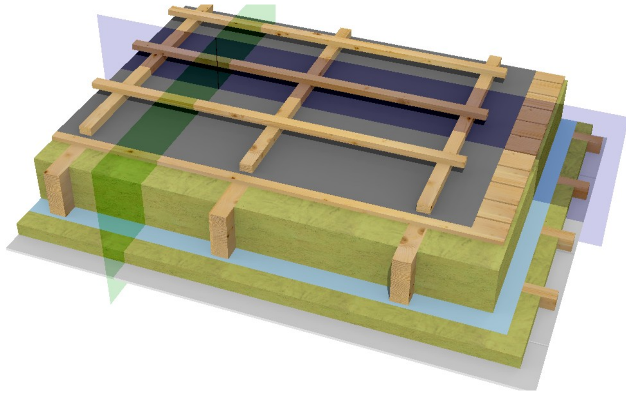
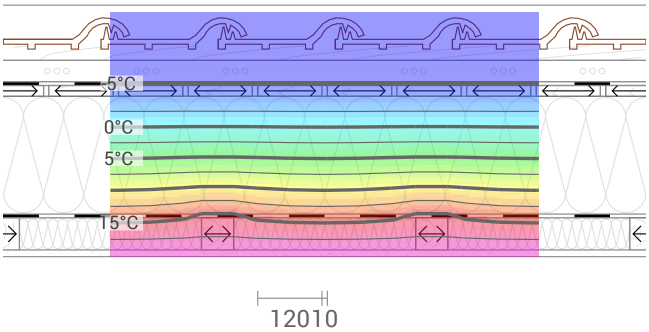
PR_Standard_T, R_{tot}=6,506 m²K/W

Temperature profile







Top left: Temperature profile in the blue section (see right illustration). Bottom left: Temperature profile in the green section.

Layers (from inside to outside)

#		Material	λ [W/mK]	R [m²K/W]	Temperatur [°C] min	max	Weight [kg/m²]
		Thermal contact resistance*		0,250	18,9	20,0	
1	1,25 cm	Gypsum regular board	0,250	0,050	18,6	19,2	8,5
2	6 cm	Stone wool	0,038	1,579	10,6	19,0	1,5
	6 cm	Instalation lath (15%)	0,130	0,462			4,1
3	0,02 cm	PE foil	0,500	0,000	10,6	14,0	0,2
4	22 cm	Stone wool	0,038	5,789	-4,1	14,0	5,9
	22 cm	Structural timber (10%)	0,130	1,692	-3,1	11,2	9,9
5	2 cm	Air gap	0,080	0,251	-4,9	-2,9	0,0
	2 cm	Wood cladding (92%)	0,130	0,154			8,2
6	0,07 cm	Vapour permeable underlay	0,500	0,001	-4,9	-4,7	0,2
		Thermal contact resistance*		0,040	-5,0	-4,7	
7	4 cm	Rear ventilated level (outside air)			-5,0	-5,0	0,0
8	10,3 cm	Roof lath with covering			-5,0	-5,0	51,5
	45,64 cm	Whole component		6,506			91,4

*Thermal contact resistances according to DIN 4108-3 for moisture protection and temperature profile. The values for the U-value calculation can be found on the page 'U-value calculation'.

Surface temperature inside (min / average / max):	18,9°C	19,1°C	19,2°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,7°C

PR_Standard_T, R_{tot}=6,506 m²K/W

Moisture proofing

For the calculation of the amount of condensation water, the component was exposed to the following constant climate for 90 days: inside: 20°C und 50% Humidity; outside: -5°C und 80% Humidity. This climate complies with DIN 4108-3.

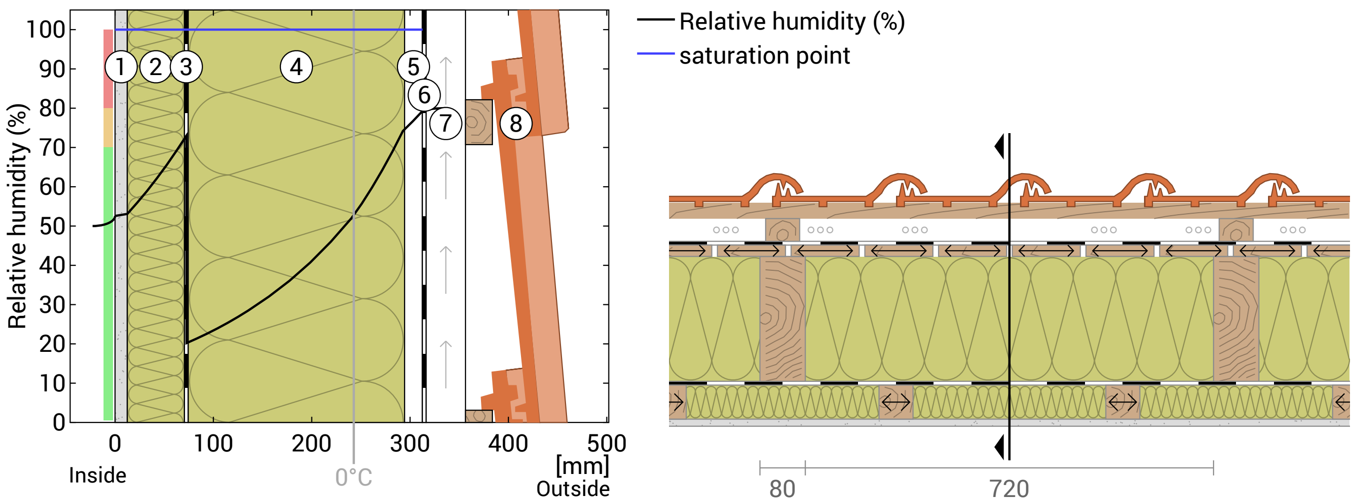
This component is free of condensate under the given climate conditions.

Drying reserve according to DIN 4108-3:2018: 9089 g/(m²a)
At least required by DIN 68800-2: 250 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1,25 cm	Gypsum regular board	0,05	-		8,5
2	6 cm	Stone wool	0,06	-		1,5
	6 cm	Instalation lath (15%)		-	-	4,1
3	0,02 cm	PE foil	100,00	-		0,2
4	22 cm	Stone wool	0,22	-		5,9
	22 cm	Structural timber (10%)	11,00	-	-	9,9
5	2 cm	Air gap	0,01	-		0,0
	2 cm	Wood cladding (92%)		-	-	8,2
6	0,07 cm	Vapour permeable underlay	0,10	-		0,2
	45,64 cm	Whole component	101,27	0		91,4

Humidity

The temperature of the inside surface is 18,9 °C leading to a relative humidity on the surface of 54%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



① Gypsum regular board (12,5 mm)
② Stone wool (60 mm)
③ PE foil
④ Stone wool (220 mm)
⑤ Air gap (20 mm)
⑥ Vapour permeable underlay
⑦ Rear ventilated level (40 mm)
⑧ Roof lath with covering (103 mm)

Layers marked with <-> run parallel to the illustrated cutting plane and were not taken into account in the moisture protection calculation.
Notes: Calculation using the Ubakus 2D-FE method. Convection and the capillarity of the building materials were not considered. The drying time may take longer under unfavorable conditions (shading, damp / cool summers) than calculated here.

PR_Standard_T, R_{tot}=6,506 m²K/W

Moisture protection in accordance with DIN 4108-3:2018 Appendix A

This moisture proofing is only valid for **non-air-conditioned** residential buildings.

In the case of roof structures with **tile coverings and wooden gratings**, this standard may not be applied. Whether this construction falls under it, is to be examined by the planner.

Please note the hints at the end of these moisture proofing calculations.

#		Material	λ [W/mK]	R [m²K/W]	sd [m]	ρ [kg/m³]
		Thermal contact resistance		0,250		
1	1,25 cm	Gypsum regular board	0,250	0,050	0,05	680
2	6 cm	Stone wool	0,038	1,579	0,06	30
3	0,02 cm	PE foil	0,500	0,000	100	900
4	22 cm	Stone wool	0,038	5,789	0,22	30
5	2 cm	Air gap	0,080	0,251	0,01	1
6	0,07 cm	Vapour permeable underlay	0,500	0,001	0,1	286
		Thermal contact resistance		0,040		

T [°C]	ps [Pa]	Σsd [m]
19,21	2226	0
19,06	2204	0,05
14,10	1609	0,11
14,10	1608	100
-4,08	434	100
-4,87	406	100
-4,87	406	100

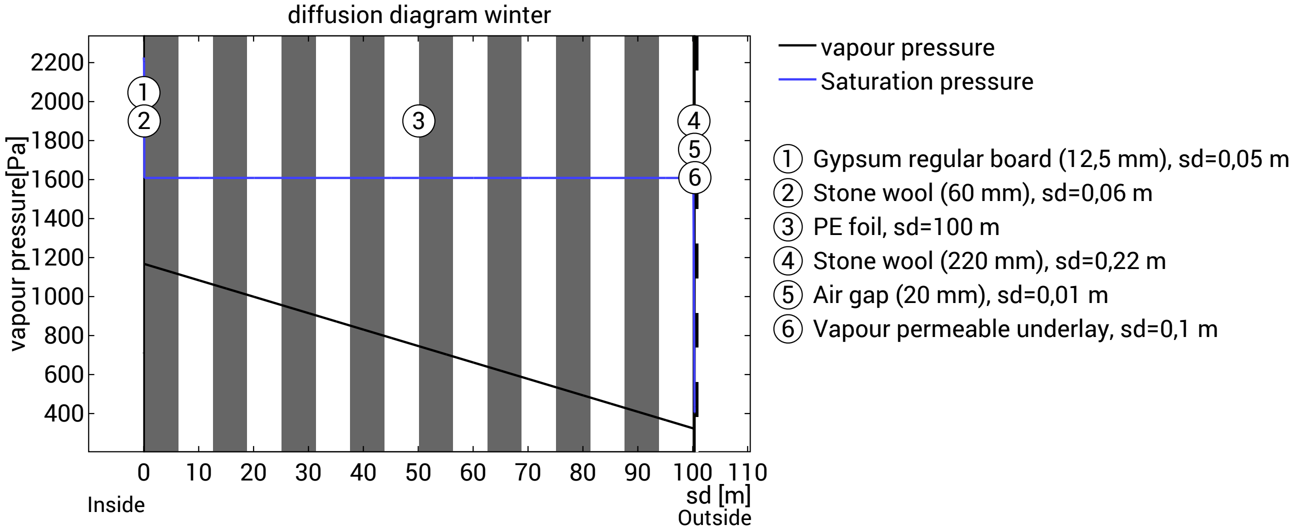
Temperature (T), vapor saturation pressure (ps), and the sum of the sd-values (Σsd) apply to the layer boundary.

Relative air humidity on the surface

The relative humidity on the interior surface is 52%. Requirements for the prevention of building material corrosion depend on material and coating and have not been investigated. ✓

Dew period (winter)

Boundary conditions	
Vapor pressure inside at 20°C and 50% humidity	pi = 1168 Pa
Vapor pressure outside at -5°C and 80% humidity	pe = 321 Pa
Duration of condensation period (90 days)	tc = 7776000 s
Water vapor diffusion coefficient in static air	δ0 = 2.0E-10 kg/(m*s*Pa)
sd-value (Whole component.)	sde = 100,44 m



The section under investigation is free of condensate under the given climate conditions. ✓

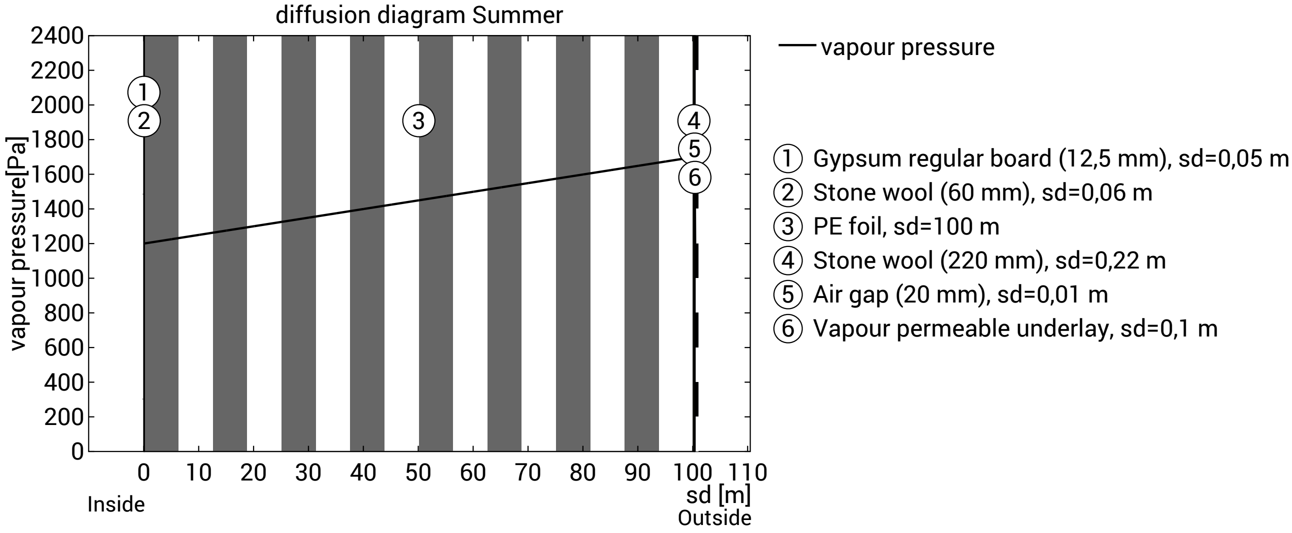
Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential:
sd=100,34 m; x=31,27 cm; ps=406 pa:
Layer boundary between Air gap and Vapour permeable underlay

Mev,Tauperiode = tc * δ0 * ((ps-pi)/sd_{ev} + (ps-pe)/(sd_e-sd_{ev})) = **1,305 kg/m²**

PR_Standard_T, R_{tot}=6,506 m²K/W

Evaporation period (summer)

Boundary conditions	
Interior vapor pressure	pi = 1200 Pa
Exterior vapor pressure	pe = 1200 Pa
Saturation vapour pressure in the condensation area	ps = 1700 Pa
Length of drying season (90 days)	tev = 7776000 s
sd-values remain unchanged.	



Condensate-free component: The maximum possible evaporation mass for the drying reserve is calculated. Consider the level that has the lowest evaporation potential in the dew period, at sd=100,34 m; x=31,27 cm:
Layer boundary between Air gap and Vapour permeable underlay
Evaporation mass: Mev = δ0 * tev * [(ps-pi)/sd + (ps-pe)/(sde-sd)] = **7,78 kg/m²**

Drying reserve (DIN 68800-2)

Dew-water-free component: The evaporation potential of the dew period is also taken into account.
Drying reserve: Mr = (Mev + Mev,Tauperiode) * 1000 = **9089 g/m²/a**
Minimum requested for roofs: 250 g/m²/a

✓

Evaluation according to DIN 4108-3

The component is permissible regarding the moisture protection.

Hints

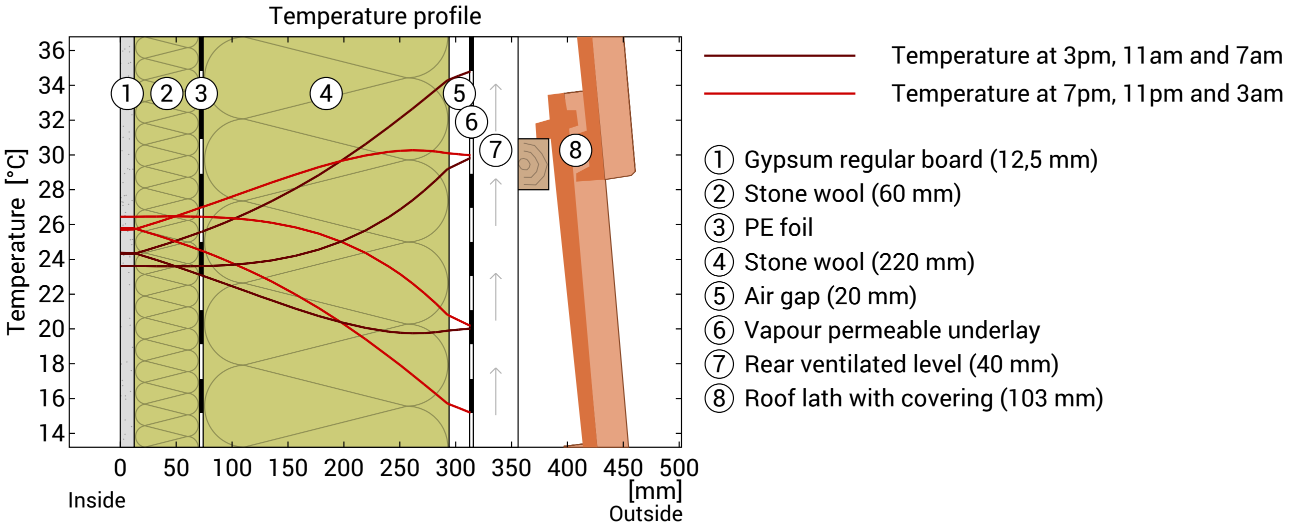
In the case of inhomogeneous constructions, such as skeleton-, stand- or frame constructions, as well as in wooden beam, rafter or half-timbered constructions or the like, the one-dimensional diffusion calculations are only to be demonstrated for the compartment area. Exceptional cases are special constructions in which, for example, The diffusion-inhibiting layer is also laid section-wise over the outer area. In these exceptional cases, the calculation performed here is invalid.

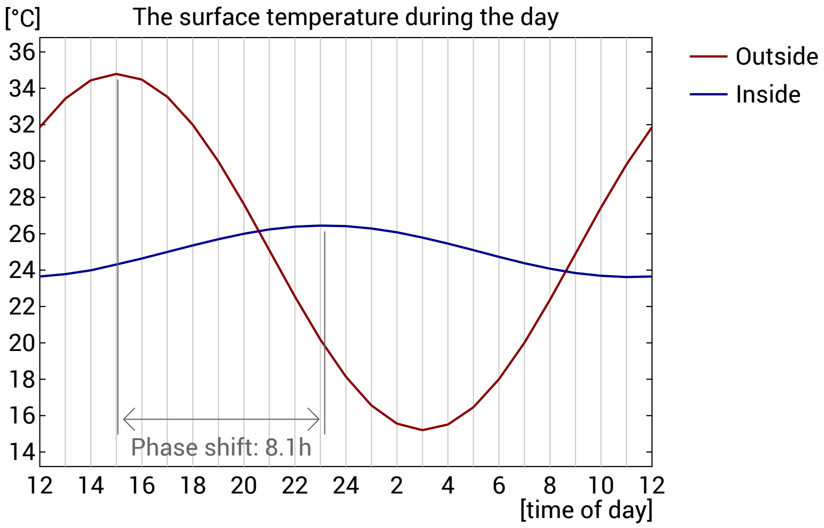
DIN 4108-3 describes in Section 5.3 components for which no moisture proofing is required as there is no risk of condensation water or the method is not suitable for the assessment. It is not possible to assess whether the component under test is underneath.

PR_Standard_T, R_{tot}=6,506 m²K/W

Heat protection

The following results are properties of the tested component alone and do not make any statement about the heat protection of the entire room:





Top: Temperature profile within the component at different times. From top to bottom, brown lines: at 3 pm, 11 am and 7 am and red lines at 7 pm , 11 pm and 3 am.
Bottom: Temperature on the outer (red) and inner (blue) surface in the course of a day. The arrows indicate the location of the temperature maximum values . The maximum of the inner surface temperature should preferably occur during the second half of the night.

Phase shift*	8,1 h	Heat storage capacity (whole component):	32 kJ/m²K
Amplitude attenuation **	6,9	Thermal capacity of inner layers:	18 kJ/m²K
TAV ***	0,145		

* The phase shift is the time in hours after which the temperature peak of the afternoon reaches the component interior.
** The amplitude attenuation describes the attenuation of the temperature wave when passing through the component. A value of 10 means that the temperature on the outside varies 10x stronger than on the inside, e.g. outside 15-35 °C, inside 24-26 °C.
*** The temperature amplitude ratio TAV is the reciprocal of the attenuation: TAV = 1 / amplitude attenuation

Note: The heat protection of a room is influenced by several factors, but essentially by the direct solar radiation through windows and the total amount of heat storage capacity (including floor, interior walls and furniture). A single component usually has only a very small influence on the heat protection of the room.

The calculations presented above have been created for a 1-dimensional cross-section of the component.

Hints

Layers of unequal width

This component includes several inhomogeneous layers of different overall width. For all the calculations it was assumed that the layer arrangement is repeated in width all 40 cm. This, however, is not true for at least layer 5 with a total width of 13 cm and can cause increased inaccuracy of the U-value.

Rear ventilation level

The thickness of the rear ventilation level is 4 cm. Generally, the thickness should be at least 3 cm. If the inclination of the rear ventilation plane is less than 40°, e.g. for (flat) roofs, a larger value must be selected. The same applies if the air inlet and the air outlet are particularly far apart.

The part of your component that is relevant to the calculation ends at the inside of the rear ventilation level. Outlying layers do not need to be entered.

Beams and joists which penetrate the rear ventilation level are only considered up to the inside of the rear ventilation level.

Please note: The U-value calculator basically assumes that a rear ventilation level is adequately permeated by outside air. Whether this is actually the case depends not only on the thickness of the rear ventilation level, but also on their width and length and possible obstacles in the air inlet and outlet and can not be assessed by the U-value calculator.

Non-ventilated air layers

A stationary air layer is a cavity enclosed on all sides, which does not have any connections to the room or outside air. Two adjacent air layers are only calculated correctly if no air exchange is possible between the two layers, e.g. if the air layers are separated by a thin foil. Otherwise, the entire cavity must be modelled as a single layer.

An air layer as the most interiour or exterior layer of a building component, which thus has a connection to the room or outside air, is not considered a resting air layer. In this case, Ubakus tries to treat the air layer as a rear ventilation layer, room air or outside air. However, the calculation result may then contain significant uncertainties.

Resting air has a very low thermal conductivity. Above a certain layer thickness, however, convection occurs, which greatly reduces the insulation effect. If the layer thickness is more than 30 cm, the air layer can no longer be taken into account correctly.

If the air layer has openings to the outside air whose size exceeds 1,500 mm² per m length for vertical air layers or 1,500 mm² per m² surface for horizontal air layers, it is a rear ventilation layer. You will find rear ventilation levels in the building material menu under Various.