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Calculations for thermal insulation, moisture protection and heat protection

created on 17.7.2023 12:23

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1	Wall	0,2	-	20,4	25,05	43,9	2
2	Roof	0,21	-	11,0	33,80	118,7	9

Comparison with different maximum values*

Component	GEG 2020 Bestand	BEG Einzelmaßn.	GEG 2020 Neubau	DIN 4108
Wall	✓	✓	✓	✓
Roof	✓			✓

*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

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Radley House Partnership

Project: UK-2023-2043-U
created on 17.7.2023

Exterior wall

Wall

Thermal protection

U = 0,198 W/(m²K)

GEG 2020 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

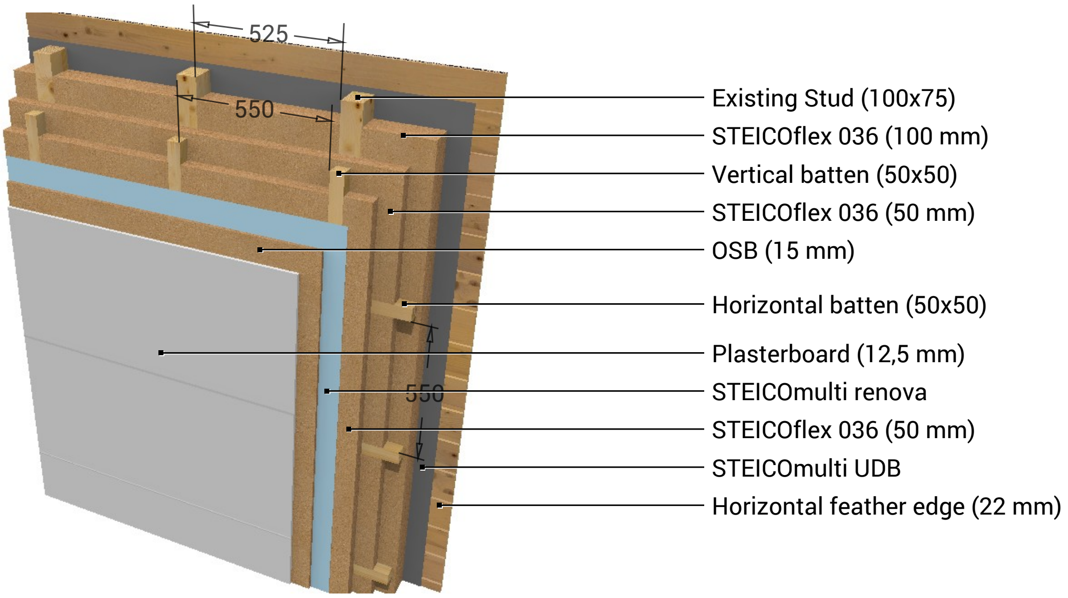
Drying reserve: 1405 g/m²a
No condensate

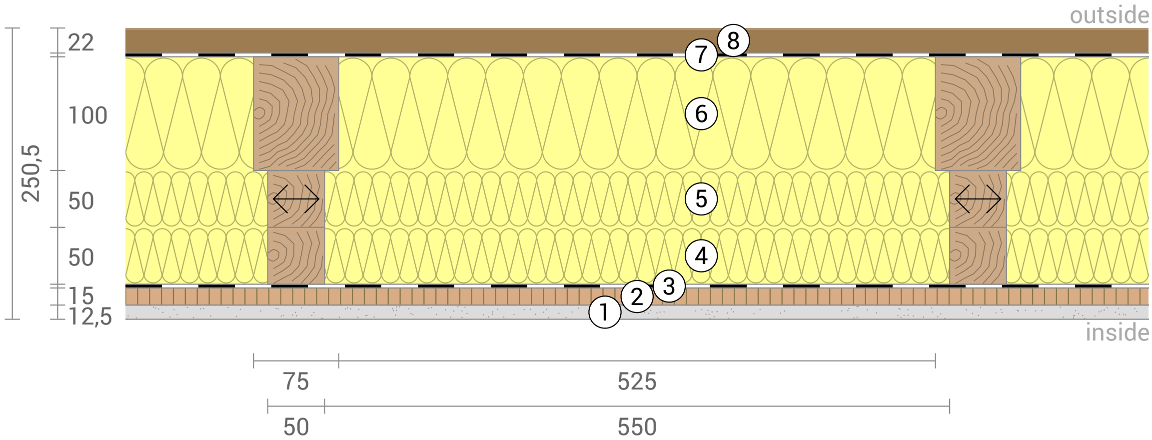
excellent insufficient

Heat protection

Temperature amplitude damping: 20
phase shift: 11,3 h
Thermal capacity inside: 41 kJ/m²K

excellent insufficient





(1) Plasterboard (12,5 mm)
(2) OSB (15 mm)
(3) STEICOmulti renova
(4) STEICOflex 036 (50 mm)
(5) STEICOflex 036 (50 mm)
(6) STEICOflex 036 (100 mm)
(7) STEICOmulti UDB
(8) Horizontal feather edge (22 mm)

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

Inside air :	20,0°C / 50%			Thickness:	25,1 cm
Outside air:	-5,0°C / 80%	sd-value:	14,9 m	Weight:	44 kg/m²
Surface temperature.:	18,4°C / -4,8°C	Drying reserve:	1405 g/m²a	Heat capacity:	68 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

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Wall, U=0,198 W/(m²K)

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	Plasterboard (12,5mm)	1,25	0,210	0,060
2	OSB	1,50	0,130	0,115
3	STEICOmulti renova	0,05	0,170	0,003
4	STEICOflex 036	5,00	0,036	1,389
	Vertical batten (8,3%)	5,00	0,130	0,385
5	STEICOflex 036	5,00	0,036	1,389
	Horizontal batten (8,3%)	5,00	0,130	0,385
6	STEICOflex 036	10,00	0,036	2,778
	Existing Stud (12%)	10,00	0,130	0,769
7	STEICOmulti UDB	0,05	0,170	0,003
8	Horizontal feather edge	2,20	0,260	0,085
	Thermal contact resistance outside (Rse)			0,040

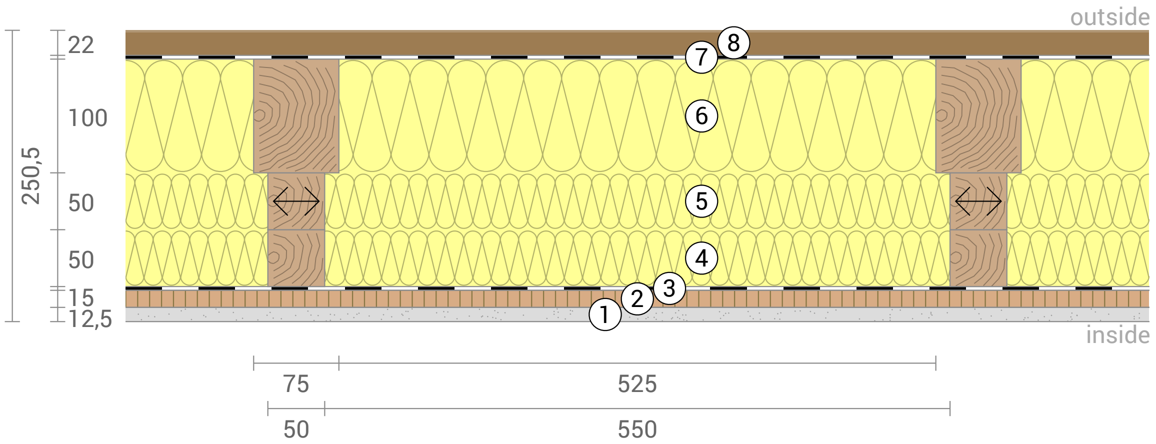
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction horizontally
Rse: heat flow direction horizontally, outside: Direct contact to outside air

Upper limit of thermal resistance $R_{tot;upper}$ = 5,307 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 4,811 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,103 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance $R_{tot} = (R_{tot;upper} + R_{tot;lower})/2$ = 5,059 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 4,9%

Heat transfer coefficient $U = 1/R_{tot}$ = **0,20 W/(m²K)**



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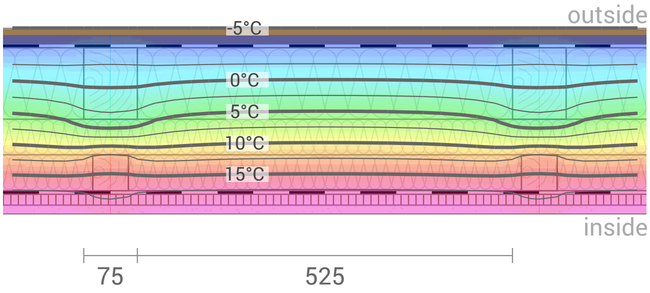
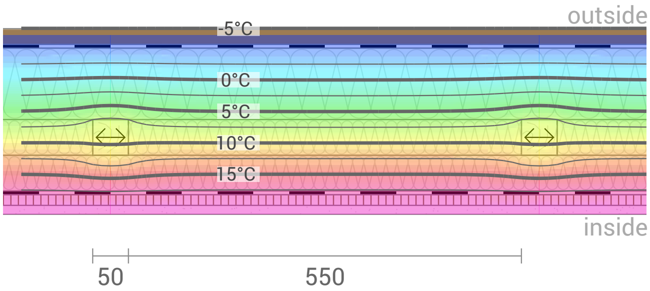
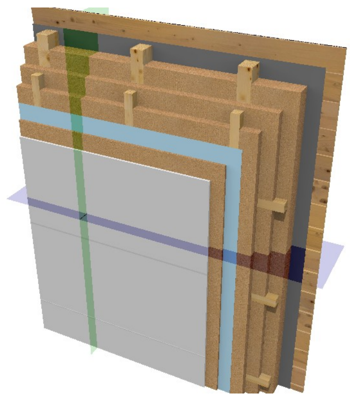
Wall, U=0,198 W/(m²K)

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	18,4	20,0	
1	1,25 cm	Plasterboard (12,5mm)	0,210	0,060	18,0	19,0	9,9
2	1,5 cm	OSB	0,130	0,115	17,1	18,7	9,8
3	0,05 cm	STEICOmulti renova	0,170	0,003	17,0	18,2	0,1
4	5 cm	STEICOflex 036	0,036	1,389	12,0	18,2	2,8
	5 cm	Vertical batten (8,3%)	0,130	0,385	13,5	17,3	1,9
5	5 cm	STEICOflex 036	0,036	1,389	3,4	13,5	2,8
	5 cm	Horizontal batten (8,3%)	0,130	0,385			1,9
6	10 cm	STEICOflex 036	0,036	2,778	-4,5	6,8	5,3
	10 cm	Existing Stud (12%)	0,130	0,769	-4,0	4,0	5,6
7	0,05 cm	STEICOmulti UDB	0,170	0,003	-4,5	-3,9	0,2
8	2,2 cm	Horizontal feather edge	0,260	0,085	-4,8	-3,9	3,9
		Thermal contact resistance*		0,040	-5,0	-4,7	
	25,05 cm	Whole component		5,059			43,9

*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'.

	min	average	max
Surface temperature inside (min / average / max):	18,4°C	18,8°C	19,0°C
Surface temperature outside (min / average / max):	-4,8°C	-4,8°C	-4,7°C

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Wall, U=0,198 W/(m²K)

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.

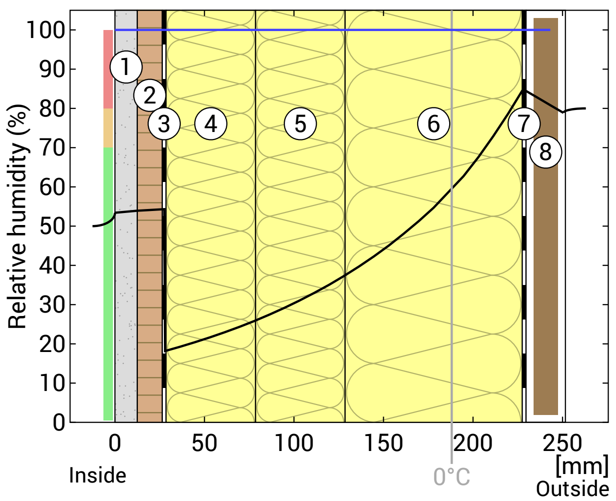
This component is free of condensate under the given climate conditions.

Drying reserve according to DIN 4108-3:2018: 1405 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

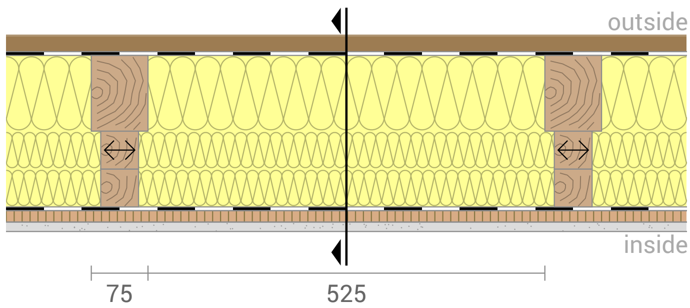
#		Material	sd-value [m]	Condensate [kg/m²]	Condensate [Gew.-%]	Weight [kg/m²]
1	1,25 cm	Plasterboard (12,5mm)	0,10	-		9,9
2	1,5 cm	OSB	0,45	-	-	9,8
3	0,05 cm	STEICOmulti renova	13,00	-		0,1
4	5 cm	STEICOflex 036	0,10	-		2,8
	5 cm	Vertical batten (8,3%)	1,00	-	-	1,9
5	5 cm	STEICOflex 036	0,10	-		2,8
	5 cm	Horizontal batten (8,3%)		-	-	1,9
6	10 cm	STEICOflex 036	0,20	-		5,3
	10 cm	Existing Stud (12%)	5,00	-	-	5,6
7	0,05 cm	STEICOmulti UDB	0,02	-		0,2
8	2,2 cm	Horizontal feather edge	0,55	-		3,9
	25,05 cm	Whole component	14,95	0		43,9

Humidity

The temperature of the inside surface is 18,4 °C leading to a relative humidity on the surface of 55%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



Relative humidity (%)
saturation point



① Plasterboard (12,5 mm)
② OSB (15 mm)
③ STEICOmulti renova
④ STEICOflex 036 (50 mm)
⑤ STEICOflex 036 (50 mm)
⑥ STEICOflex 036 (100 mm)
⑦ STEICOmulti UDB
⑧ Horizontal feather edge (22 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.

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Wall, U=0,198 W/(m²K)

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	1,25 cm	Plasterboard (12,5mm)	0,210	0,060	0,1	790
2	1,5 cm	OSB	0,130	0,115	0,45	650
3	0,05 cm	STEICOmulti renova	0,170	0,003	13	220
4	5 cm	STEICOflex 036	0,036	1,389	0,1	60
5	5 cm	STEICOflex 036	0,036	1,389	0,1	60
6	10 cm	STEICOflex 036	0,036	2,778	0,2	60
7	0,05 cm	STEICOmulti UDB	0,170	0,003	0,1	340
8	2,2 cm	Horizontal feather edge	0,260	0,085	0,55	175
		Thermal contact resistance		0,040		

T [°C]	ps [Pa]	Σsd [m]
18,98	2193	0
18,73	2161	0,1
18,26	2098	0,55
18,25	2096	13,6
12,57	1456	13,7
6,89	993	13,8
-4,48	420	13,9
-4,49	419	14
-4,84	407	14,6

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

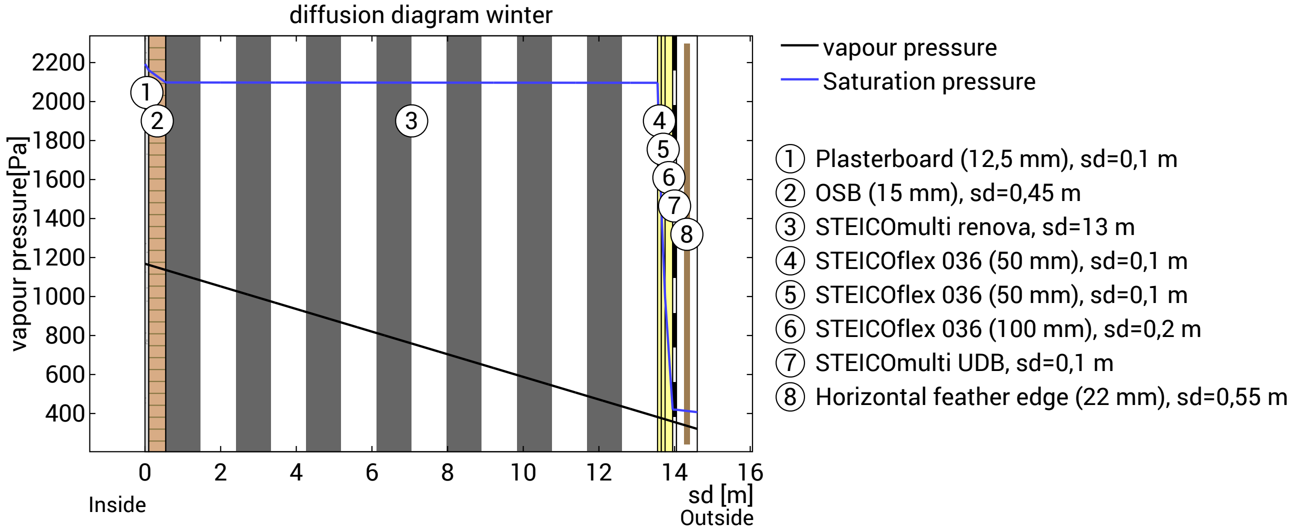
Relative air humidity on the surface

The relative humidity on the interior surface is 53%. 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 = 14,60 m

diffusion diagram winter



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

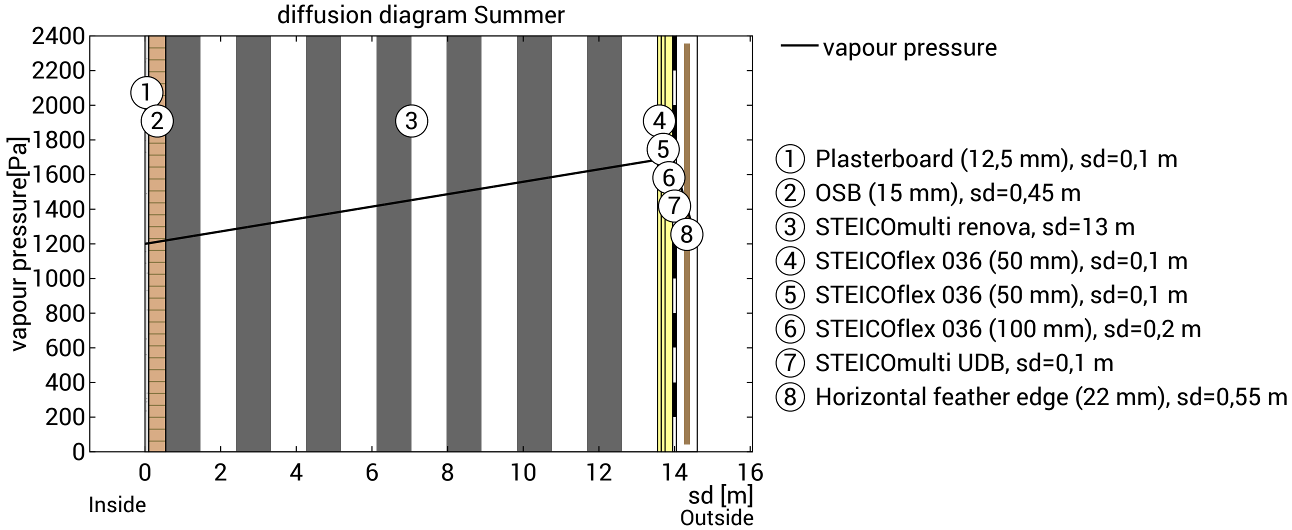
Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential:
sd=13,95 m; x=22,8 cm; ps=420 pa:
Layer boundary between STEICOflex 036 and STEICOmulti UDB

Mev,Tauperiode = tc * δ0 * ((ps-pi)/sd_{ev} + (ps-pe)/(sd_e-sd_{ev})) = **0,153 kg/m²**

Wall, U=0,198 W/(m²K)

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=13,95 m; x=22,8 cm:
Layer boundary between STEICOflex 036 and STEICOmulti UDB
Evaporation mass: Mev = δ0 * tev * [(ps-pi)/sd + (ps-pe)/(sde-sd)] = **1,25 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 = **1405 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.

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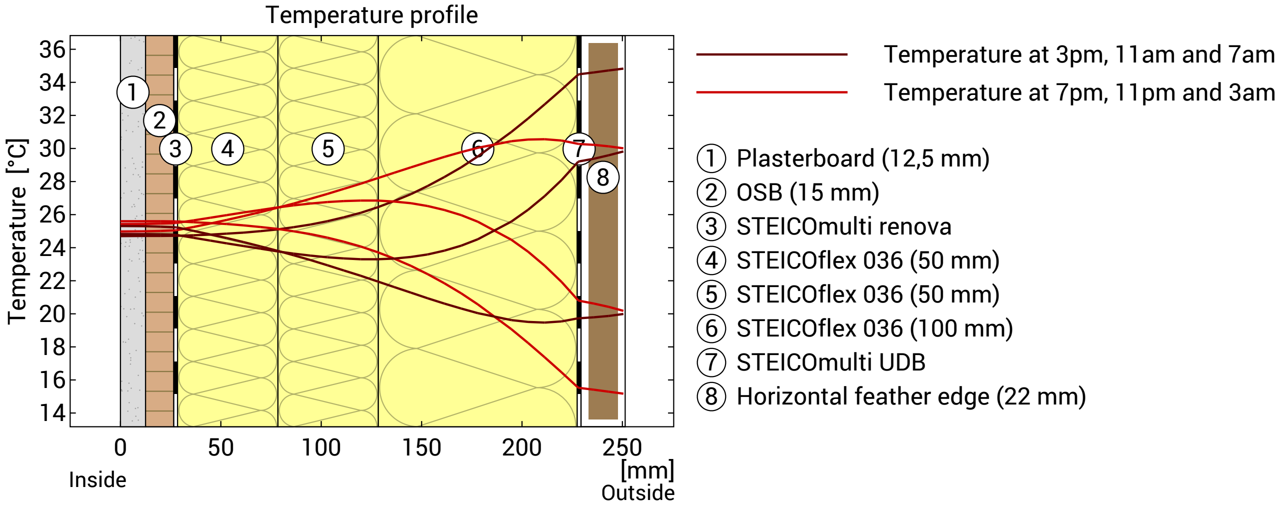
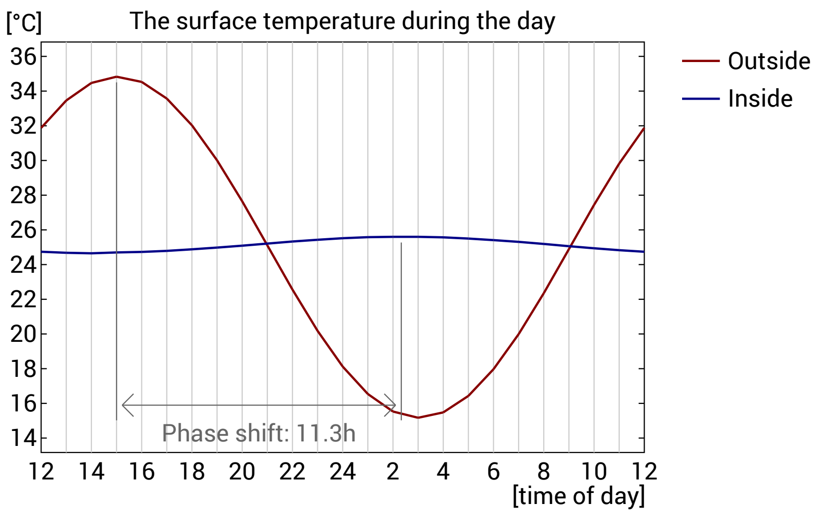
Wall, U=0,198 W/(m²K)

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*	11,3 h	Heat storage capacity (whole component):	68 kJ/m²K
Amplitude attenuation **	20,4	Thermal capacity of inner layers:	41 kJ/m²K
TAV ***	0,049		

* 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.

Roof

Thermal protection

U = 0,209 W/(m²K)

GEG 2020 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

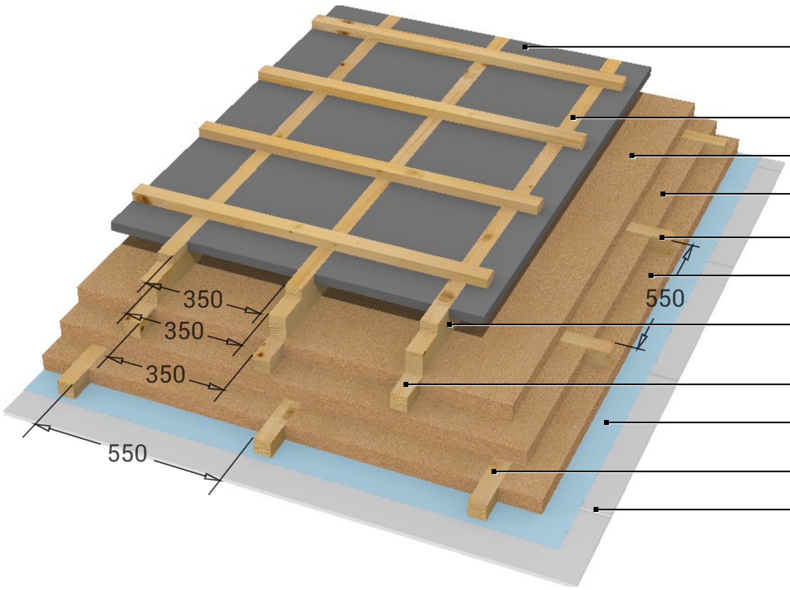
Drying reserve: 1877 g/m²a
No condensate

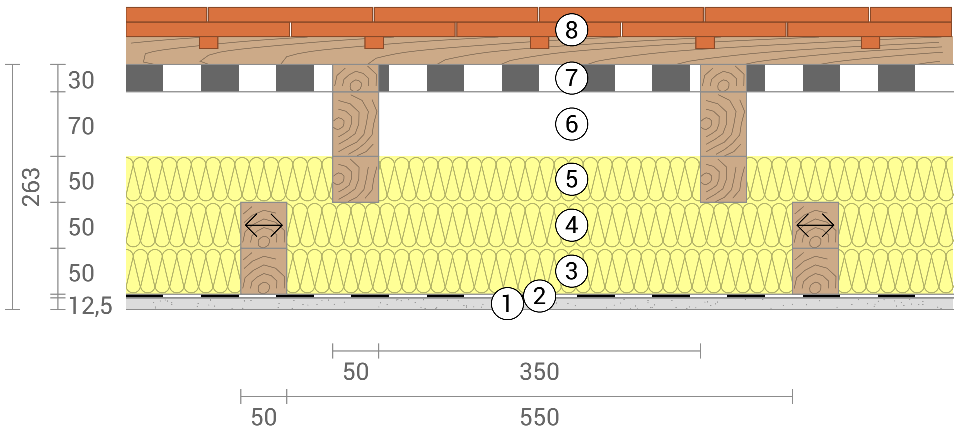
excellent insufficient

Heat protection

Temperature amplitude damping: 11
phase shift: 12,2 h
Thermal capacity inside: 29 kJ/m²K

excellent insufficient





1. Plasterboard (12,5 mm)
2. STEICOmulti renova
3. STEICOflex 036 (50 mm)
4. STEICOflex 036 (50 mm)
5. STEICOflex 036 (50 mm)
6. Stationary air (70 mm)
7. TLX Gold
8. Slates and battens (75 mm)

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

Roof, U=0,209 W/(m²K)

Inside air :	20,0°C / 50%			Thickness:	33,8 cm
Outside air:	-5,0°C / 80%	sd-value:	14,4 m	Weight:	119 kg/m²
Surface temperature.:	18,5°C / -4,8°C	Drying reserve:	1877 g/m²a	Heat capacity:	121 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

Roof, U=0,209 W/(m²K)

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	Plasterboard (12,5mm)	1,25	0,210	0,060
2	STEICOmulti renova	0,05	0,170	0,003
3	STEICOflex 036	5,00	0,036	1,389
	Vertical batten (8,3%)	5,00	0,130	0,385
4	STEICOflex 036	5,00	0,036	1,389
	Horizontal batten (8,3%)	5,00	0,130	0,385
5	STEICOflex 036	5,00	0,036	1,389
	Rafter (12%)	5,00	0,130	0,385
6	Stationary air (unventilated)	7,00	0,357	0,196
	Rafter (12%)	7,00	0,130	0,538
7	TLX Gold	3,00	0,036	0,845
	Rafter (12%)	3,00	0,130	0,231
8	Slates and battens	7,50	0,750	0,100
	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 6.1: Thickness 7 cm, Width 35 cm, DIN EN ISO 6946 Appendix D.4, heat flow direction 45° upwards, Temperature ca. -0°C, Emissionsgrad der Oberflächen: 0,9

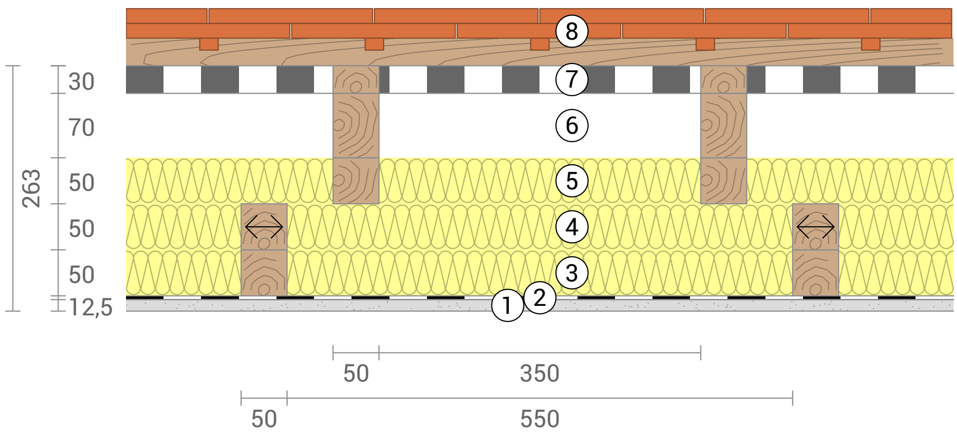
Upper limit of thermal resistance $R_{tot;upper}$ = 5,114 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 4,478 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,142 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance $R_{tot} = (R_{tot;upper} + R_{tot;lower})/2$ = 4,796 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 6,6%

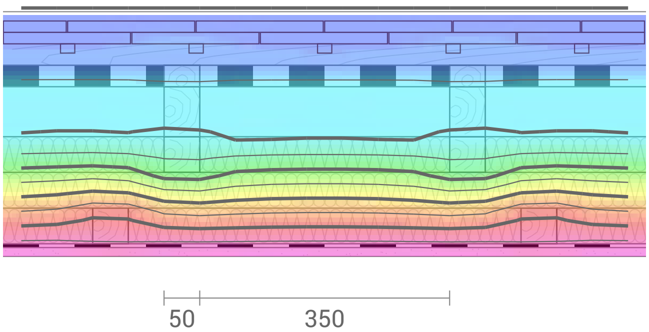
Heat transfer coefficient U = $1/R_{tot}$ = **0,21 W/(m²K)**

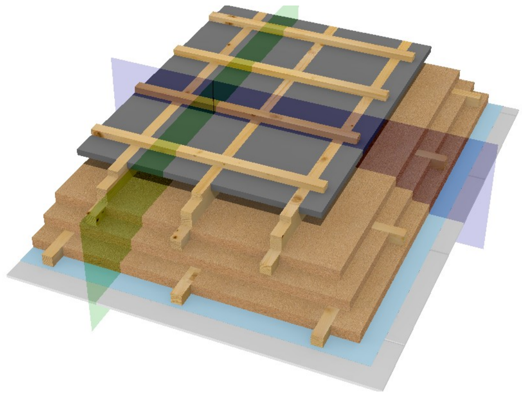
This component includes several inhomogeneous layers of different overall width. For all the calculations it was assumed that the layer arrangement is repeated in width all 60 cm. This, however, is not true for at least layer 5 with a total width of 40 cm and can cause increased inaccuracy of the U-value.

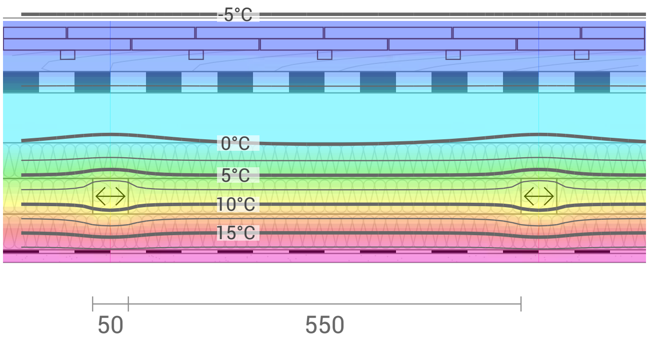


Roof, U=0,209 W/(m^2K)

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 [m^2K/W]	Temperatur [°C] min	max	Weight [kg/m^2]
		Thermal contact resistance*		0,250	18,5	20,0	
1	1,25 cm	Plasterboard (12,5mm)	0,210	0,060	18,1	18,9	9,9
2	0,05 cm	STEICOmulti renova	0,170	0,003	18,1	18,6	0,1
3	5 cm	STEICOflex 036	0,036	1,389	11,5	18,6	2,8
	5 cm	Vertical batten (8,3%)	0,130	0,385	14,3	18,1	1,9
4	5 cm	STEICOflex 036	0,036	1,389	3,7	14,3	2,8
	5 cm	Horizontal batten (8,3%)	0,130	0,385			1,9
5	5 cm	STEICOflex 036	0,036	1,389	-0,1	6,9	2,6
	5 cm	Rafter (12%)	0,130	0,385	0,6	4,2	2,8
6	7 cm	Stationary air (unventilated)	0,357	0,196	-1,5	0,4	0,1
	7 cm	Rafter (12%)	0,130	0,538	-2,0	0,6	3,9
7	3 cm	TLX Gold	0,036	0,845	-4,4	-0,8	18,4
	3 cm	Rafter (12%)	0,130	0,231	-4,1	-1,4	1,7
8	7,5 cm	Slates and battens	0,750	0,100	-4,8	-4,1	70,0
		Thermal contact resistance*		0,040	-5,0	-4,8	
	33,8 cm	Whole component		4,796			118,7

*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):	18,5°C	18,8°C	18,9°C
Surface temperature outside (min / average / max):	-4,8°C	-4,8°C	-4,8°C

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Roof, U=0,209 W/(m²K)

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.

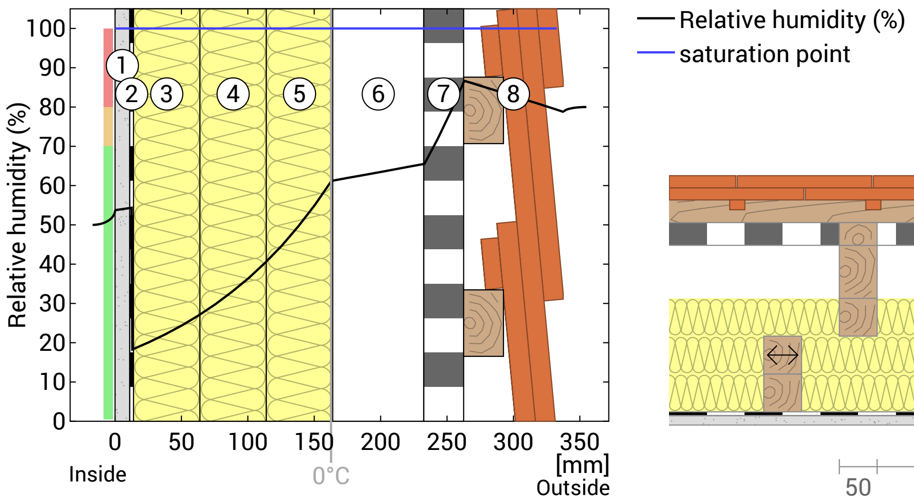
This component is free of condensate under the given climate conditions.

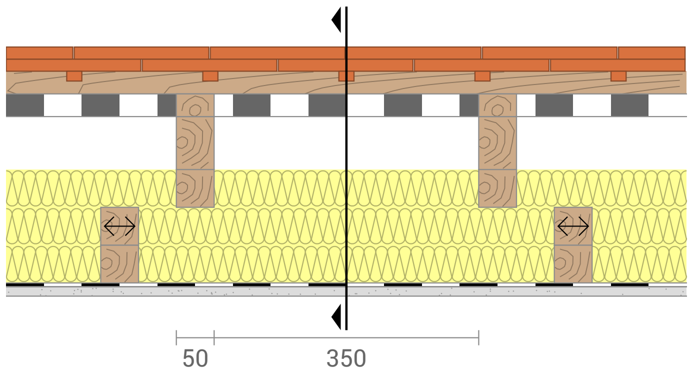
Drying reserve according to DIN 4108-3:2018: 1877 g/(m²a)
At least required by DIN 68800-2: 250 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	Condensate [Gew.-%]	Weight [kg/m²]
1	1,25 cm	Plasterboard (12,5mm)	0,10	-		9,9
2	0,05 cm	STEICOmulti renova	13,00	-		0,1
3	5 cm	STEICOflex 036	0,10	-		2,8
	5 cm	Vertical batten (8,3%)	1,00	-	-	1,9
4	5 cm	STEICOflex 036	0,10	-		2,8
	5 cm	Horizontal batten (8,3%)		-	-	1,9
5	5 cm	STEICOflex 036	0,10	-		2,6
	5 cm	Rafter (12%)	1,00	-	-	2,8
6	7 cm	Stationary air (unventilated)	0,01	-		0,1
	7 cm	Rafter (12%)	3,50	-	-	3,9
7	3 cm	TLX Gold	0,09	-		18,4
	3 cm	Rafter (12%)	1,50	-	-	1,7
8	7,5 cm	Slates and battens	0,75	-		70,0
	33,8 cm	Whole component	14,39	0		118,7

Humidity

The temperature of the inside surface is 18,5 °C leading to a relative humidity on the surface of 55%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.





① Plasterboard (12,5 mm)
② STEICOmulti renova
③ STEICOflex 036 (50 mm)
④ STEICOflex 036 (50 mm)
⑤ STEICOflex 036 (50 mm)
⑥ Stationary air (70 mm)
⑦ TLX Gold
⑧ Slates and battens (75 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.

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Roof, U=0,209 W/(m²K)

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	Plasterboard (12,5mm)	0,210	0,060	0,1	790
2	0,05 cm	STEICOmulti renova	0,170	0,003	13	220
3	5 cm	STEICOflex 036	0,036	1,389	0,1	60
4	5 cm	STEICOflex 036	0,036	1,389	0,1	60
5	5 cm	STEICOflex 036	0,036	1,389	0,1	60
6	7 cm	Stationary air (unventilated)	0,357	0,196	0,01	1
7	3 cm	TLX Gold	0,036	0,845	0	700
8	7,5 cm	Slates and battens	0,750	0,100	0,75	933
		Thermal contact resistance		0,040		

T [°C]	ps [Pa]	Σsd [m]
18,90	2182	0
18,63	2147	0,1
18,62	2145	13,1
12,49	1448	13,2
6,35	958	13,3
0,22	621	13,4
-0,65	579	13,4
-4,38	423	13,4
-4,82	407	14,2

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

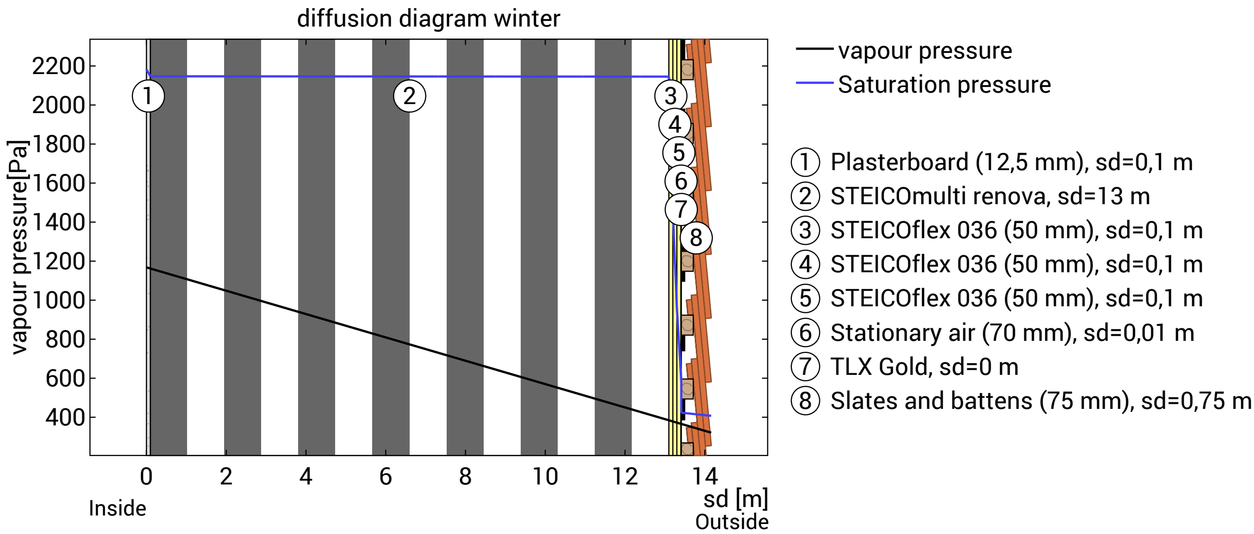
Relative air humidity on the surface

The relative humidity on the interior surface is 54%. 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 = 14,16 m



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

✓

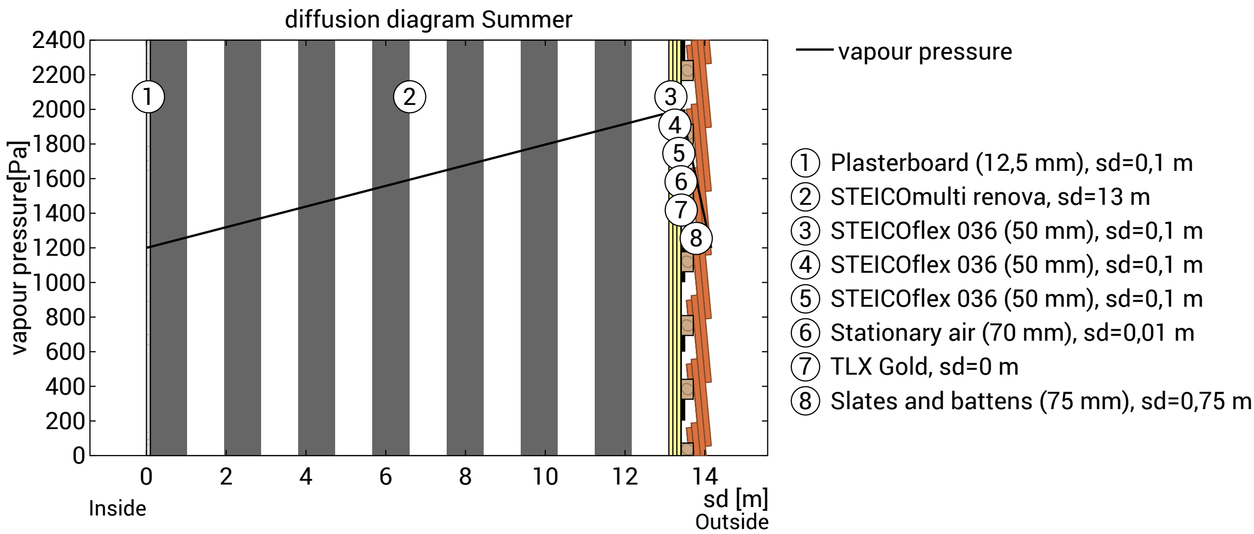
Roof, U=0,209 W/(m²K)

Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential: sd=13,41 m; x=26,3 cm; ps=423 pa:
Layer boundary between TLX Gold and Slates and battens

Mev,Tauperiode = tc * δ0 * ((ps-pi)/sd_{ev} + (ps-pe)/(sd_e-sd_{ev})) = **0,126 kg/m²**

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 = 2000 Pa (Roof against outside air)
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=13,41 m; x=26,3 cm:
Layer boundary between TLX Gold and Slates and battens
Evaporation mass: Mev = δ0 * tev * [(ps-pi)/sd + (ps-pe)/(sde-sd)] = **1,75 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 = **1877 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.

It is assumed that the roof is not predominantly shaded and does not have a very bright surface (as determined by the user).

This has a positive effect on the drying capacity.

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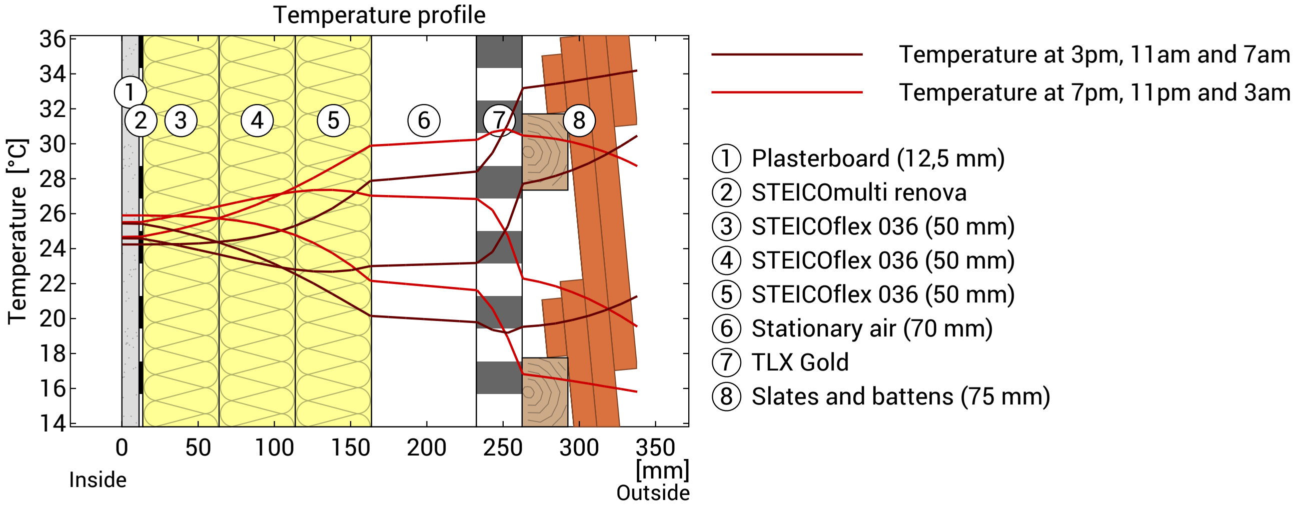
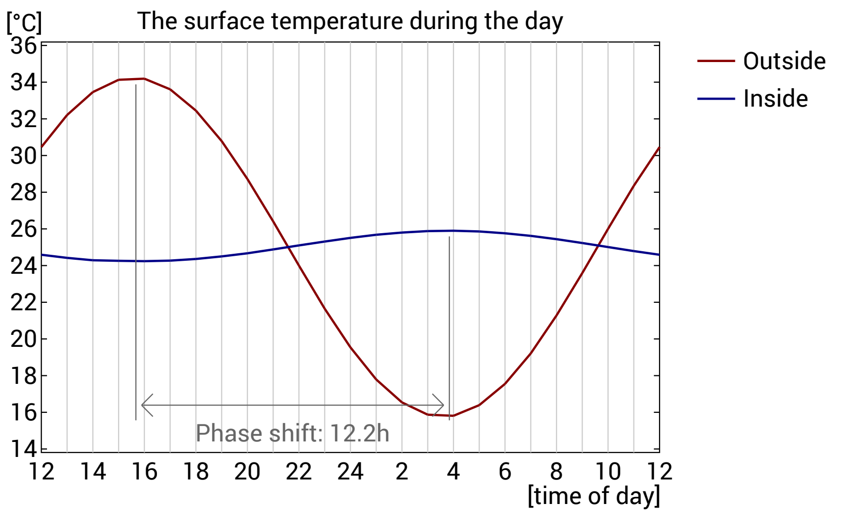
Heat protection

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*	12,2 h	Heat storage capacity (whole component):	121 kJ/m²K
Amplitude attenuation **	11,0	Thermal capacity of inner layers:	29 kJ/m²K
TAV ***	0,091		

* 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.