Wohnhauses mit 4 roof

Roof construction
created on 2.10.2024

Thermal protection

U = 0,12 W/(m²K)

GEG 2020/24 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

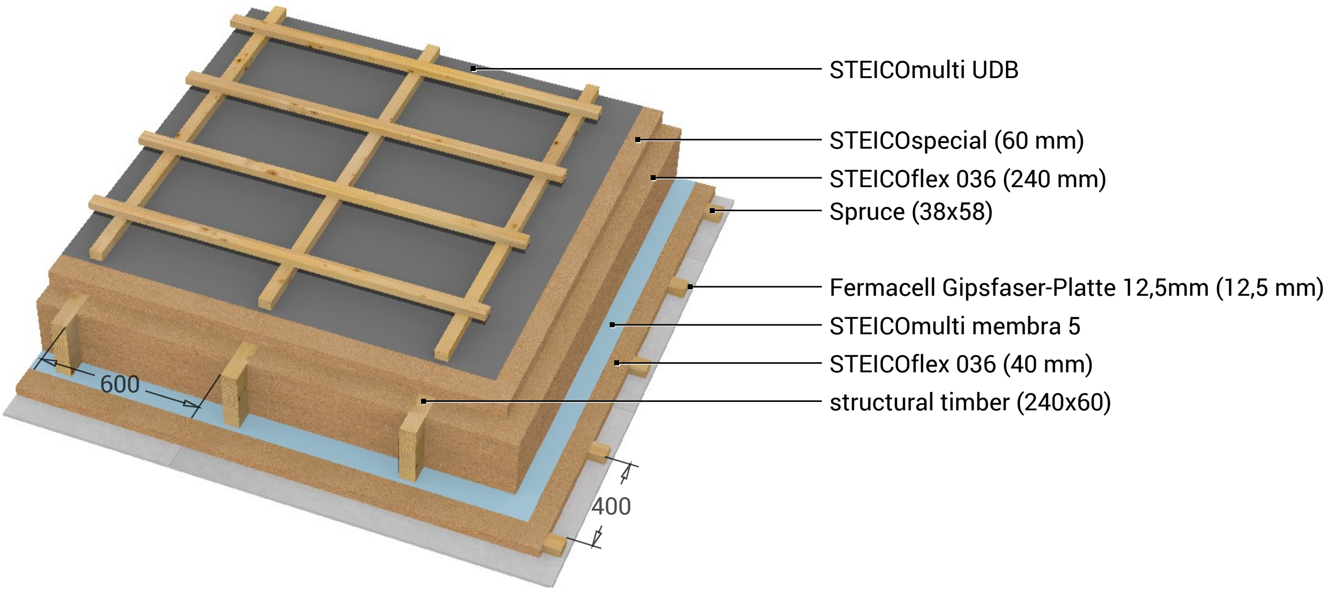
Drying reserve: 2750 g/m²a
No condensate

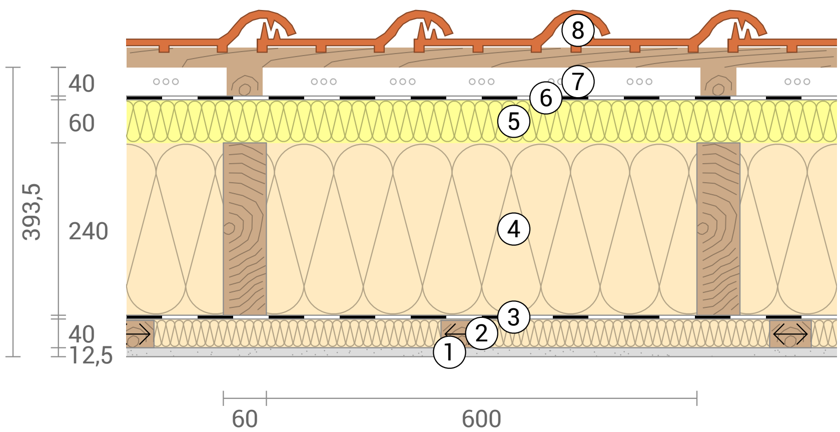
excellent insufficient

Heat protection

Temperature amplitude damping: 67
phase shift: 17,3 h
Thermal capacity inside: 42 kJ/m²K

excellent insufficient





1. Fermacell Gipsfaser-Platte 12,5mm (12,5 mm)
2. STEICOflex 036 (40 mm)
3. STEICOmulti membra 5
4. STEICOflex 036 (240 mm)
5. STEICOspecial (60 mm)
6. STEICOmulti UDB
7. Rear ventilated level (40 mm)
8. Roofing tiles (103 mm)

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

Inside air :	20,0°C / 50%			Thickness:	49,6 cm
Outside air:	-5,0°C / 80%	sd-value:	6,3 m	Weight:	105 kg/m²
Surface temperature.:	19,0°C / -4,9°C	Drying reserve:	2750 g/m²a	Heat capacity:	88 kJ/m²K

☑ GEG 2020/24 Bestand ☑ BEG Einzelmaßn. ☑ GEG 2023/24 Neubau ☑ DIN 4108

*Comparison of the U-value with den Höchstwerten aus GEG Anlage 7 (GEG 2020-2024 Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; 70% des U-Werts der Referenzausführung aus GEG 2023/2024 Anlage 1 (GEG Neubau); den R-Werten aus DIN 4108-2 Tabelle 3

Wohnhauses mit 4 roof, U=0,12 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	Fermacell Gipsfaser-Platte 12,5mm	1,25	0,320	0,039
2	STEICOflex 036	4,00	0,036	1,111
	Spruce (Width: 5,8 cm)	3,80	0,130	0,292
3	STEICOmulti membra 5	0,05	0,170	0,003
4	STEICOflex 036	24,00	0,036	6,667
	structural timber (9,1%)	24,00	0,130	1,846
5	STEICOspecial	6,00	0,048	1,250
6	STEICOmulti UDB	0,05	0,170	0,003
	Thermal contact resistance outside (Rse)			0,100

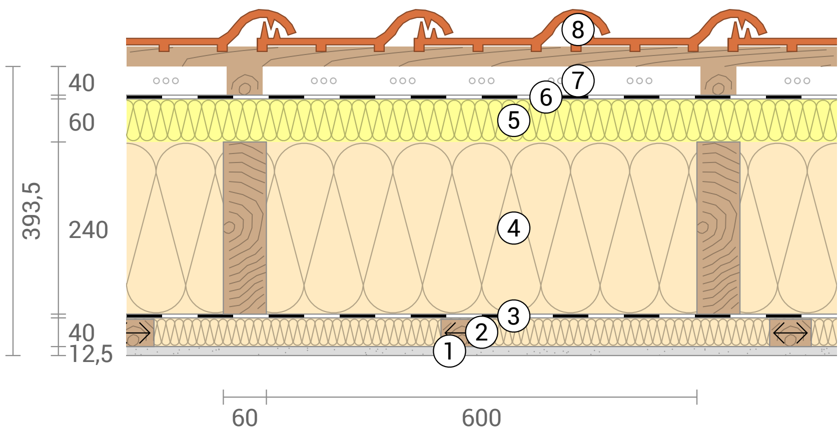
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction upwards
Rse: heat flow direction upwards, outside: Ventilation level

Upper limit of thermal resistance $R_{tot;upper}$ = 8,326 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 7,732 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,077 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 8,029 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 3,7%

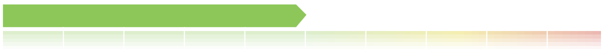
Heat transfer coefficient U = 1/R_{tot} = **0,12 W/(m²K)**



Wohnhauses mit 4 roof, U=0,12 W/(m²K)

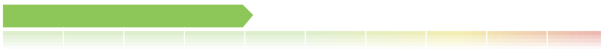
LCA

Heat loss: 10 kWh/m² per heating season



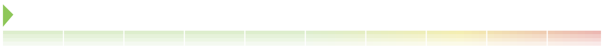
Amount of heat that escapes through one square meter of this component during the heating period. Please note: Due to internal and solar gains, the heating demand is lower than the heat loss.

Primary energy (non renewable): 139 kWh/m²



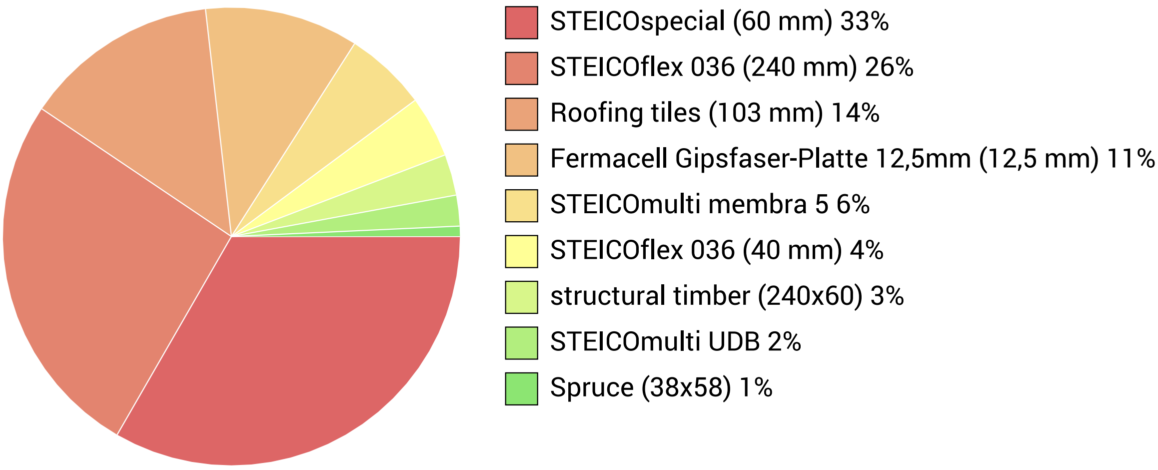
Non-renewable primary energy (= energy from fossil fuels and nuclear energy) that was used to produce the new building materials ("cradle to gate").

Green house gas potential: -32 kg CO2 Äqv./m²

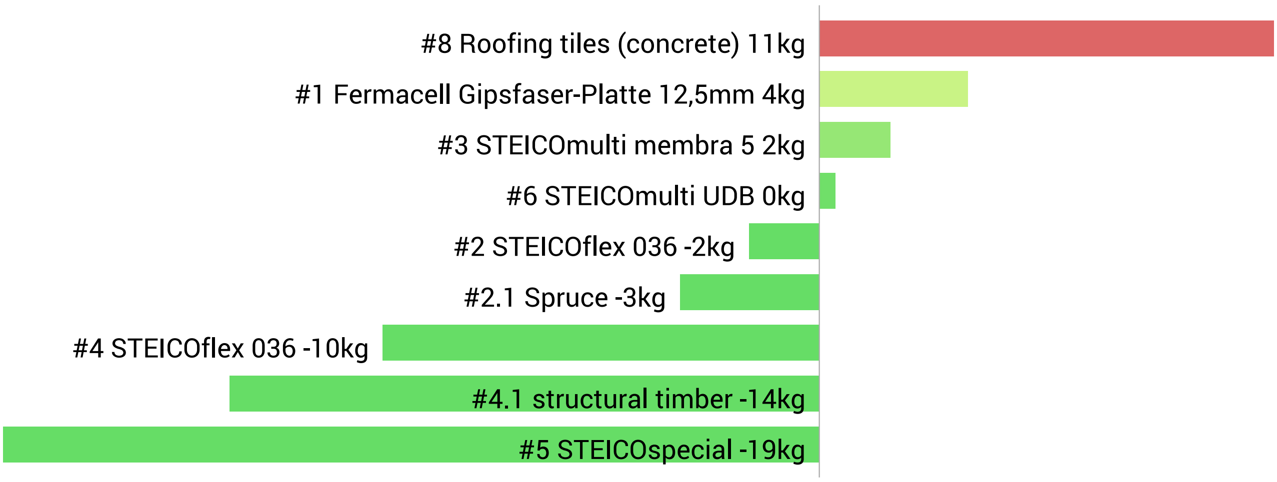


For the production of the building materials used, more greenhouse gases were withdrawn from the atmosphere than emitted.

Composition of non-renewable primary energy of production:

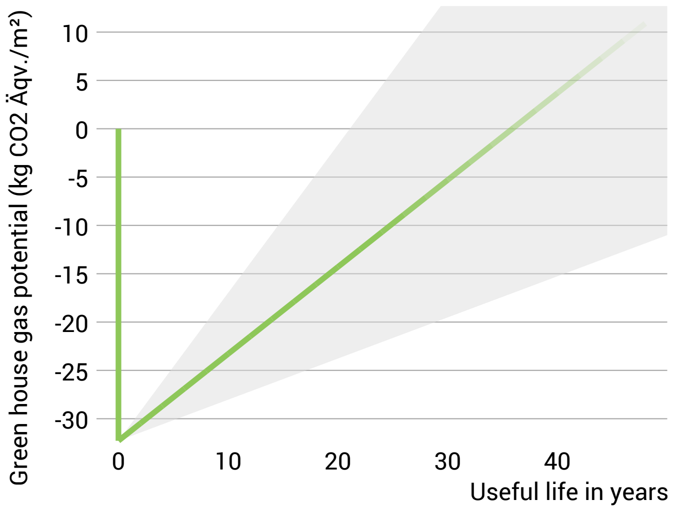


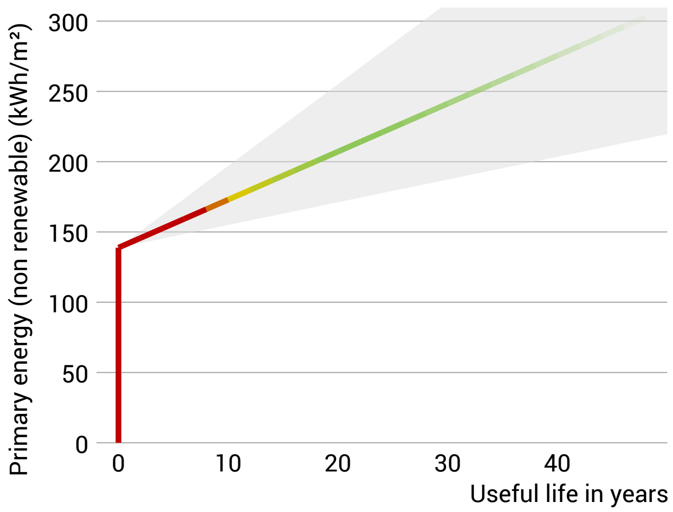
Composition of the greenhouse potential of production:



Wohnhauses mit 4 roof, U=0,12 W/(m²K)

Global warming potential and primary energy for construction and use





The **left figure** shows the global warming potential of the production of the component in the vertical part of the curve. Greenhouse gas emissions (through heating) arising during use of the building are indicated by the upward curve.

The **figure at the bottom left** shows the non-renewable primary energy expenditure for the production of the component in the vertical part of the curve. The primary energy required during use of the building (through heating) is represented by the upward curve.

The longer the component is used unchanged, the more environmentally friendly it is, because the production costs contribute less to the total emissions (indicated by the color of the curve).

Due to unknown solar and internal gains, the heating demand can only be estimated. Accordingly, primary energy consumption and global warming potential during the use phase are only vaguely known. For the estimation it was assumed that solar and internal profits contribute with 4 kWh/a/m² component area. The light gray area indicates the area in which the curve is located with great certainty. For heat generation, a primary energy input of 0,60 kWh per kWh of heat and a global warming potential of 0,16 kg CO2 eqv/m² per kWh of heat was used. Heat source: Heat pump (air-water).

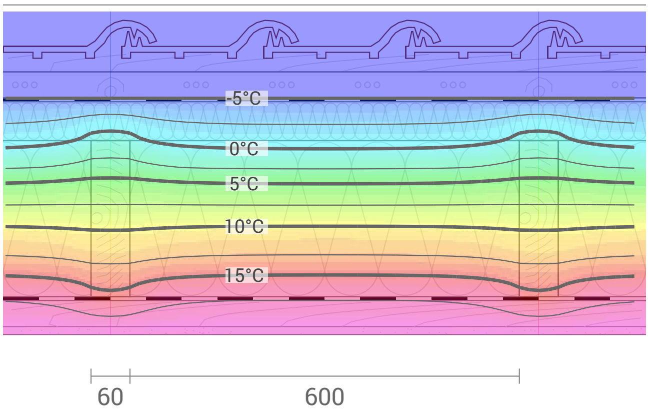
Hints

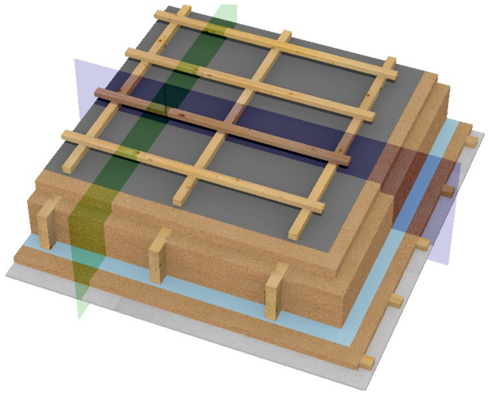
Calculated for the location DIN V 18599, heating period from Mid of October to End of April. The calculation is based on monthly average temperatures. Source: DIN V 18599-10:2007-02

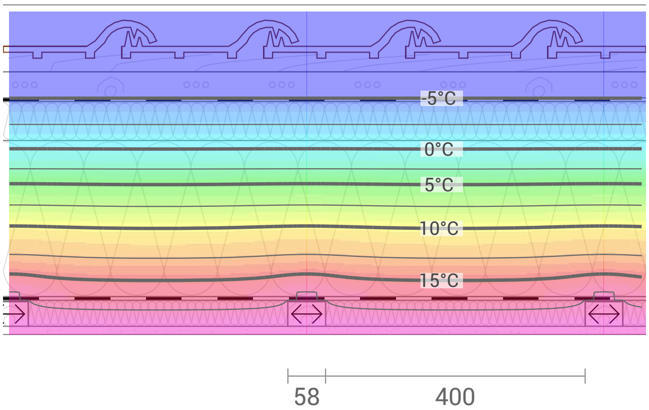
The climate and energy data on which this calculation is based can, in some cases, show considerable fluctuations and, in individual cases, deviate considerably from the actual value.

Wohnhauses mit 4 roof, U=0,12 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	19,0	20,0	
1	1,25 cm	Fermacell Gipsfaser-Platte 12,5mm	0,320	0,039	18,9	19,3	14,4
2	4 cm	STEICOflex 036	0,036	1,111	13,9	19,2	1,8
	3,8 cm	Spruce (Width: 5,8 cm)	0,130	0,292			2,2
3	0,05 cm	STEICOmulti membra 5	0,170	0,003	13,9	16,2	0,2
4	24 cm	STEICOflex 036	0,036	6,667	-1,5	16,2	10,9
	24 cm	structural timber (9,1%)	0,130	1,846	0,6	14,2	9,2
5	6 cm	STEICOspecial	0,048	1,250	-4,9	0,7	14,4
6	0,05 cm	STEICOmulti UDB	0,170	0,003	-4,9	-4,8	0,1
		Thermal contact resistance*		0,040	-5,0	-4,8	
7	4 cm	Rear ventilated level (outside air)			-5,0	-5,0	0,0
8	10,3 cm	Roofing tiles (concrete)			-5,0	-5,0	51,5
	49,65 cm	Whole component		8,029			104,6

*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):	19,0°C	19,2°C	19,3°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,8°C

Wohnhauses mit 4 roof, U=0,12 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.

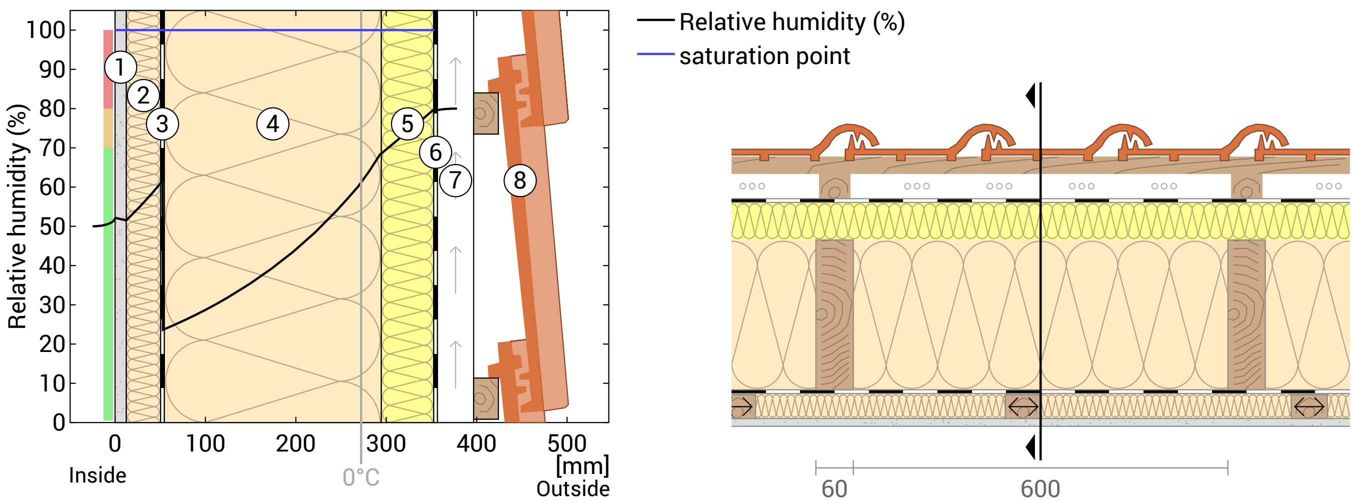
This component is free of condensate under the given climate conditions.

Drying reserve according to DIN 4108-3:2018: 2750 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	Fermacell Gipsfaser-Platte 12,5mm	0,16	-		14,4
2	4 cm	STEICOflex 036	0,08	-		1,8
	3,8 cm	Spruce (Width: 5,8 cm)		-	-	2,2
3	0,05 cm	STEICOmulti membra 5	5,00	-		0,2
4	24 cm	STEICOflex 036	0,48	-		10,9
	24 cm	structural timber (9,1%)	9,60	-	-	9,2
5	6 cm	STEICOspecial	0,30	-		14,4
6	0,05 cm	STEICOmulti UDB	0,02	-		0,1
	49,65 cm	Whole component	6,32	0		104,6

Humidity

The temperature of the inside surface is 19,0 °C leading to a relative humidity on the surface of 53%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.



① Fermacell Gipsfaser-Platte 12,5mm...
② STEICOflex 036 (40 mm)
③ STEICOmulti membra 5
④ STEICOflex 036 (240 mm)
⑤ STEICOspecial (60 mm)
⑥ STEICOmulti UDB
⑦ Rear ventilated level (40 mm)
⑧ Roofing tiles (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.

Wohnhauses mit 4 roof, U=0,12 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]	T [°C]	ps [Pa]	Σsd [m]
		Thermal contact resistance		0,250			19,33	2243	0
1	1,25 cm	Fermacell Gipsfaser-Platte 12,5mm	0,320	0,039	0,16	1150	19,23	2228	0,16
2	4 cm	STEICOflex 036	0,036	1,111	0,08	50	16,26	1848	0,24
3	0,05 cm	STEICOmulti membra 5	0,170	0,003	5	325	16,25	1847	5,24
4	24 cm	STEICOflex 036	0,036	6,667	0,48	50	-1,55	537	5,72
5	6 cm	STEICOspecial	0,048	1,250	0,3	240	-4,89	405	6,02
6	0,05 cm	STEICOmulti UDB	0,170	0,003	0,1	270	-4,89	405	6,12
		Thermal contact resistance		0,040					

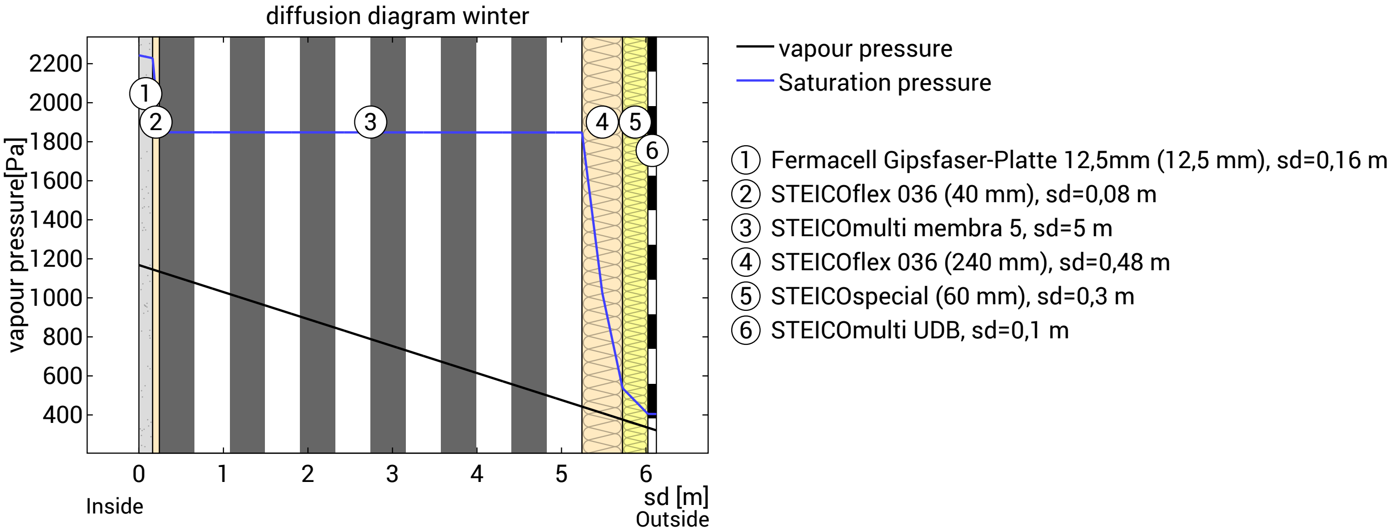
Temperature (T), vapor saturation pressure (ps), and the sum of the sd-values (Σsd) apply to the layer boundary.

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 = 6,12 m



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

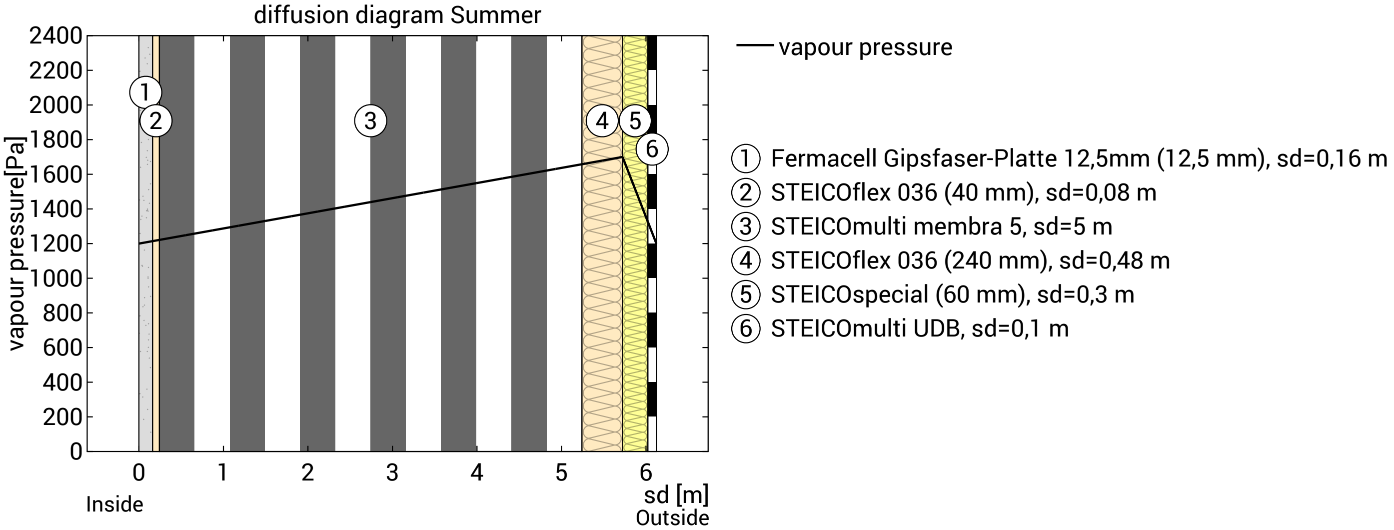
Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential:
sd=5,72 m; x=29,3 cm; ps=537 pa:
Layer boundary between STEICOflex 036 and STEICOspecial

Mev,Tauperiode = tc * δ0 * ((ps-pi)/sd_{ev} + (ps-pe)/(sd_e-sd_{ev})) = **0,670 kg/m²**

Wohnhauses mit 4 roof, U=0,12 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=5,72 m; x=29,3 cm:
Layer boundary between STEICOflex 036 and STEICOspecial
Evaporation mass: Mev = δ0 * tev * [(ps-pi)/sd + (ps-pe)/(sde-sd)] = **2,08 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 = **2750 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

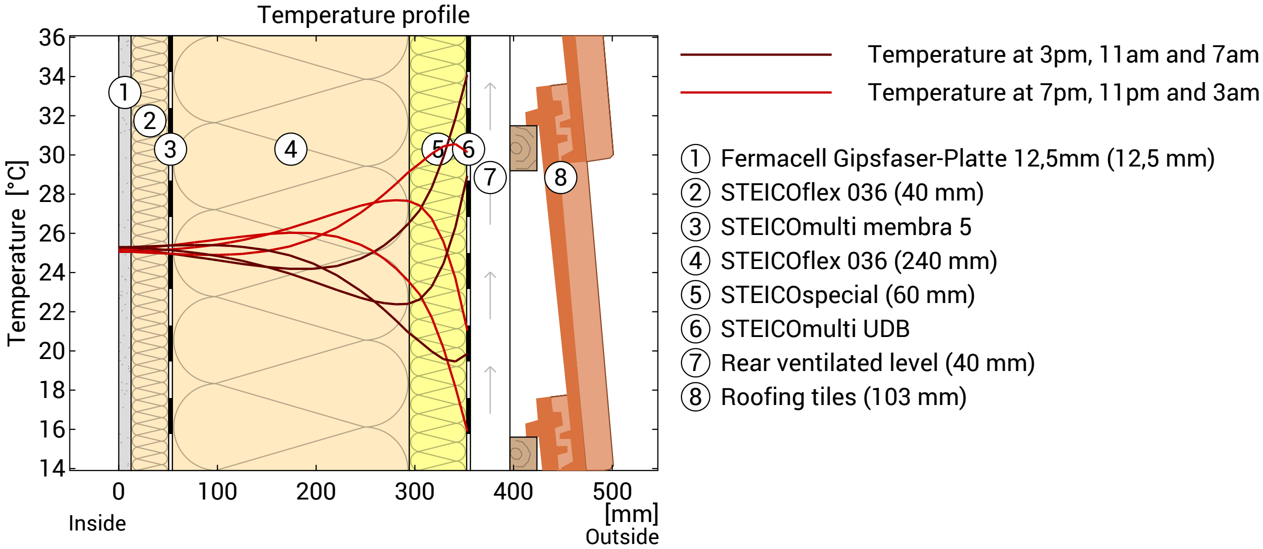
In the case of inhomogeneous constructions, such as skeleton-, stand- or frame constructions, as well as in wooden beam, rafter or half-timbered constructions or the like, the one-dimensional diffusion calculations are only to be demonstrated for the compartment area. Exceptional cases are special constructions 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.

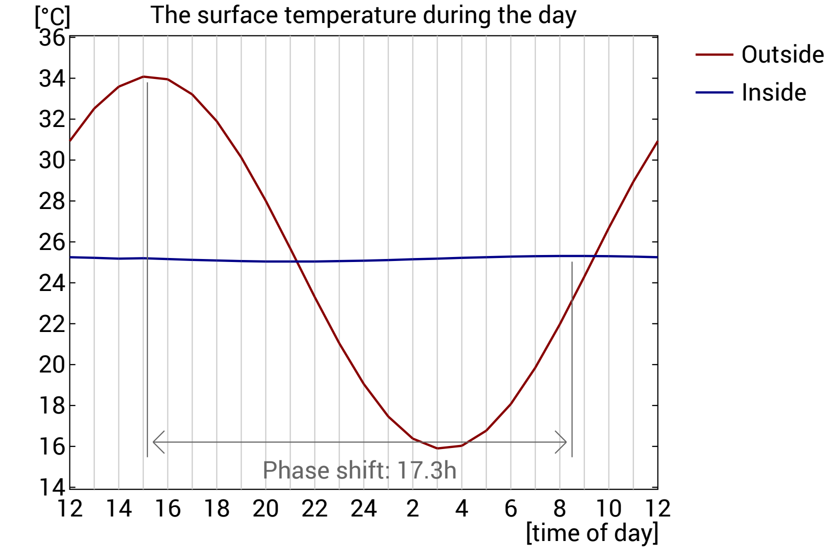
DIN 4108-3 describes in Section 5.3 components for which no moisture proofing is required as there is no risk of condensation water or the method is not suitable for the assessment. It is not possible to assess whether the component under test is underneath.

Wohnhauses mit 4 roof, U=0,12 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*	17,3 h	Heat storage capacity (whole component):	88 kJ/m²K
Amplitude attenuation **	66,7	Thermal capacity of inner layers:	42 kJ/m²K
TAV ***	0,015		

* 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.

Wohnhauses mit 4 roof, U=0,12 W/(m²K)

Hints

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.

Exterior sd value

Wohnhauses mit 4 wall

Exterior wall
created on 2.10.2024

Thermal protection

U = 0,14 W/(m²K)

GEG 2020/24 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

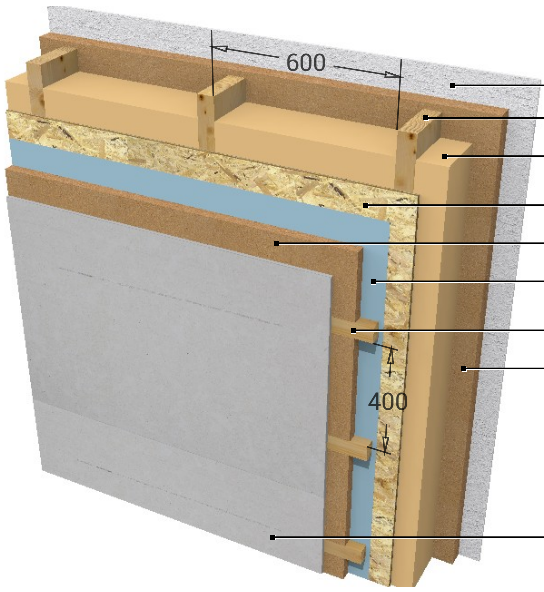
Drying reserve: 1352 g/m²a
No condensate

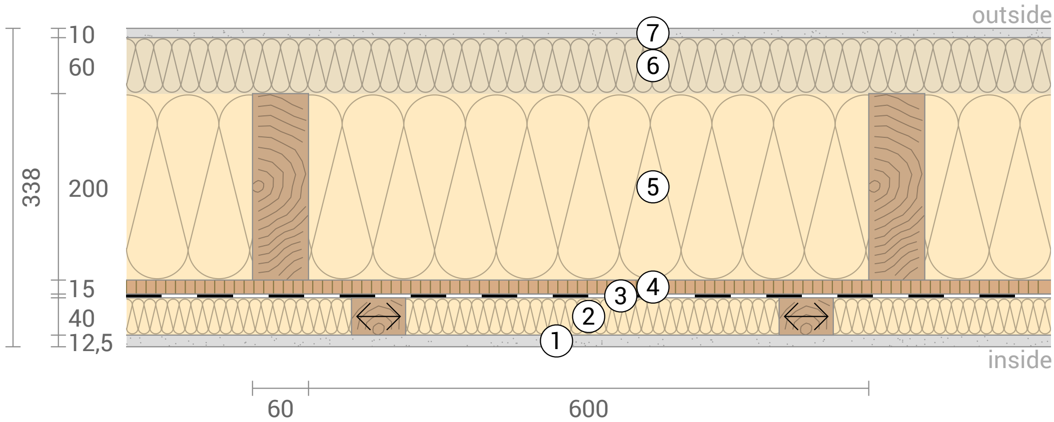
excellent insufficient

Heat protection

Temperature amplitude damping: 55
phase shift: 15,8 h
Thermal capacity inside: 49 kJ/m²K

excellent insufficient





1. Fermacell Gipsfaser-Platte 12,5mm (12,5 mm)
2. STEICOflex 036 (40 mm)
3. STEICOmulti membra 5
4. OSB/3 (15 mm)
5. STEICOzell (200 mm)
6. STEICOprotect M dry (60 mm)
7. Silicone Resin Plaster (10 mm)

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

Inside air :	20,0°C / 50%			Thickness:	33,8 cm
Outside air:	-5,0°C / 80%	sd-value:	8,8 m	Weight:	70 kg/m²
Surface temperature.:	19,0°C / -4,9°C	Drying reserve:	1352 g/m²a	Heat capacity:	100 kJ/m²K

☑ GEG 2020/24 Bestand ☑ BEG Einzelmaßn. ☑ GEG 2023/24 Neubau ☑ DIN 4108

*Comparison of the U-value with den Höchstwerten aus GEG Anlage 7 (GEG 2020-2024 Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; 70% des U-Werts der Referenzausführung aus GEG 2023/2024 Anlage 1 (GEG Neubau); den R-Werten aus DIN 4108-2 Tabelle 3

Wohnhauses mit 4 wall, U=0,14 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	Fermacell Gipsfaser-Platte 12,5mm	1,25	0,320	0,039
2	STEICOflex 036	4,00	0,036	1,111
	Spruce (13%)	4,00	0,130	0,308
3	STEICOmulti membra 5	0,05	0,170	0,003
4	OSB/3	1,50	0,130	0,115
5	STEICOzell	20,00	0,038	5,263
	Spruce (9,1%)	20,00	0,130	1,538
6	STEICOprotect M dry	6,00	0,040	1,500
7	Silicone Resin Plaster	1,00	0,700	0,014
	Thermal contact resistance outside (Rse)			0,040

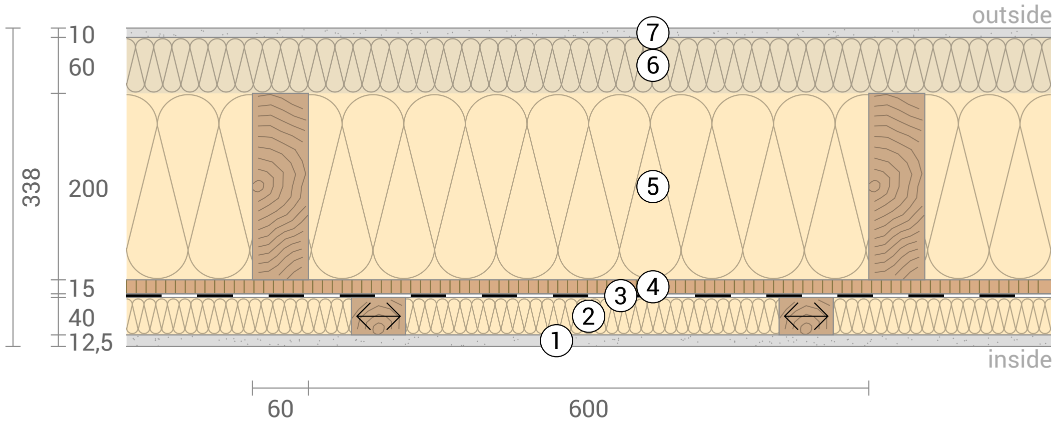
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction horizontally
Rse: heat flow direction horizontally, outside: Direct contact to outside air

Upper limit of thermal resistance $R_{tot;upper}$ = 7,521 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 6,990 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,076 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 7,256 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 3,7%

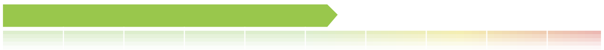
Heat transfer coefficient U = 1/R_{tot} = **0,14 W/(m²K)**



Wohnhauses mit 4 wall, U=0,14 W/(m²K)

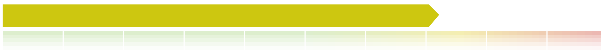
LCA

Heat loss: 11 kWh/m² per heating season



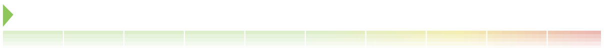
Amount of heat that escapes through one square meter of this component during the heating period. Please note: Due to internal and solar gains, the heating demand is lower than the heat loss.

Primary energy (non renewable): 247 kWh/m²



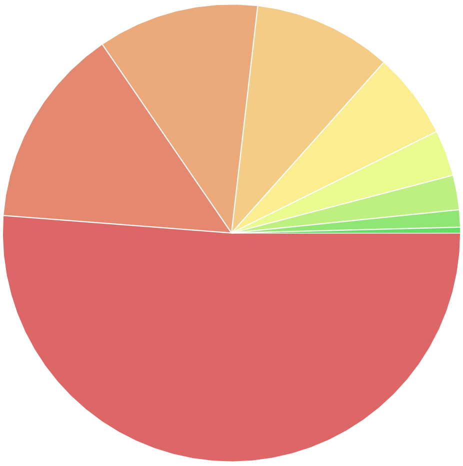
Non-renewable primary energy (= energy from fossil fuels and nuclear energy) that was used to produce the new building materials ("cradle to gate").

Green house gas potential: -13 kg CO2 Äqv./m²



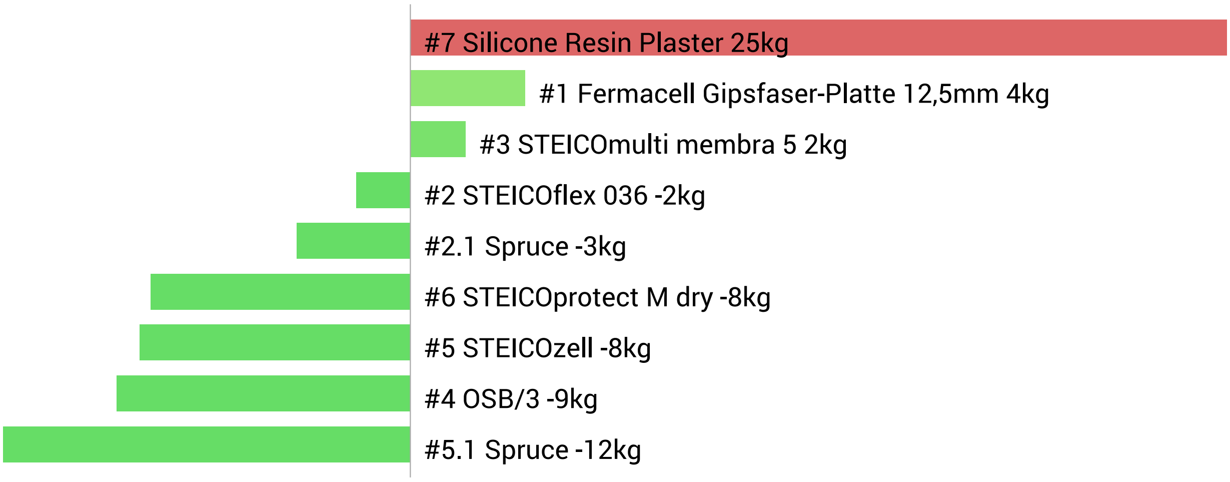
For the production of the building materials used, more greenhouse gases were withdrawn from the atmosphere than emitted.

Composition of non-renewable primary energy of production:



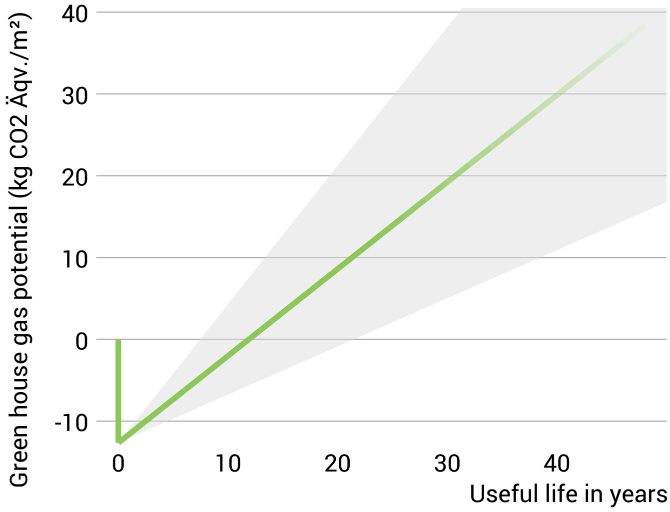
- Silicone Resin Plaster (10 mm) 51%
- OSB/3 (15 mm) 14%
- STEICOprotect M dry (60 mm) 11%
- STEICOzell (200 mm) 10%
- Fermacell Gipsfaser-Platte 12,5mm (12,5 mm) 6%
- STEICOmulti membra 5 3%
- STEICOflex 036 (40 mm) 2%
- Spruce (200x60) 1%
- Spruce (40x58) 0%

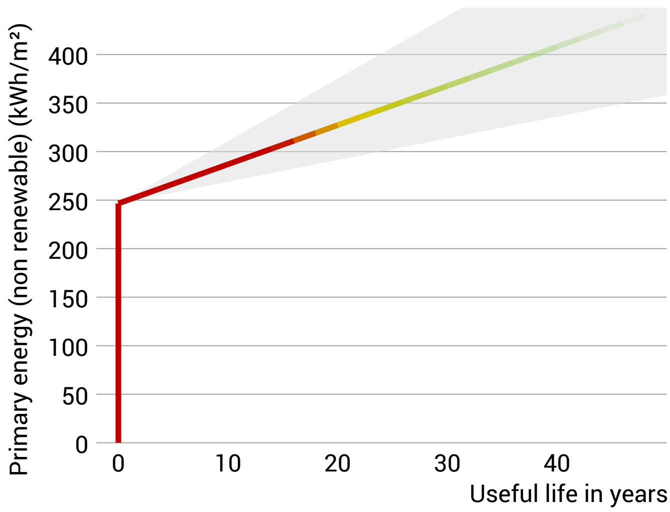
Composition of the greenhouse potential of production:



Wohnhauses mit 4 wall, U=0,14 W/(m²K)

Global warming potential and primary energy for construction and use





The **left figure** shows the global warming potential of the production of the component in the vertical part of the curve. Greenhouse gas emissions (through heating) arising during use of the building are indicated by the upward curve.

The **figure at the bottom left** shows the non-renewable primary energy expenditure for the production of the component in the vertical part of the curve. The primary energy required during use of the building (through heating) is represented by the upward curve.

The longer the component is used unchanged, the more environmentally friendly it is, because the production costs contribute less to the total emissions (indicated by the color of the curve).

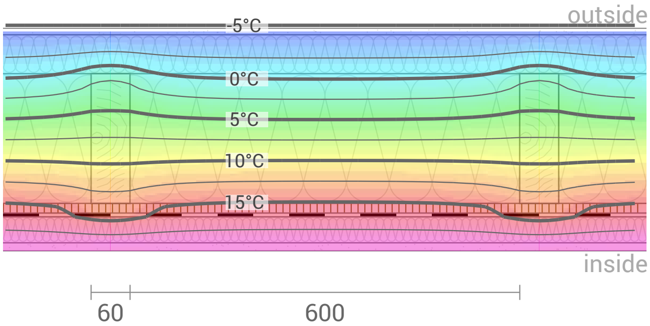
Due to unknown solar and internal gains, the heating demand can only be estimated. Accordingly, primary energy consumption and global warming potential during the use phase are only vaguely known. For the estimation it was assumed that solar and internal profits contribute with 4 kWh/a/m² component area. The light gray area indicates the area in which the curve is located with great certainty. For heat generation, a primary energy input of 0,60 kWh per kWh of heat and a global warming potential of 0,16 kg CO2 eqv/m² per kWh of heat was used. Heat source: Heat pump (air-water).

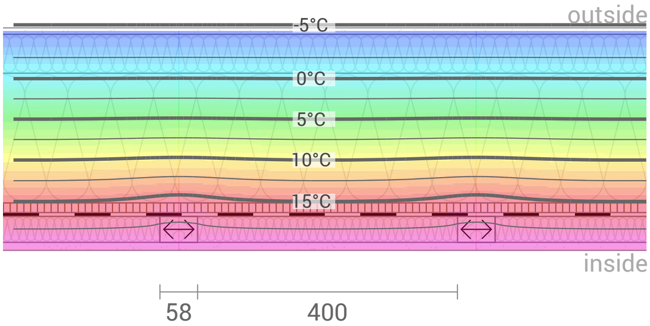
Hints

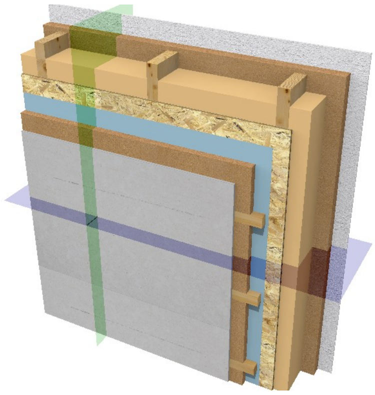
Calculated for the location DIN V 18599, heating period from Mid of October to End of April. The calculation is based on monthly average temperatures. Source: DIN V 18599-10:2007-02

The climate and energy data on which this calculation is based can, in some cases, show considerable fluctuations and, in individual cases, deviate considerably from the actual value.

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	Temperatur [°C] max	Weight [kg/m²]
		Thermal contact resistance*		0,250	19,0	20,0	
1	1,25 cm	Fermacell Gipsfaser-Platte 12,5mm	0,320	0,039	18,9	19,2	14,4
2	4 cm	STEICOflex 036	0,036	1,111	14,1	19,1	1,7
	4 cm	Spruce (13%)	0,130	0,308			2,3
3	0,05 cm	STEICOmulti membra 5	0,170	0,003	14,0	15,8	0,2
4	1,5 cm	OSB/3	0,130	0,115	13,4	15,8	9,3
5	20 cm	STEICOzell	0,038	5,263	-0,3	15,4	7,3
	20 cm	Spruce (9,1%)	0,130	1,538	2,0	13,8	8,2
6	6 cm	STEICOprotect M dry	0,040	1,500	-4,8	2,1	8,4
7	1 cm	Silicone Resin Plaster	0,700	0,014	-4,9	-4,8	18,0
		Thermal contact resistance*		0,040	-5,0	-4,8	
	33,8 cm	Whole component		7,256			69,7

*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):	19,0°C	19,2°C	19,2°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,8°C

Wohnhauses mit 4 wall, U=0,14 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.

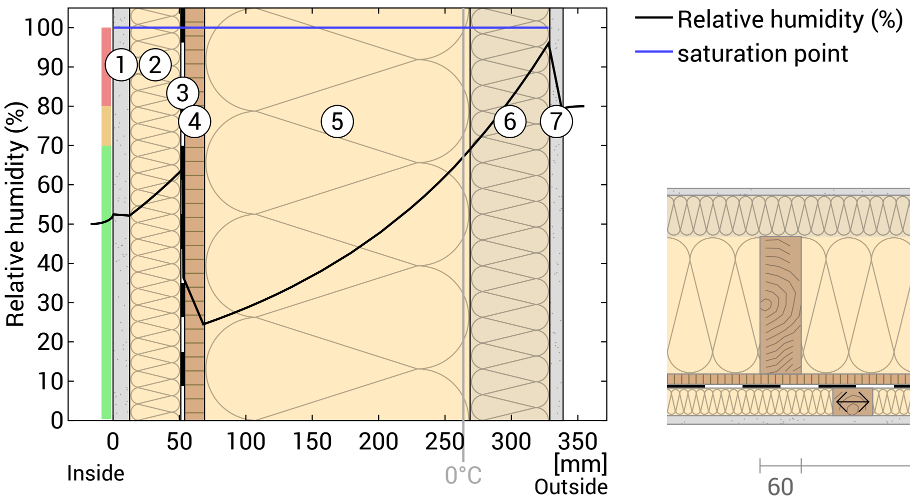
This component is free of condensate under the given climate conditions.

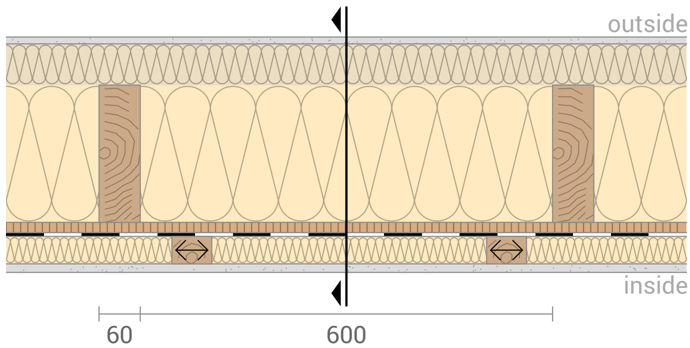
Drying reserve according to DIN 4108-3:2018: 1352 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1,25 cm	Fermacell Gipsfaser-Platte 12,5mm	0,16	-		14,4
2	4 cm	STEICOflex 036	0,08	-		1,7
	4 cm	Spruce (13%)		-	-	2,3
3	0,05 cm	STEICOmulti membra 5	5,00	-		0,2
4	1,5 cm	OSB/3	2,25	-	-	9,3
5	20 cm	STEICOzell	0,20	-		7,3
	20 cm	Spruce (9,1%)	4,00	-	-	8,2
6	6 cm	STEICOprotect M dry	0,18	-		8,4
7	1 cm	Silicone Resin Plaster	0,70	-		18,0
	33,8 cm	Whole component	8,76	0		69,7

Humidity

The temperature of the inside surface is 19,0 °C leading to a relative humidity on the surface of 53%.Mould formation is not expected under these conditions.
The following figure shows the relative humidity inside the component.





① Fermacell Gipsfaser-Platte 12,5mm...
② STEICOflex 036 (40 mm)
③ STEICOmulti membra 5
④ OSB/3 (15 mm)
⑤ STEICOzell (200 mm)
⑥ STEICOprotect M dry (60 mm)
⑦ Silicone Resin Plaster (10 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.

Wohnhauses mit 4 wall, U=0,14 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	Fermacell Gipsfaser-Platte 12,5mm	0,320	0,039	0,16	1150
2	4 cm	STEICOflex 036	0,036	1,111	0,08	50
3	0,05 cm	STEICOmulti membra 5	0,170	0,003	5	325
4	1,5 cm	OSB/3	0,130	0,115	2,25	620
5	20 cm	STEICOzell	0,038	5,263	0,2	40
6	6 cm	STEICOprotect M dry	0,040	1,500	0,18	140
7	1 cm	Silicone Resin Plaster	0,700	0,014	0,7	1800
		Thermal contact resistance		0,040		

T [°C]	ps [Pa]	Σsd [m]
19,25	2231	0
19,13	2215	0,16
15,80	1794	0,24
15,79	1793	5,24
15,45	1754	7,49
-0,34	594	7,69
-4,84	407	7,87
-4,88	405	8,57

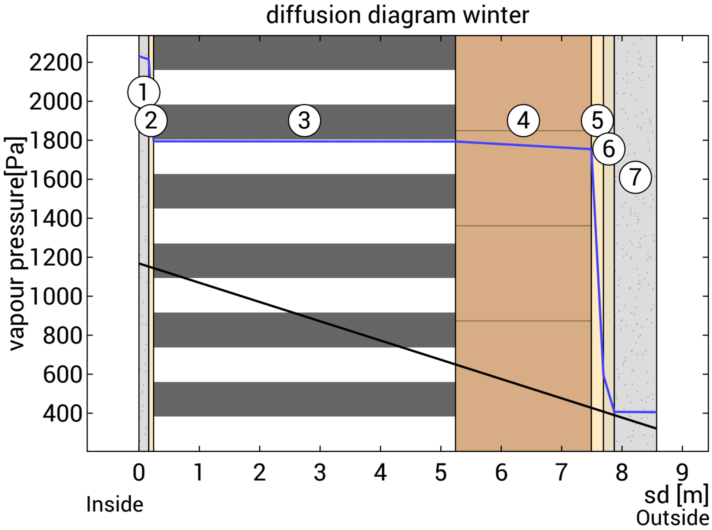
Temperature (T), vapor saturation pressure (ps), and the sum of the sd-values (Σsd) apply to the layer boundary.

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 = 8,57 m



1. Fermacell Gipsfaser-Platte 12,5mm (12,5 mm), sd=0,16 m
2. STEICOflex 036 (40 mm), sd=0,08 m
3. STEICOmulti membra 5, sd=5 m
4. OSB/3 (15 mm), sd=2,25 m
5. STEICOzell (200 mm), sd=0,2 m
6. STEICOprotect M dry (60 mm), sd=0,18 m
7. Silicone Resin Plaster (10 mm), sd=0,7 m

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

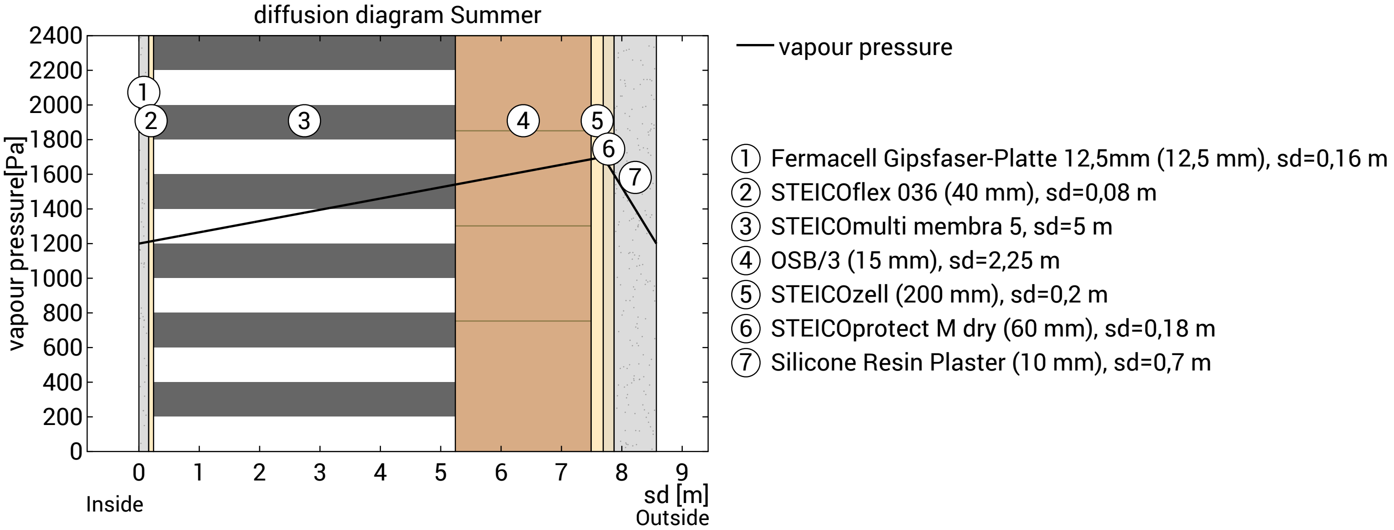
Calculate evaporation potential for the drying reserve in the dew period for the plane with the lowest evaporation potential:
sd=7,69 m; x=26,8 cm; ps=594 pa:
Layer boundary between STEICOzell and STEICOprotect M dry

Mev,Tauperiode = $tc * δ0 * ((ps-pi)/sd_{ev} + (ps-pe)/(sd_e-sd_{ev}))$ = **0,367 kg/m²**

Wohnhauses mit 4 wall, U=0,14 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=7,69 m; x=26,8 cm:
Layer boundary between STEICOzell and STEICOprotect M dry
Evaporation mass: Mev = δ0 * tev * [(ps-pi)/sd + (ps-pe)/(sde-sd)] = **0,98 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 = **1352 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

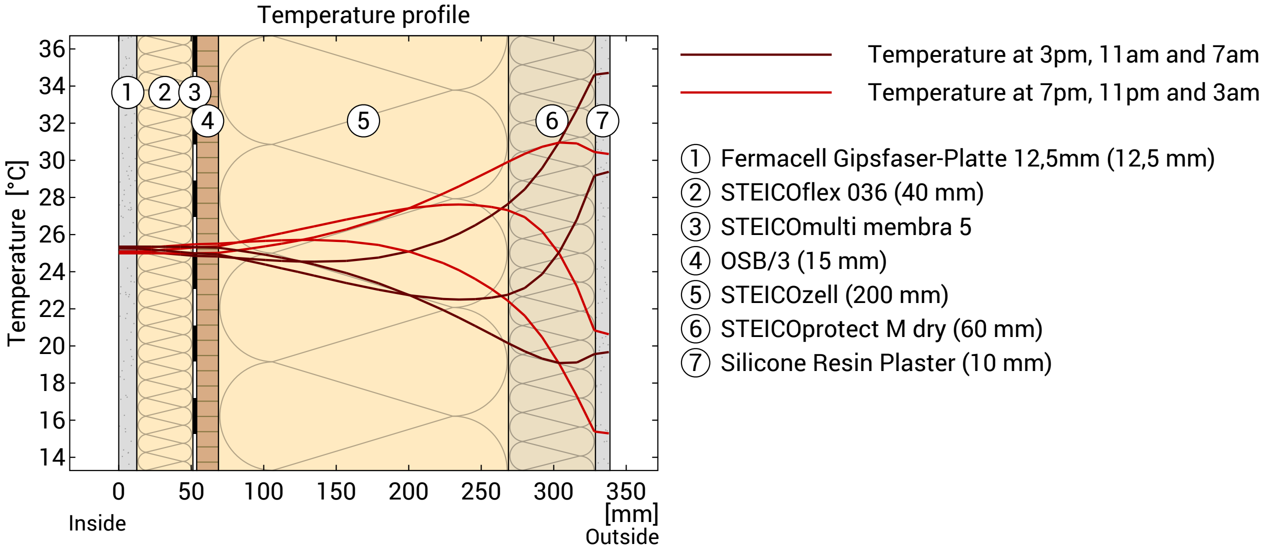
In the case of inhomogeneous constructions, such as skeleton-, stand- or frame constructions, as well as in wooden beam, rafter or half-timbered constructions or the like, the one-dimensional diffusion calculations are only to be demonstrated for the compartment area. Exceptional cases are special constructions 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.

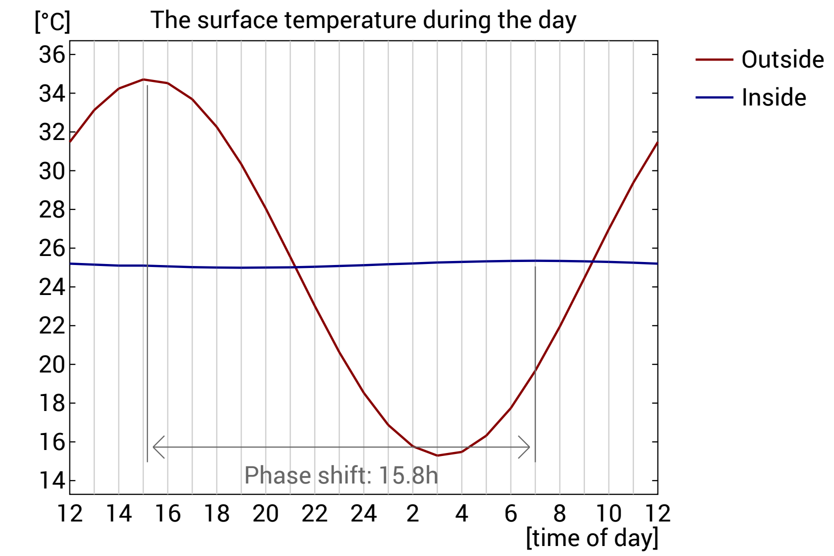
DIN 4108-3 describes in Section 5.3 components for which no moisture proofing is required as there is no risk of condensation water or the method is not suitable for the assessment. It is not possible to assess whether the component under test is underneath.

Wohnhauses mit 4 wall, U=0,14 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*	15,8 h	Heat storage capacity (whole component):	100 kJ/m²K
Amplitude attenuation **	54,9	Thermal capacity of inner layers:	49 kJ/m²K
TAV ***	0,018		

* 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.

Wohnhauses mit 4 wall, U=0,14 W/(m²K)

Hints

There are no hints available for your calculation.

Wohnhauses mit 4 celing

Ceiling
created on 2.10.2024

Thermal protection

U = 0,26 W/(m²K)

Heated on both sides: No requirement*

excellent insufficient

Moisture proofing

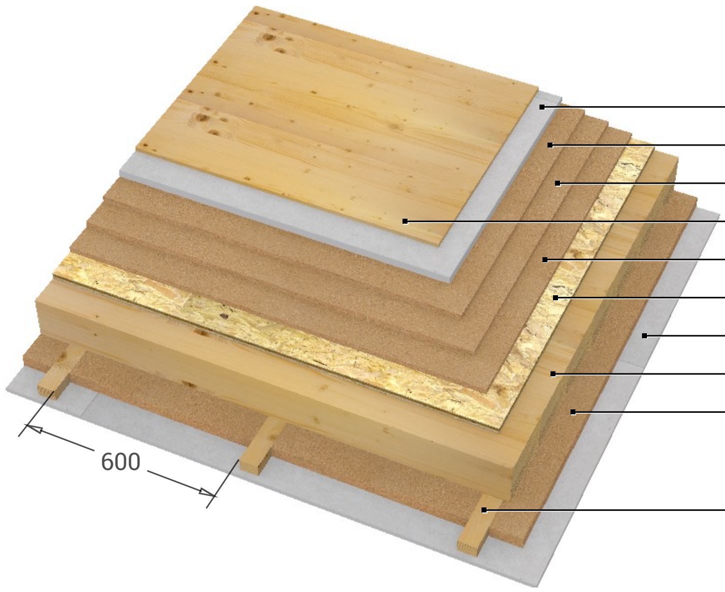
Drying reserve: 236 g/m²a
No condensate

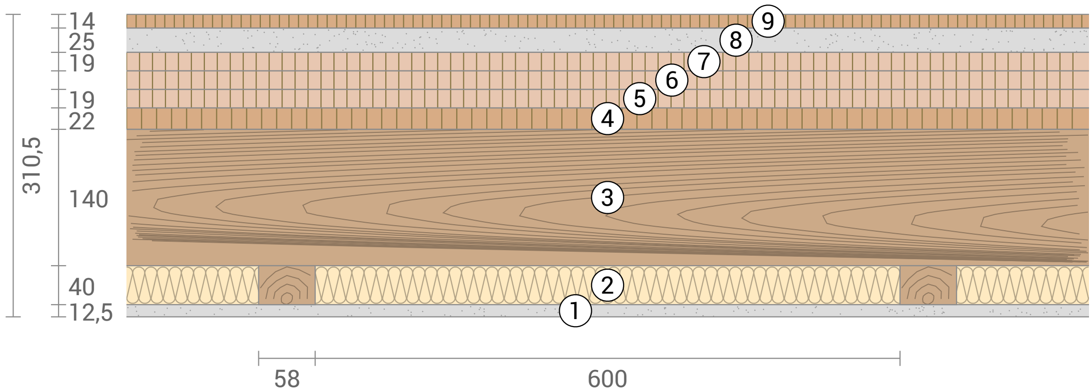
excellent insufficient

Heat protection

Temperature amplitude damping: 80
phase shift: 18,5 h
Thermal capacity inside: 93 kJ/m²K

excellent insufficient





1. Fermacell Gipsfaser-Platte 12,5mm (12,5 mm)
2. STEICOflex 036 (40 mm)
3. Spruce (140 mm)
4. OSB/3 (22 mm)
5. STEICOisorel (19 mm)
6. STEICOisorel (19 mm)
7. STEICOisorel (19 mm)
8. Fermacell Gipsfaser-Platte 12,5mm (25 mm)
9. 3-layer panel (14 mm)

Inside air :	20,0°C / 50%		Thickness:	31,0 cm
Inside air 2:	20,0°C / 50%	sd-value: 13,4 m	Weight:	143 kg/m²
Surface temperature.:	20,0°C / 20,0°C		Heat capacity:	216 kJ/m²K

☐ GEG 2020/24 Bestand ☐ BEG Einzelmaßn. ☐ GEG 2023/24 Neubau ☑ DIN 4108

*Comparison of the U-value with den Höchstwerten aus GEG Anlage 7 (GEG 2020-2024 Bestand); den techn. Mindestanforderungen für BEG Einzelmaßnahmen; 70% des U-Werts der Referenzausführung aus GEG 2023/2024 Anlage 1 (GEG Neubau); den R-Werten aus DIN 4108-2 Tabelle 3

Wohnhauses mit 4 celing, U=0,26 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	Fermacell Gipsfaser-Platte 12,5mm	1,25	0,320	0,039
2	STEICOflex 036	4,00	0,036	1,111
	Spruce (8,8%)	4,00	0,130	0,308
3	Spruce	14,00	0,130	1,077
4	OSB/3	2,20	0,130	0,169
5	STEICOisorel	1,90	0,050	0,380
6	STEICOisorel	1,90	0,050	0,380
7	STEICOisorel	1,90	0,050	0,380
8	Fermacell Gipsfaser-Platte 12,5mm	2,50	0,320	0,078
9	3-layer panel	1,40	0,130	0,108
	Thermal contact resistance outside (Rse)			0,100

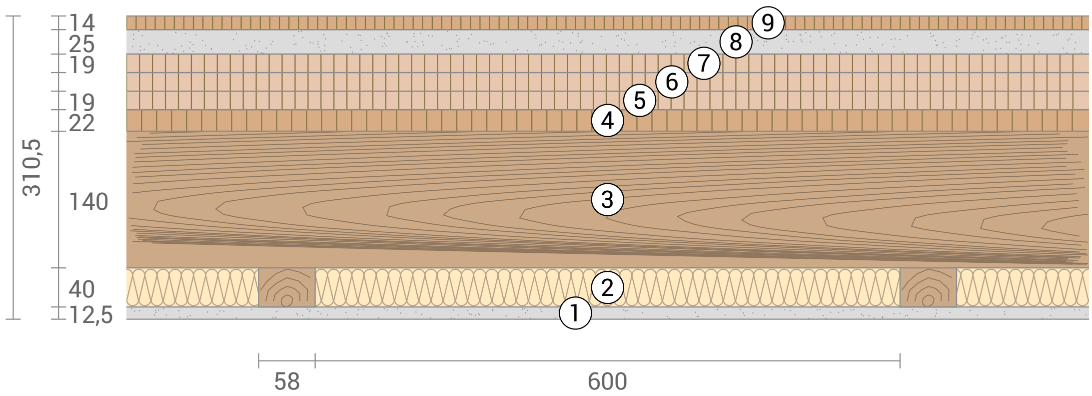
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction upwards
Rse: heat flow direction upwards, outside: Heated room

Upper limit of thermal resistance $R_{tot;upper}$ = 3,835 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 3,714 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,033 (maximum allowed: 1,5)

The procedure may be used.

Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 3,775 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 1,6%

Heat transfer coefficient U = 1/R_{tot} = **0,26 W/(m²K)**



Wohnhauses mit 4 celing, U=0,26 W/(m²K)

LCA

Heat loss: 21 kWh/m² per heating season

Amount of heat that escapes through one square meter of this component during the heating period. Please note: Due to internal and solar gains, the heating demand is lower than the heat loss.

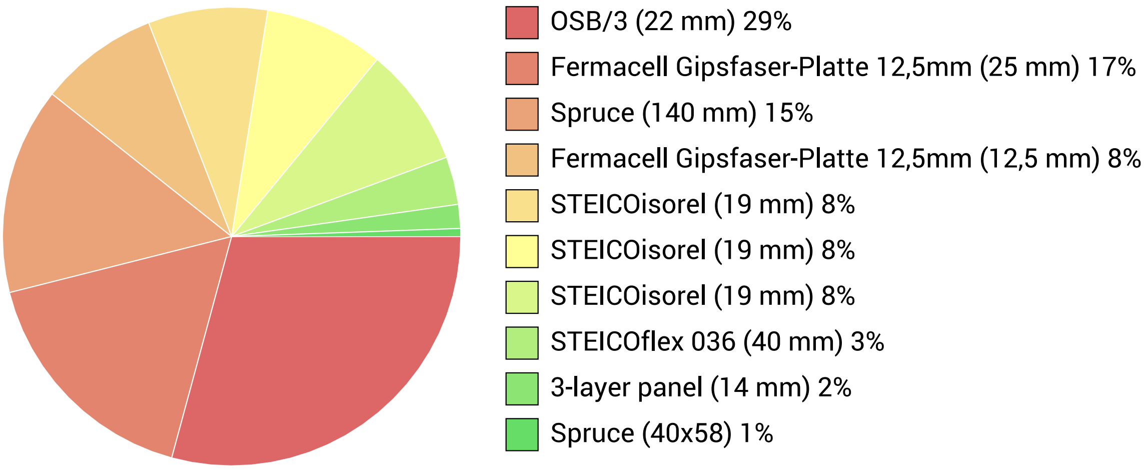
Primary energy (non renewable): 177 kWh/m²

Non-renewable primary energy (= energy from fossil fuels and nuclear energy) that was used to produce the new building materials ("cradle to gate").

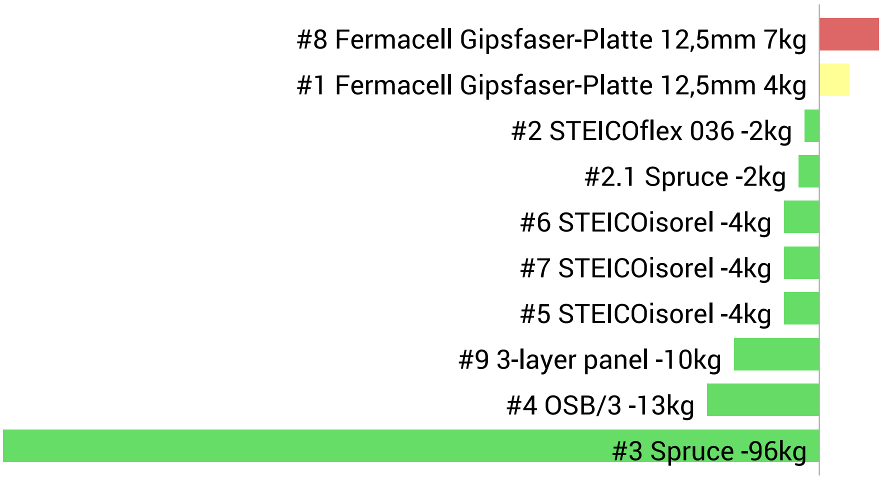
Green house gas potential: -125 kg CO2 Äqv./m²

For the production of the building materials used, more greenhouse gases were withdrawn from the atmosphere than emitted.

Composition of non-renewable primary energy of production:

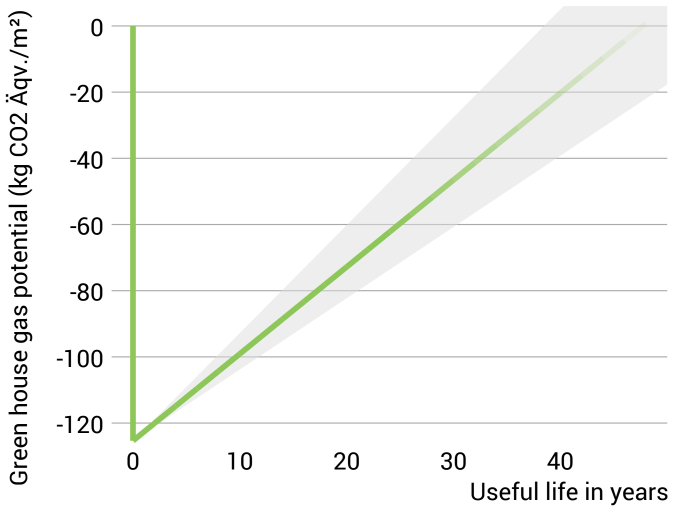


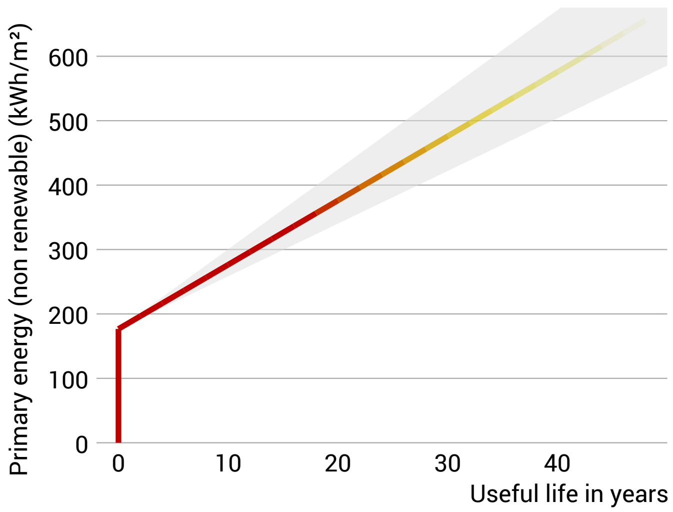
Composition of the greenhouse potential of production:



Wohnhauses mit 4 celing, U=0,26 W/(m²K)

Global warming potential and primary energy for construction and use





The **left figure** shows the global warming potential of the production of the component in the vertical part of the curve. Greenhouse gas emissions (through heating) arising during use of the building are indicated by the upward curve.

The **figure at the bottom left** shows the non-renewable primary energy expenditure for the production of the component in the vertical part of the curve. The primary energy required during use of the building (through heating) is represented by the upward curve.

The longer the component is used unchanged, the more environmentally friendly it is, because the production costs contribute less to the total emissions (indicated by the color of the curve).

Due to unknown solar and internal gains, the heating demand can only be estimated. Accordingly, primary energy consumption and global warming potential during the use phase are only vaguely known. For the estimation it was assumed that solar and internal profits contribute with 4 kWh/a/m² component area. The light gray area indicates the area in which the curve is located with great certainty. For heat generation, a primary energy input of 0,60 kWh per kWh of heat and a global warming potential of 0,16 kg CO2 eqv/m² per kWh of heat was used. Heat source: Heat pump (air-water).

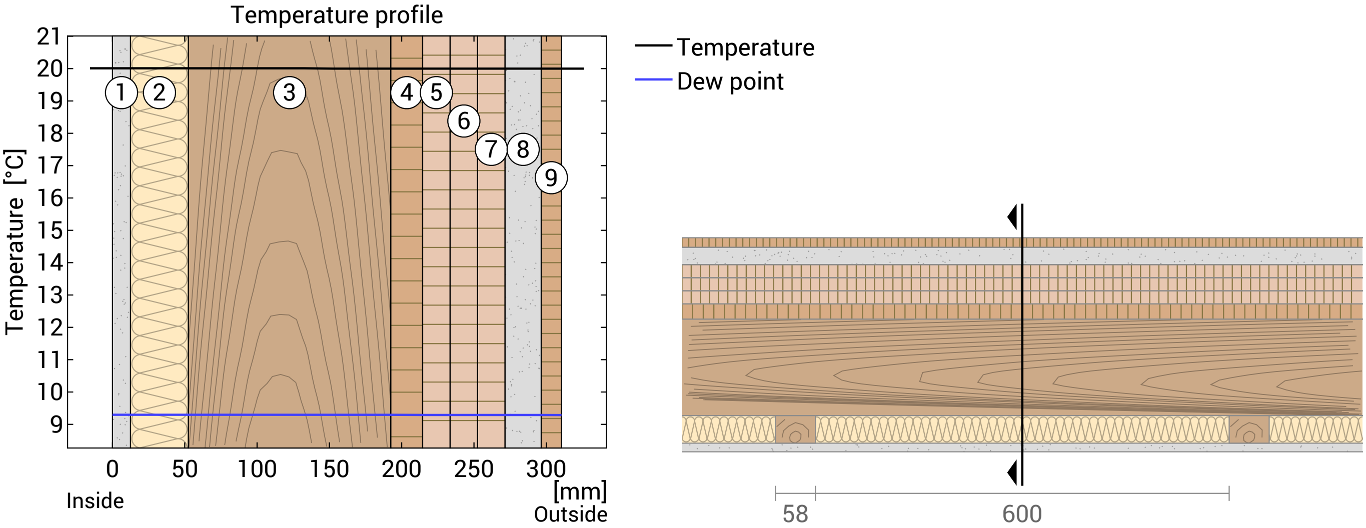
Hints

Calculated for the location DIN V 18599, heating period from Mid of October to End of April. The calculation is based on monthly average temperatures. Source: DIN V 18599-10:2007-02

The climate and energy data on which this calculation is based can, in some cases, show considerable fluctuations and, in individual cases, deviate considerably from the actual value.

Wohnhauses mit 4 celing, U=0,26 W/(m²K)

Temperature profile



① Fermacell Gipsfaser-Platte 12,5mm...
② STEICOflex 036 (40 mm)
③ Spruce (140 mm)
④ OSB/3 (22 mm)
⑤ STEICOisorel (19 mm)
⑥ STEICOisorel (19 mm)
⑦ STEICOisorel (19 mm)
⑧ Fermacell Gipsfaser-Platte 12,5m...
⑨ 3-layer panel (14 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	1,25 cm	Fermacell Gipsfaser-Platte 12,5mm	0,320	0,039	20,0	20,0	14,4
2	4 cm	STEICOflex 036	0,036	1,111	20,0	20,0	1,8
	4 cm	Spruce (8,8%)	0,130	0,308	20,0	20,0	1,6
3	14 cm	Spruce	0,130	1,077	20,0	20,0	63,0
4	2,2 cm	OSB/3	0,130	0,169	20,0	20,0	13,6
5	1,9 cm	STEICOisorel	0,050	0,380	20,0	20,0	4,4
6	1,9 cm	STEICOisorel	0,050	0,380	20,0	20,0	4,4
7	1,9 cm	STEICOisorel	0,050	0,380	20,0	20,0	4,4
8	2,5 cm	Fermacell Gipsfaser-Platte 12,5mm	0,320	0,078	20,0	20,0	28,8
9	1,4 cm	3-layer panel	0,130	0,108	20,0	20,0	6,6
		Thermal contact resistance*		0,040	20,0	20,0	
	31,05 cm	Whole component		3,775			142,9

*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'.

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

Wohnhauses mit 4 celing, U=0,26 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: 20.01°C und 50% Humidity; outside: 20°C und 50% Humidity (Climate according to user input).

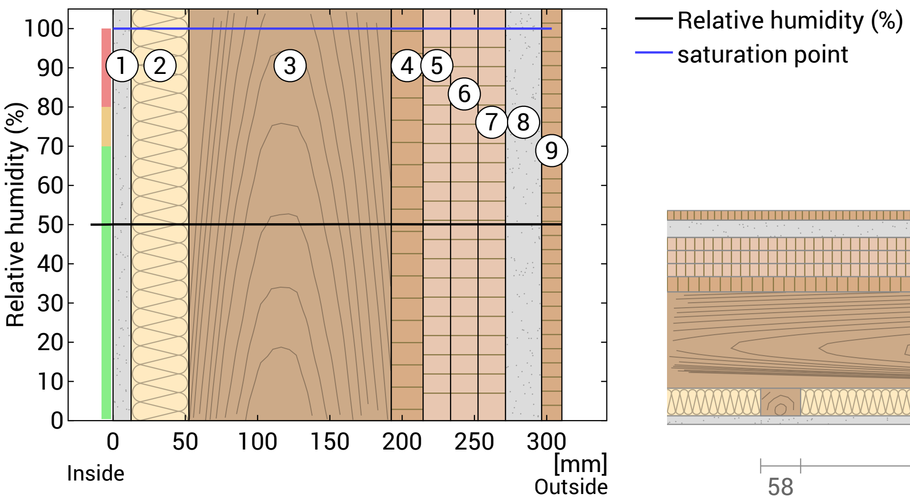
This component is free of condensate under the given climate conditions.

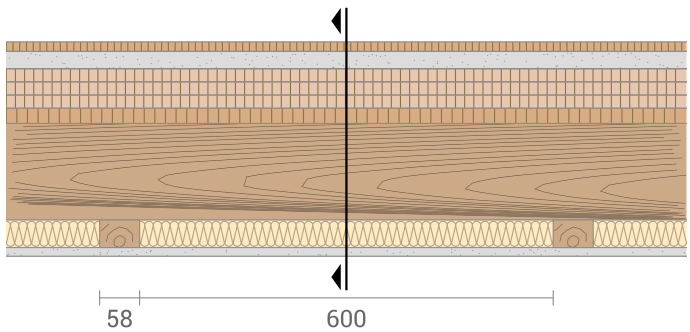
Drying reserve according to Ubakus 2D-FE method: 236 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1,25 cm	Fermacell Gipsfaser-Platte 12,5mm	0,16	-		14,4
2	4 cm	STEICOflex 036	0,08	-		1,8
	4 cm	Spruce (8,8%)	0,80	-	-	1,6
3	14 cm	Spruce	2,80	-	-	63,0
4	2,2 cm	OSB/3	6,60	-	-	13,6
5	1,9 cm	STEICOisorel	0,10	-	-	4,4
6	1,9 cm	STEICOisorel	0,10	-	-	4,4
7	1,9 cm	STEICOisorel	0,10	-	-	4,4
8	2,5 cm	Fermacell Gipsfaser-Platte 12,5mm	0,33	-		28,8
9	1,4 cm	3-layer panel	3,08	-	-	6,6
	31,05 cm	Whole component	13,38	0		142,9

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 Fermacell Gipsfaser-Platte 12,5mm...
② STEICOflex 036 (40 mm)
③ Spruce (140 mm)
④ OSB/3 (22 mm)
⑤ STEICOisorel (19 mm)
⑥ STEICOisorel (19 mm)
⑦ STEICOisorel (19 mm)
⑧ Fermacell Gipsfaser-Platte 12,5m...
⑨ 3-layer panel (14 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.

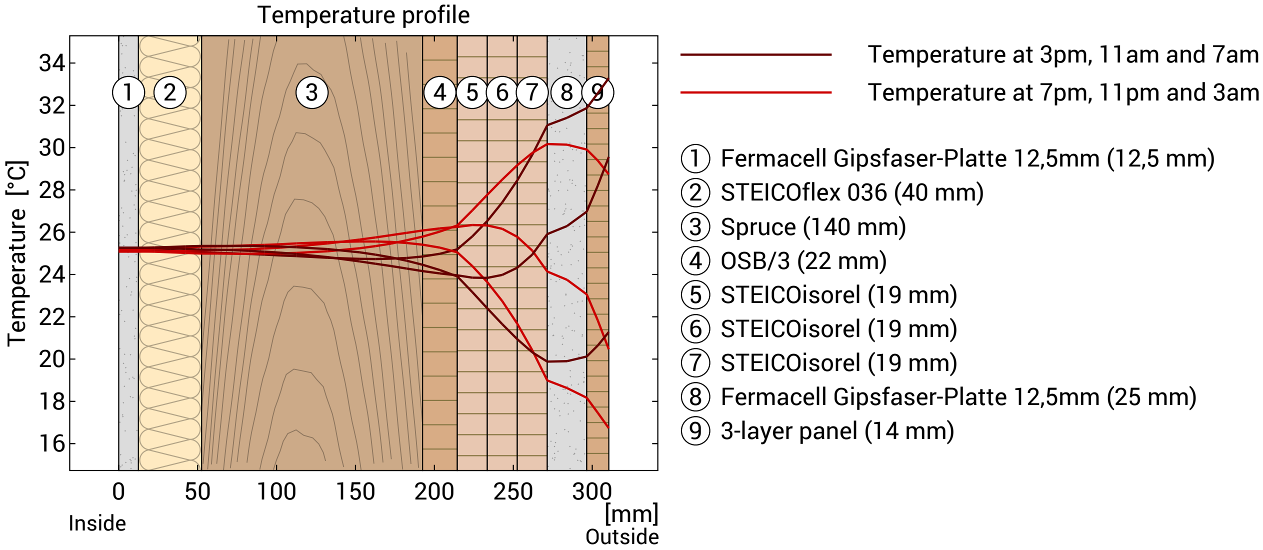
Moisture protection in accordance with DIN 4108-3:2018 Appendix A

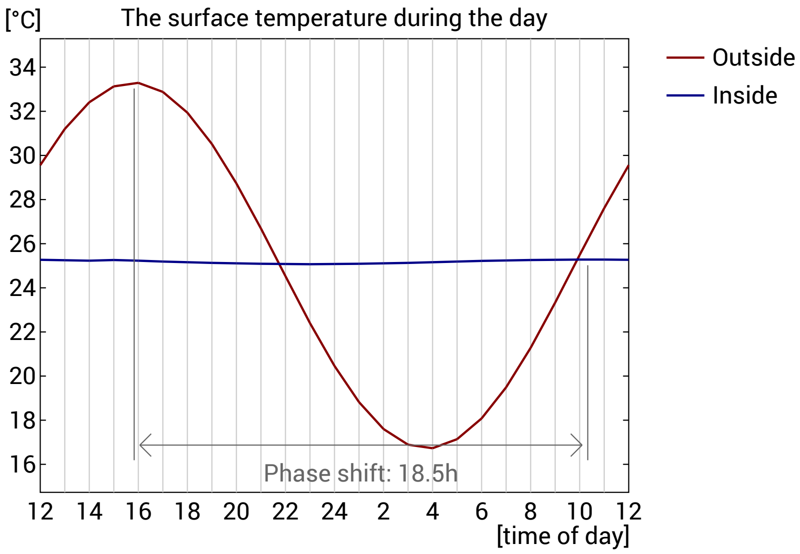
The temperatures and / or humidities you specify are not in accordance with DIN 4108-3. The following values are given by DIN 4108-3: 20°C / 50% humidity inside and -5°C / 80% humidity outside. Change the values in the input form to enable the calculation according to DIN 4108-3.

Wohnhauses mit 4 celing, U=0,26 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*	18,5 h	Heat storage capacity (whole component):	216 kJ/m²K
Amplitude attenuation **	80,0	Thermal capacity of inner layers:	93 kJ/m²K
TAV ***	0,013		

* 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.

Wohnhauses mit 4 celing, U=0,26 W/(m²K)

Hints

There are no hints available for your calculation.