CHD
COMMONS HOUSE DESIGN

I Domus HBE 100 mm & STEICO 200

Exterior wall
created on 7.9.2020

Thermal protection

U = 0,150 W/(m²K)

EnEV16 Neubau*: U<0,22 W/(m²K)

excellent insufficient

Moisture proofing

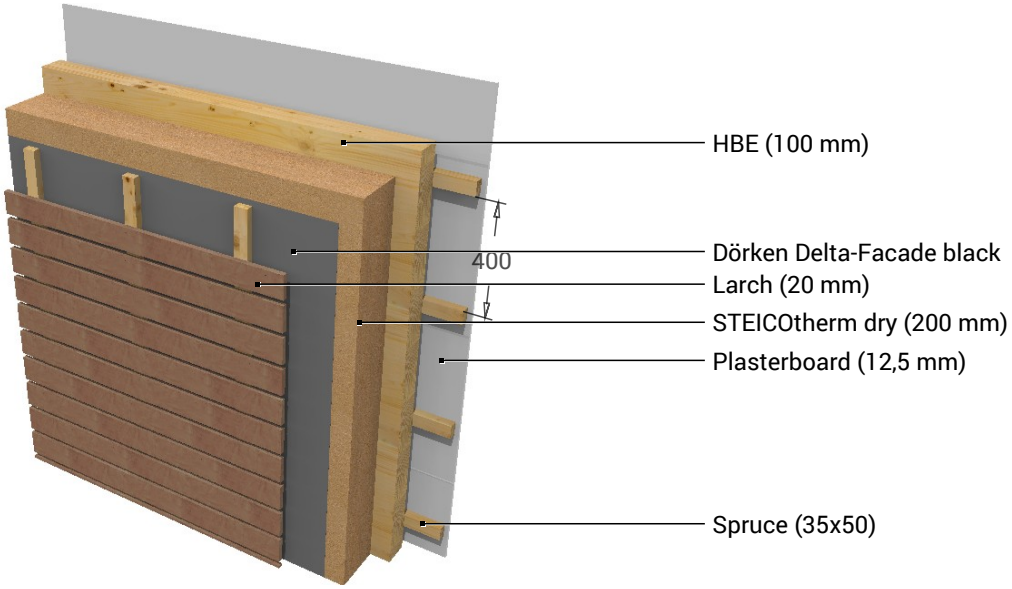
Drying reserve: 8612 g/m²a
No condensate

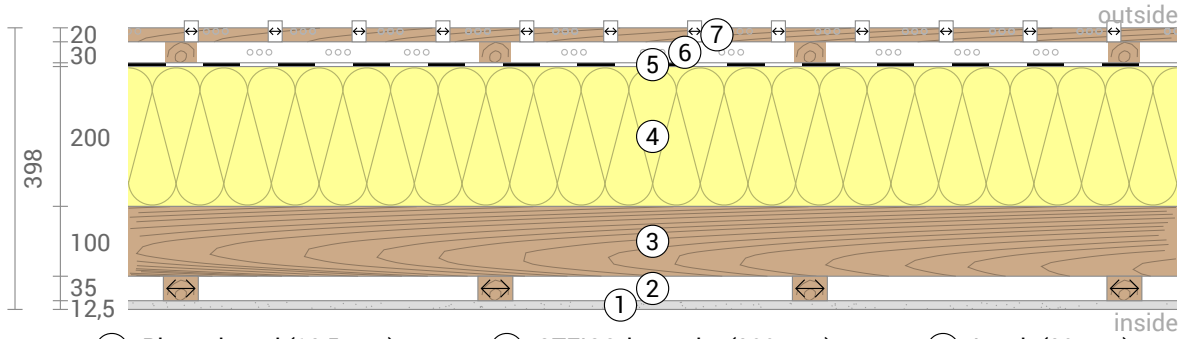
excellent insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 93 kJ/m²K

excellent insufficient





1. Plasterboard (12,5 mm)
2. Installation level (35 mm)
3. HBE (100 mm)
4. STEICOtherm dry (200 mm)
5. Dörken Delta-Facade black
6. Rear ventilated level (30 mm)
7. Larch (20 mm)

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

Inside air :	20,0°C / 50%			Thickness:	39,8 cm
Outside air:	-5,0°C / 80%	sd-value:	0,8 m	Weight:	86 kg/m²
Surface temperature.:	19,1°C / -4,9°C	Drying reserve:	8612 g/m²a	Heat capacity:	128 kJ/m²K

☑ EnEV16 Neubau ☑ ESanMV ☑ EnEV14 Neubau ☑ EnEV Bestand

*Comparison of the U-value with den Höchstwerten aus EnEV 2014 Anlage 3 Tabelle 1 (EnEV Bestand); den Höchstwerten der Energetische Sanierungsmaßnahmen-Verordnung (ESanMV); 80% des U-Werts der Referenzausführung aus EnEV 2014 Anlage 1 Tabelle 1 (EnEV16 Neubau); der Referenzausführung aus EnEV 2014 Anlage 1 Tabelle 1 (EnEV14 Neubau)

I Domus HBE 100 mm & STEICO 200 , U=0,150 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	Installation level	3,50	0,194	0,180
	Spruce (11%)	3,50	0,130	0,269
3	HBE	10,00	0,130	0,769
4	STEICOtherm dry	20,00	0,037	5,405
5	Dörken Delta-Facade black	0,05	0,200	0,003
	Thermal contact resistance outside (Rse)			0,130

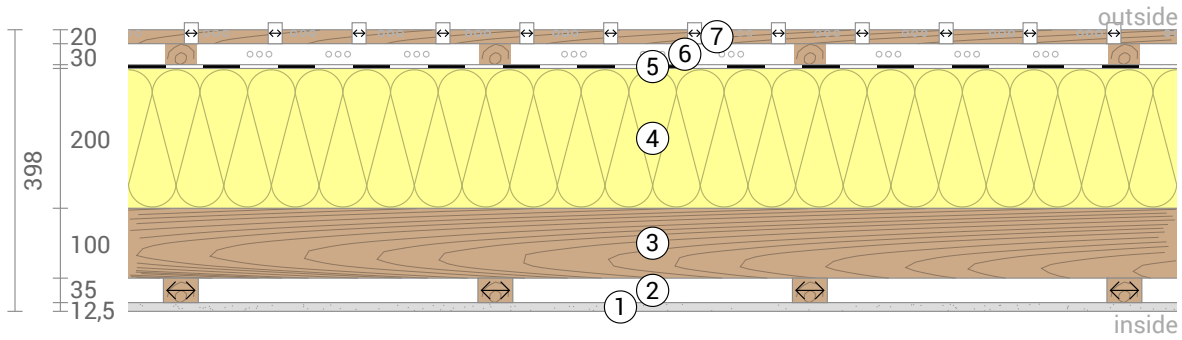
Thermal contact resistances have been taken from DIN 6946 Table 7.
Rsi: heat flow direction horizontally
Rse: heat flow direction horizontally, outside: Ventilation level

Upper limit of thermal resistance $R_{tot;upper}$ = 6,686 m²K/W.
Lower limit of thermal resistance $R_{tot;lower}$ = 6,684 m²K/W.
Check applicability: $R_{tot;upper}$ / $R_{tot;lower}$ = 1,000 (maximum allowed: 1,5)

The procedure may be used.

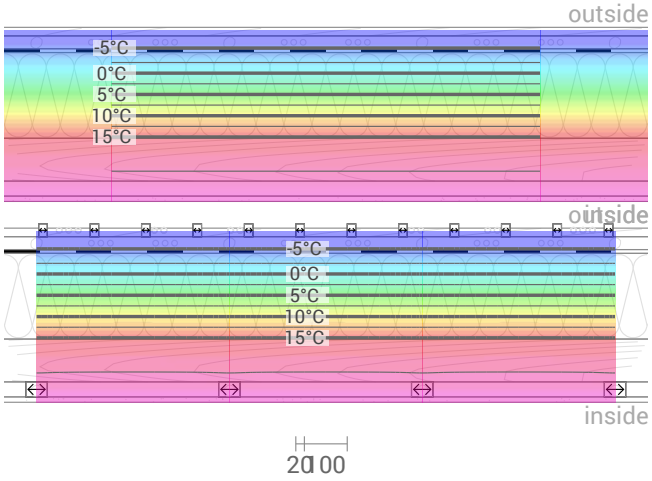
Thermal resistance R_{tot} = ($R_{tot;upper}$ + $R_{tot;lower}$)/2 = 6,685 m²K/W
Estimated maximum relative uncertainty according to section 6.7.2.5: 0,022%

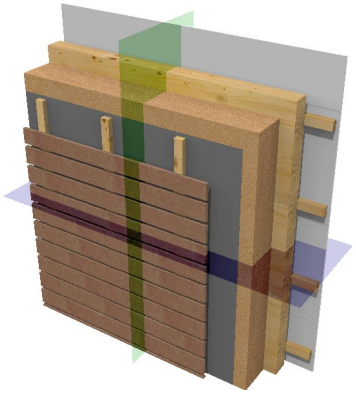
Heat transfer coefficient U = 1/R_{tot} = **0,15 W/(m²K)**



I Domus HBE 100 mm & STEICO 200 , U=0,150 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	19,1	20,0	
1	1,25 cm	Plasterboard (12,5mm)	0,210	0,060	18,8	19,1	9,9
2	3,5 cm	Installation level	0,194	0,180	18,2	18,8	0,0
	3,5 cm	Spruce (11%)	0,130	0,269			1,8
3	10 cm	HBE	0,130	0,769	15,3	18,2	45,0
4	20 cm	STEICOtherm dry	0,037	5,405	-4,8	15,3	22,0
5	0,05 cm	Dörken Delta-Facade black	0,200	0,003	-4,9	-4,8	0,1
		Thermal contact resistance*		0,040	-5,0	-4,9	
6	3 cm	Rear ventilated level (outside air)			-5,0	-5,0	0,0
7	2 cm	Larch			-5,0	-5,0	9,2
	39,8 cm	Whole component		6,685			86,4

*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):	19,1°C	19,1°C	19,1°C
Surface temperature outside (min / average / max):	-4,9°C	-4,9°C	-4,9°C

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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.

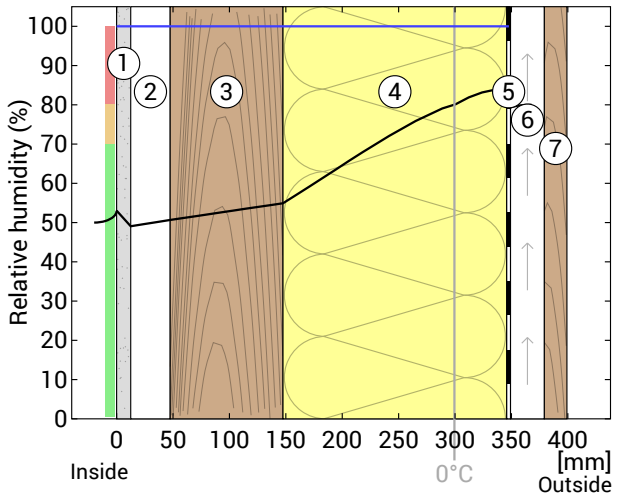
This component is free of condensate under the given climate conditions.

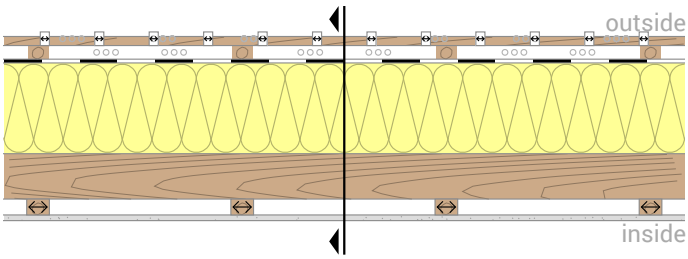
Drying reserve according to DIN 4108-3:2018: 8612 g/(m²a)
At least required by DIN 68800-2: 100 g/(m²a)

#		Material	sd-value [m]	Condensate [kg/m²]	[Gew.-%]	Weight [kg/m²]
1	1,25 cm	Plasterboard (12,5mm)	0,10	-		9,9
2	3,5 cm	Installation level	0,01	-		0,0
	3,5 cm	Spruce (11%)		-	-	1,8
3	10 cm	HBE	0,10	-	-	45,0
4	20 cm	STEICOtherm dry	0,60	-		22,0
5	0,05 cm	Dörken Delta-Facade black	0,02	-		0,1
	39,8 cm	Whole component	0,83			86,4

Humidity

The temperature of the inside surface is 19,1 °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 Plasterboard (12,5 mm)
② Installation level (35 mm)
③ HBE (100 mm)
④ STEICOtherm dry (200 mm)
⑤ Dörken Delta-Facade black
⑥ Rear ventilated level (30 mm)
⑦ Larch (20 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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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]	T [°C]	ps [Pa]	∑sd [m]
		Thermal contact resistance		0,250			19,07	2206	0
1	1,25 cm	Plasterboard (12,5mm)	0,210	0,060	0,1	790	18,85	2176	0,1
2	3,5 cm	Installation level	0,194	0,180	0,01	1	18,18	2086	0,11
3	10 cm	HBE	0,130	0,769	0,1	450	15,31	1739	0,21
4	20 cm	STEICOtherm dry	0,037	5,405	0,6	110	-4,84	407	0,81
5	0,05 cm	Dörken Delta-Facade black	0,200	0,003	0,1	300	-4,85	406	0,91
		Thermal contact resistance		0,040					

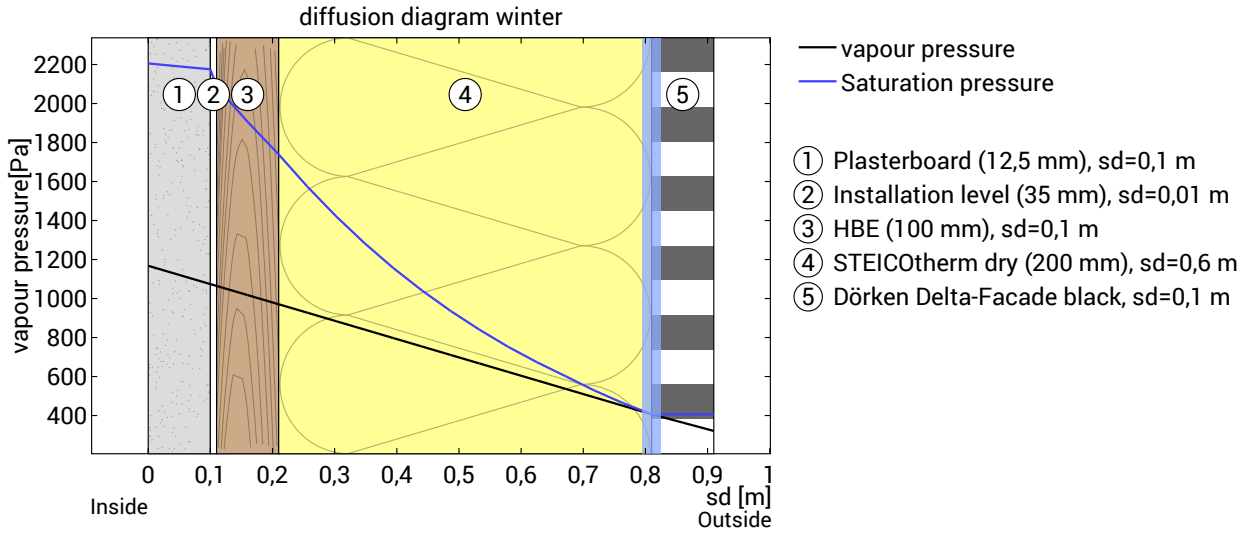
Temperature (T), vapor saturation pressure (ps), and the sum of the sd-values (Σsd) apply to the layer boundary.

Relative air humidity on the surface

The relative humidity on the interior surface is 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 = 0,91 m



Condensation area c_1: Layer boundary between STEICOtherm dry and Dörken Delta-Facade black at sd_{c1}=0,81 m; p_{c1}=407 Pa; x1=34,75 cm

Condensate amount: $Mc = tc * \delta0 * ((p_i-p_{c1})/sd_{c1} - (p_{c1}-p_e)/(sd_e-sd_{c1}))$ = **0,124 kg/m²**

STEICOtherm dry wird als wasseraufnahmefähig eingestuft weil Aw ≥ 0.1 ist.
Für Schicht Dörken Delta-Facade black wurde noch kein Wasseraufnahmekoeffizient hinterlegt. Es wird deshalb angenommen, dass mindestens eine Schicht nicht kapillar wasseraufnahmefähig ist.

The maximum allowed amount of condensation water is at least 0,5 kg/m².
Total amount of condensate: Mc = **0,124 kg/m²**

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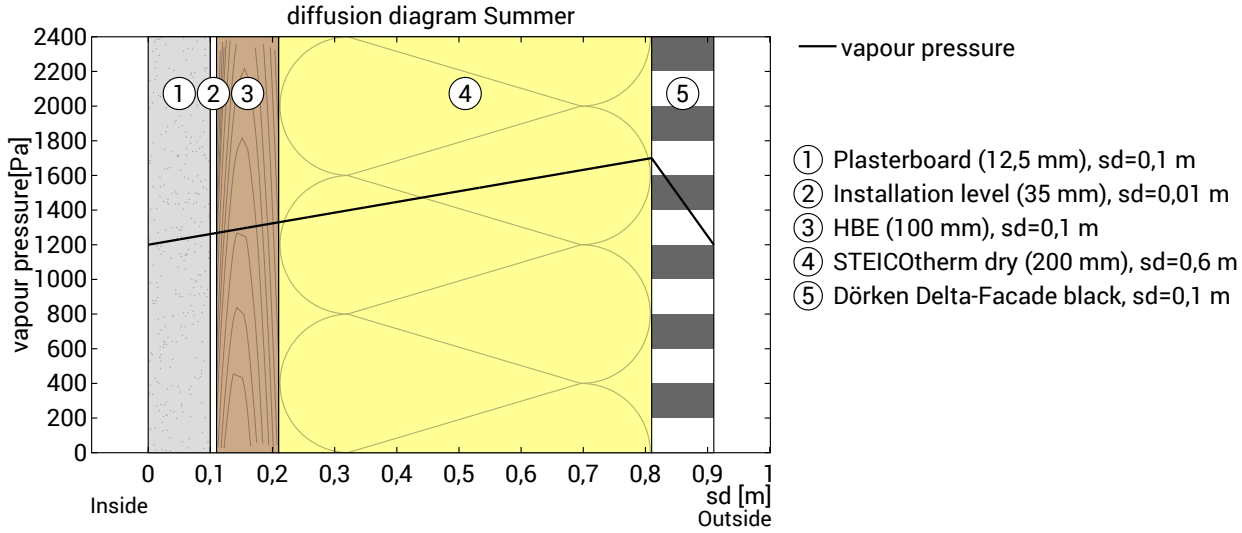
Evaporation period (summer)

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.	



Maximum possible evaporation mass
Mev = tc * δ0 * ((ps-pi)/sd_{c1} + (ps-pe)/(sd_e-sd_{c1})) = **8,736 kg/m²**
The condensation amount of 0,124 kg/m² can dry completely.

Drying reserve (DIN 68800-2)

Drying reserve: Mr = (Mev - Mc) * 1000 = **8612 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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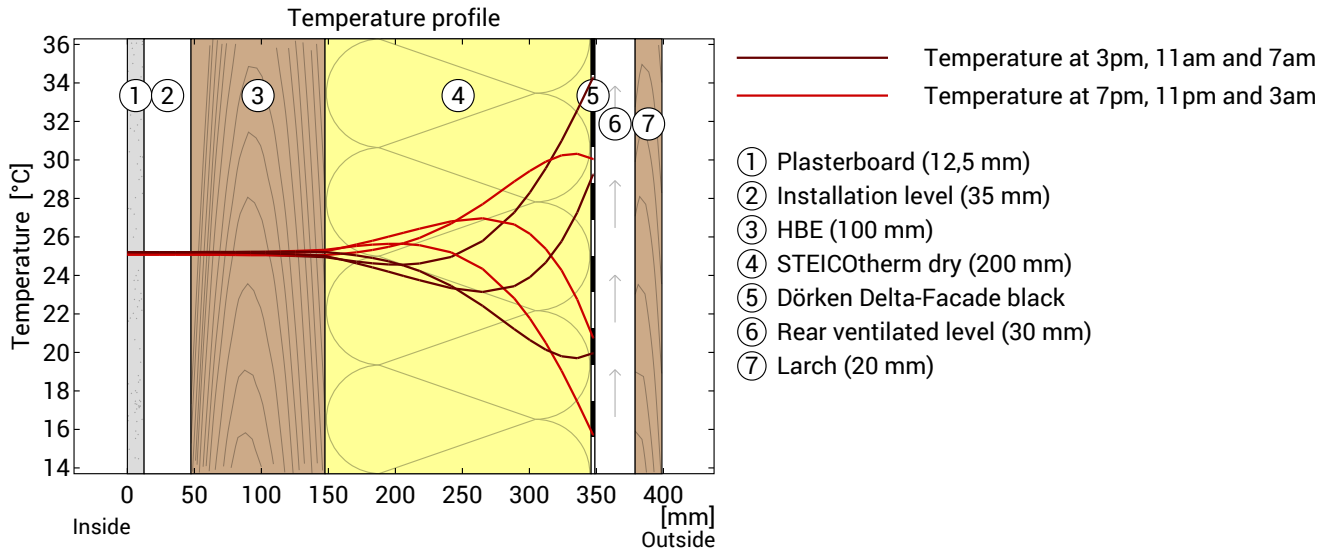
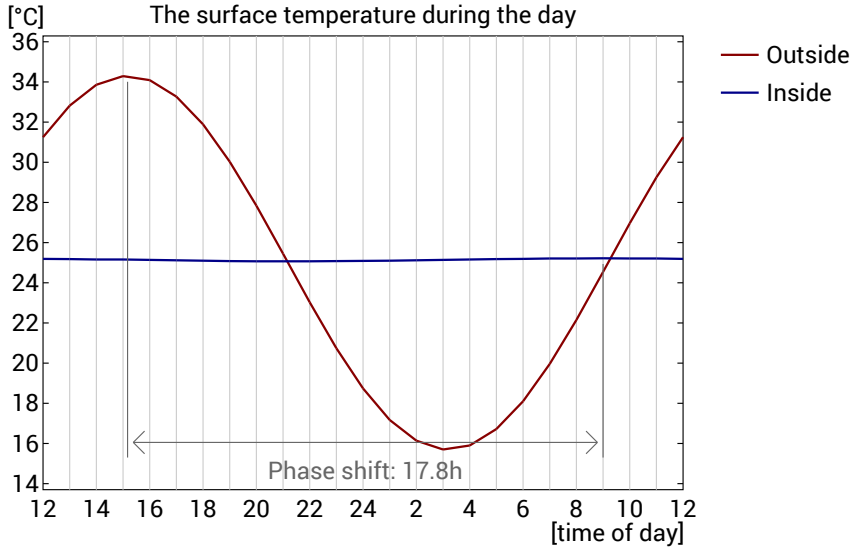
Heat protection

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):	128 kJ/m²K
Amplitude attenuation **	>100	Thermal capacity of inner layers:	93 kJ/m²K
TAV ***	0,008		

* 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.