

Tallinn ,KL-1

Roof construction

Thermal protection

$U = 0,10 \text{ W}/(\text{m}^2\text{K})$

EnEV Bestand*: $U < 0,24 \text{ W}/(\text{m}^2\text{K})$



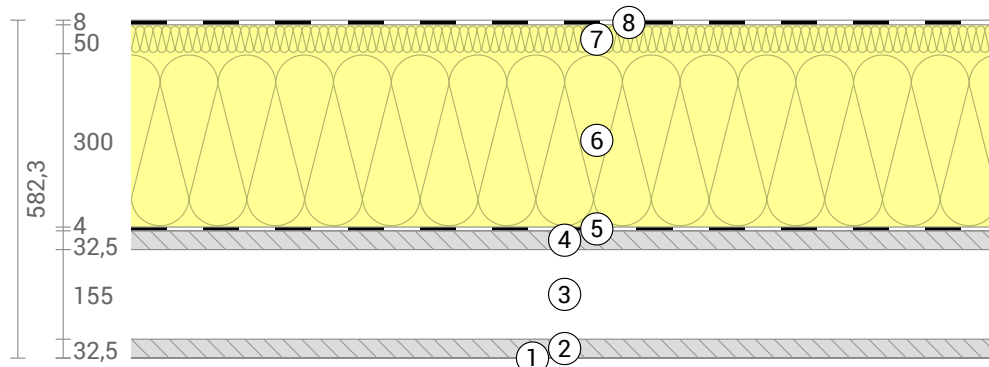
Moisture proofing

Dries 64 days
Condensate: $16 \text{ g}/\text{m}^2$



Heat protection

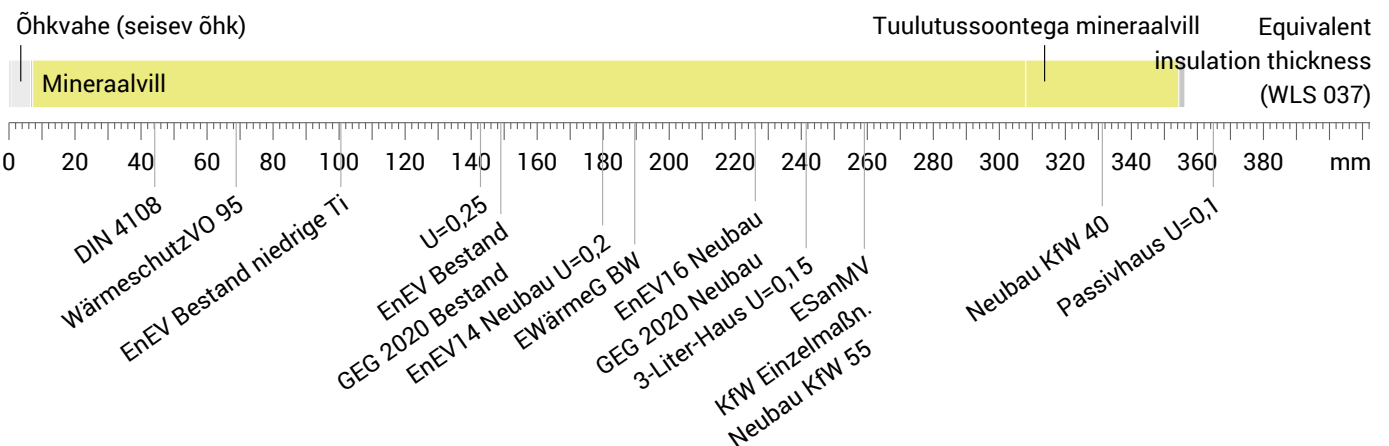
Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: $138 \text{ kJ}/\text{m}^2\text{K}$



- | | |
|---------------------------|---|
| ① Siseviimistlus (0,3 mm) | ⑤ Modifitseeritud bituumerullmaterjal |
| ② Raudbetoon (32,5 mm) | ⑥ Mineraalvill (300 mm) |
| ③ Õhkvahe (155 mm) | ⑦ Tuulutussoontega mineraalvill (50 mm) |
| ④ Raudbetoon (32,5 mm) | ⑧ Modifitseeritud bituumerullmaterjal 2 kihti |

Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity $0,037 \text{ W}/\text{mK}$.



Inside air : $20,0^\circ\text{C} / 50\%$
Outside air: $-10,0^\circ\text{C} / 80\%$
Surface temperature.: $19,7^\circ\text{C} / -9,9^\circ\text{C}$

sd-value: 245,5 m

Thickness: 58,2 cm
Weight: $157 \text{ kg}/\text{m}^2$
Heat capacity: $152 \text{ kJ}/\text{m}^2\text{K}$

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

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	Siseviimistlus	0,03	0,600	0,001
2	Raudbetoon	3,25	2,000	0,016
3	Õhkvahe (seisev õhk)	15,50	0,969	0,160
4	Raudbetoon	3,25	1,300	0,025
5	Modifitseeritud bituumerullmaterjal	0,40	0,230	0,017
6	Mineraalvill	30,00	0,037	8,108
7	Tuulutussoontega mineraalvill	5,00	0,040	1,250
8	Modifitseeritud bituumerullmaterjal 2 kihti	0,80	0,230	0,035
	Thermal contact resistance outside (Rse)			0,040

Thermal contact resistances have been taken from DIN 6946 Table 7.

Rsi: heat flow direction upwards

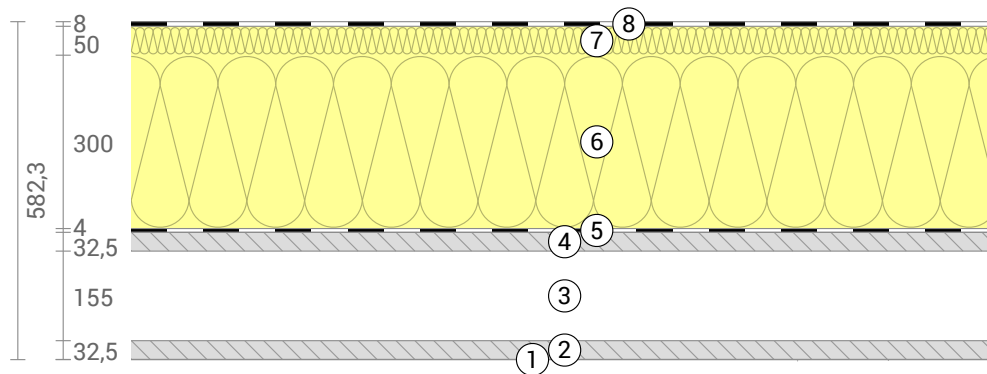
Rse: heat flow direction upwards, outside: Direct contact to outside air

Thermal transfer resistances of resting air layers were calculated as follows:

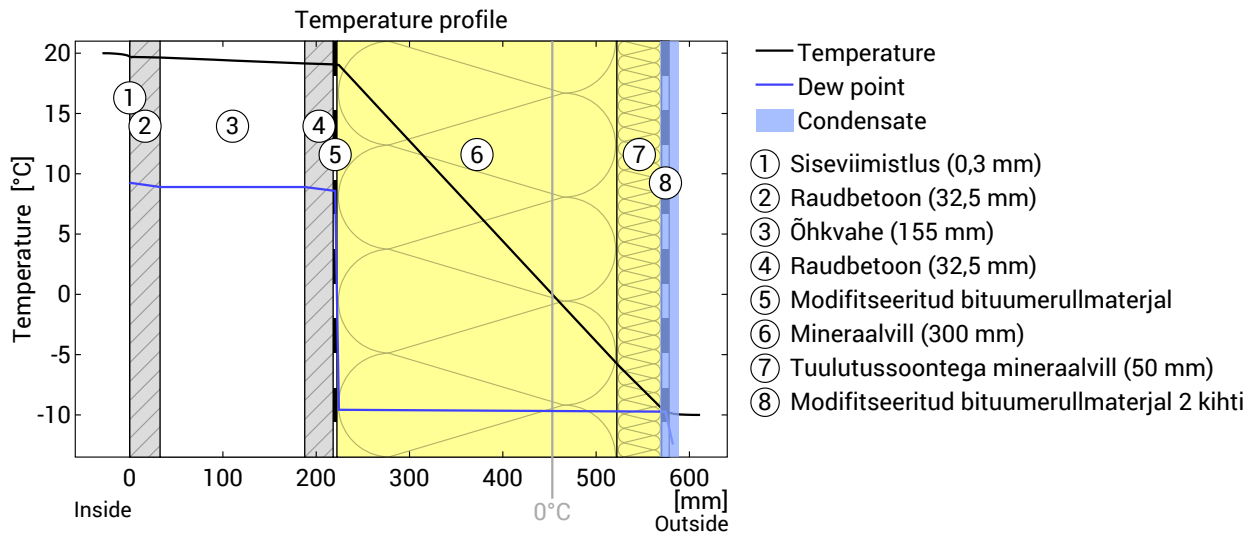
Layer 3: Thickness 15.5 cm, Width ∞ , DIN EN ISO 6946 Table 8, heat flow direction upwards

Thermal resistance $R_{\text{tot}} = 9,752 \text{ m}^2\text{K/W}$

Heat transfer coefficient $U = 1/R_{\text{tot}} = 0,10 \text{ W/(m}^2\text{K)}$



Temperature profile



Temperature and dew-point temperature in the component. 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 temperature, no condensation occurs. If the curves have contact, condensation occurs at the corresponding position.

Layers (from inside to outside)

#	Material	λ [W/mK]	R [m ² K/W]	Temperatur [°C]		Weight [kg/m ²]
				min	max	
	Thermal contact resistance*		0,100	19,7	20,0	
1	0,03 cm Siseviimistlus	0,600	0,001	19,7	19,7	0,4
2	3,25 cm Raudbetoon	2,000	0,016	19,6	19,7	78,0
3	15,5 cm Õhkvahe (seisev õhk)	0,969	0,160	19,1	19,6	0,2
4	3,25 cm Raudbetoon	1,300	0,025	19,1	19,1	58,5
5	0,4 cm Modifitseeritud bituumerullmaterjal	0,230	0,017	19,0	19,1	4,4
6	30 cm Mineraalvill	0,037	8,108	-5,9	19,0	6,0
7	5 cm Tuulutussoontega mineraalvill	0,040	1,250	-9,8	-5,9	1,0
8	0,8 cm Modifitseeritud bituumerullmaterjal 2 kihti	0,230	0,035	-9,9	-9,8	8,8
	Thermal contact resistance*		0,040	-10,0	-9,9	
	58,23 cm Whole component		9,752			157,3

*Assuming free circulating air at the inside surface.

Surface temperature inside (min / average / max): 19,7°C 19,7°C 19,7°C
 Surface temperature outside (min / average / max): -9,9°C -9,9°C -9,9°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: -10°C und 80% Humidity (Climate according to user input).

Under these conditions, a total of 0,016 kg of condensation water per square meter is accumulated. This quantity dries in summer in 64 days (Drying season according to DIN 4108-3:2018-10).

#	Material	sd-value [m]	Condensate [kg/m²] [Gew.-%]	Weight [kg/m²]
1	0,03 cm Siseviimistlus	0,27	-	0,4
2	3,25 cm Raudbetoon	2,60	-	78,0
3	15,5 cm Õhkvahe (seisev õhk)	0,01	~0	0,2
4	3,25 cm Raudbetoon	2,28	~0	58,5
5	0,4 cm Modifitseeritud bituumerullmaterjal	80,00	-	4,4
6	30 cm Mineraalvill	0,30	-	6,0
7	5 cm Tuulutussoontega mineraalvill	0,05	0,016	1,0
8	0,8 cm Modifitseeritud bituumerullmaterjal 2 kihti	160,00	-	8,8
58,23 cm Whole component		245,50	0,016	157,3

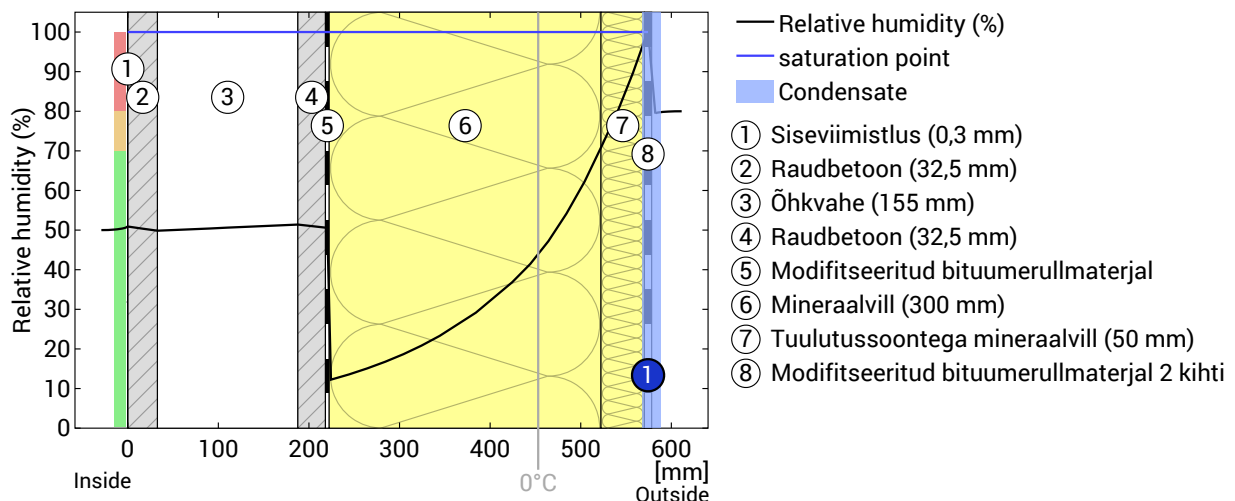
Condensation areas

- ① Condensate: 0,016 kg/m² Affected layers: Modifitseeritud bituumerullmaterjal 2 kihti, Tuulutussoontega mineraalvill

Humidity

The temperature of the inside surface is 19,7 °C leading to a relative humidity on the surface of 51%.Mould formation is not expected under these conditions.

The following figure shows the relative humidity inside the component.



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.