Certification report | Zertifizierungsbericht

Passive House Institute

Building system
Wandsystem

for cold climate

für kaltes Klima

Product I Produkt:	**VARIANT-HAUS**
Client I Auftraggeber:	**VARIANT-HAUS-GROUP GmbH**
Construction | Konstruktion:	**Insulated formwork blocks | Betonschalungsstein**
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Date I Datum: Author I Autor:	**31.01.2019** **M. Arch. Edward Lowes**

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1 Introduction | *Einleitung*

Because a separate heating system is not necessarily required in Passive Houses, high demands are placed on the quality of the building components used. The colder the climate, the higher the requirements for the components. To cover this, PHI has identified regions of similar requirements, and defined certification criteria. These criteria are available for free download at the website of the Passive House Institute.

If the below summarized requirements are met and a well-designed airtightness layer is proven, the label "Certified Passive House Component" can be awarded by the Passive House Institute (PHI)

Passivhäuser stellen aufgrund der Möglichkeit, auf ein separates Heizsystem zu verzichten, hohe Anforderungen an die Qualität der verwendeten Bauteile. Dabei steigen die Anforderungen, je kälter das Klima ist. Darum hat das Passivhaus Institut Regionen gleicher Anforderung identifiziert und für diese Zertifizierungskriterien festgelegt. Die Kriterien sind auf der Homepage des Passivhaus Instituts als kostenfreier Download verfügbar.

Werden die unten zusammengefassten Anforderungen erreicht und ist eine gut geplante luftdichte Ebene nachgewiesen, kann ein Produkt als "Zertifizierte Passivhaus Komponente“ ausgezeichnet werden.

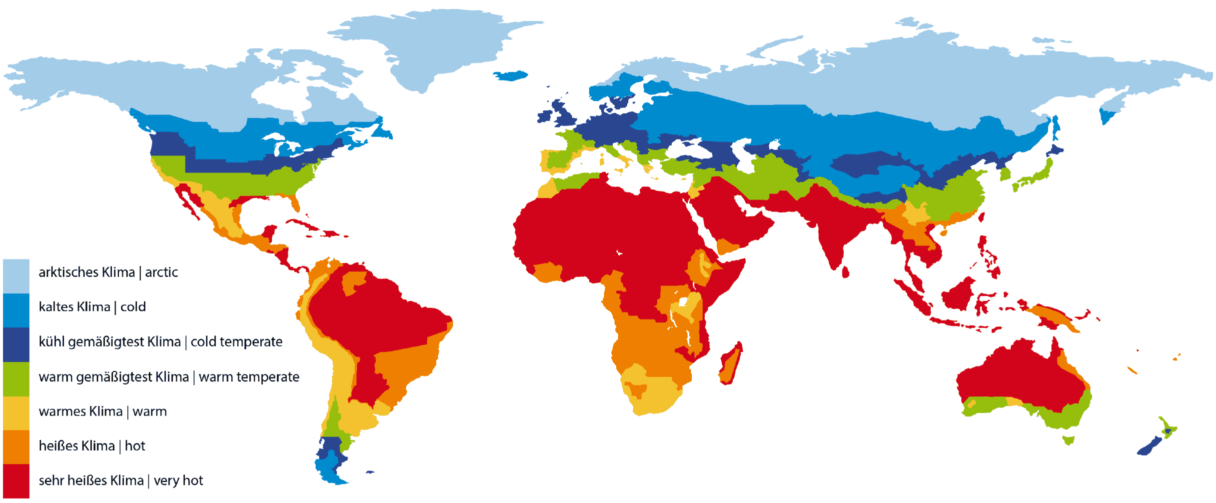
Table 1: Adequate certification criteria

Climate zone	**Hygiene criterion**	**Comfort criterion**	**Efficiency criteria**		
	$f_{Rsi=0.25\ m^2K/W} \geq$ [3]	U-value of the installed window[1] ≤	U-value opaque to ambient $U_{opaque} * f_{PHI}^{2} \leq$	Purely opaque details $f_{Rsi=0.25\ m^2K/W} \geq$	Absence of thermal bridges $\Psi_a \leq$[4]
	[-]	[W/(m²K)]	[W/(m²K)]	[-]	[W/(mK)]
1 Arctic	0.80	0.45 (0.35)	0.09	0.90	0.01
2 Cold	0.75	0.65 (0.52)	0.12	0.88	
3 Cool, temperate	0.70	0.85 (0.70)	0.15	0.86	
4 Warm,temperate	0.65	1.05 (0.90)	0.25	0.82	

1 applies for vertical windows with a test size of 1.23*1.48 m. The criteria for other transparent building com-ponents can be taken from the relevant certification criteria. Value in brackets: respective reference glazing.

2 $f_{R,\ PHI}$: Reduction factor: always 1, exception: areas in contact with the ground and towards the unheated basement: 0.6

4 as a thermal bridge loss coefficient based on external dimensions and length. Specific constructions such as inner edges are exempted from this criterion.



2 Description of the certified system | *Systembeschreibung*

2.1 Opaque building envelop | *Opake Gebäudehülle*

Variant Haus is a concrete formwork wall system. The external walls are insulated with 250 + 50mm EPS (BASF Neopor, 0,032 W/mK), the flat roof with 220mm of mineral wool (or similar with 0,040 W/mK) and the floor slab with a proprietary insulation system comprising Styrodur (0,038 W/mK) from Lohr (ISOLOHR Passivhaus Bodenplatte, Komponenten-ID 0376fs03). The system has been evaluated according to the thermal performance criteria set out by the Passive House Institute for the cold climate and, although the intermediate floor connection does not meet the efficiency criteria, the system has been validated as suitable for passive houses in the cold and cool-temperate climate zones.

Variant Haus ist ein Betonschalungsstein-Wandsystem. Die Außenwände sind mit 250 + 50 mm EPS (BASF Neopor, 0,032 W/mK) gedämmt, das Flachdach mit 220 mm Mineralwolle (oder Ähnliches mit 0,040 W/mK) und 105 mm Polyurethan (0,027 W/mK) und die Bodenplatte mit einem Bodenplatten-Dämmsystem aus Styrodur (0,038 W/mK) von der Firma Lohr (ISOLOHR Passivhaus Bodenplatte, Komponenten-ID 0376fs03). Das System wurde vom Passivhaus Institut nach den thermischen Leistungskriterien für die kalte Klimazone bewertet und obwohl der Deckeneinbindung-Anschluss erreicht das Effizienz-Kriterium nicht, gilt das System für die kalte und kühl-gemäßigte Klimazonen als geeignet..

2.2 Windows | *Fenster*

Analysis was undertaken using a generic, passive house standard timber-framed, triple-glazed window unit, featuring phA thermal values for the spacer and a polysulfide secondary seal. The calculations undertaken demonstrate that the window installation locations are suited to the cold climate zone, with no risk of surface condensation and subsequent mould growth.

Die Zertifizierung wurde mit einem Standard-Passivhaus Holzfensterrahmen durchgeführt. Für den Abstandhalter wurden die phA thermischen Werte angenommen, mit Sekundärdichtung aus Polysulfid. Die Berechnungen zeigen, dass den Fensteranschlussdetails für kalte Klimazonen geeignet sind, mit kein Oberflächenkondens- oder Schimmelrisiko.

2.3 Airtightness concept | *Luftdichtheitskonzept*

The interior plaster works as the airtightness layer of the interior walls. In the roof a membrane provides the airtightness layer, which is connected to the plaster via airtightness tapes. The windows are connected in the same way. In the bottom, the concrete floor slab serves as airtightness layer.

Der Innenputz bildet die Luftdichte Ebene der Wände. Die Stöße der Wandsteine/-elemente werden verklebt. Die Verbindung zu der Folie, welche die luftdichte Ebene des Daches darstellt, erfolgt mit überputzbarem Klebeband. Die Fenster werden über geeignete Kompribänder an die luftdichte Ebene der Wände angeschlossen.

3 Evaluation | *Bewertung*

The examined building system with the indicated details meets the PHI criteria for Certified Passive House Components.

Das untersuchte Bausystem entspricht den Anforderungen an eine Zertifizierte Passivhaus Komponente.

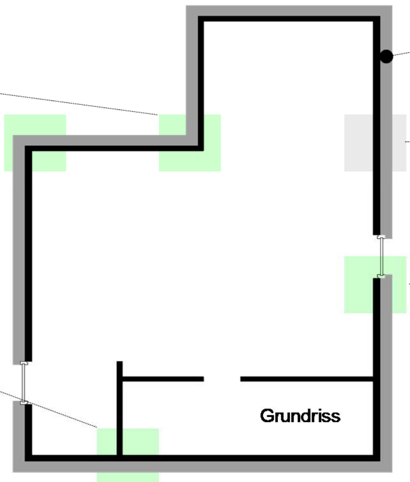
4 Summary of the results | *Zusammenfassung der Ergebnisse*

Wärmebrücke nicht berechnet
Kriterien erfüllt
Effizienzkriterium nicht erfüllt
Hygiene- oder Komfortkriterium nicht erfüllt

EWIC01	
Außenw.-Innenecke	
Ψ [W/mK]	0,025
$f_{Rsi=0,25\ m^2K/W}$	0,98

EWEC01	
Außenw.-Außenecke	
Ψ [W/mK]	-0,052
$f_{Rsi=0,25\ m^2K/W}$	0,95

EWIW01	
Außenw.-Innenw.	
Ψ [W/mK]	0,009
$f_{Rsi=0,25\ m^2K/W}$	0,97



EW01	Außenwand
U [W/(m²K)]	0,10
Dicke [m]	0,475

EWEJ01	
Außenw. Elementstoß	
Ψ [W/(mK)]	
$f_{Rsi=0,25\ m^2K/W}$	

WISI			Fenster Seite
Typ	01	02	03
b_f [m]	0,1		
U_f [W/m²K]	0,56		
Ψ_g [W/mK]	0,021		
Ψ_i [W/mK]	0,003		
$f_{Rsi=0,25\ m^2K/W}$	0,84		

ROVE01	
Ortgang	
Ψ [W/mK]	
$f_{Rsi=0,25\ m^2K/W}$	

ROIW01	
Dach-Innenwand	
Ψ [W/mK]	
$f_{Rsi=0,25\ m^2K/W}$	

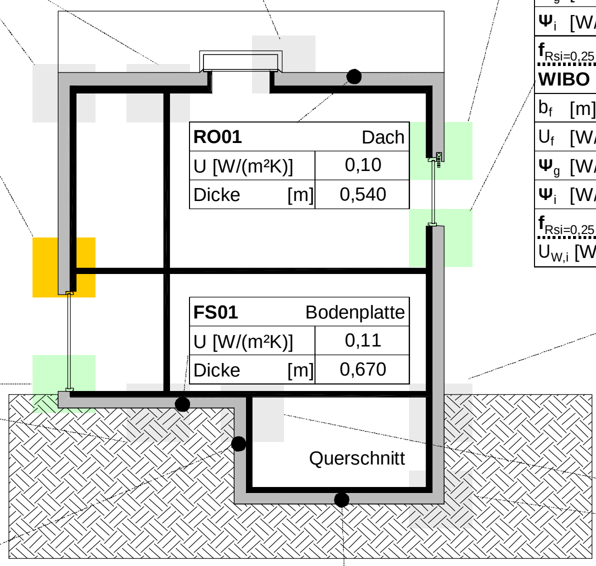
RWSI01	
Dachfenster Seite	
Ψ [W/mK]	
$f_{Rsi=0,25\ m^2K/W}$	

EWCE01	
Deckeneinbindung	
Ψ [W/mK]	0,015
$f_{Rsi=0,25\ m^2K/W}$	0,95

WITH01	
Fenster Schwelle	
b_f [m]	0,100
U_f [W/m²K]	0,97
Ψ_e [W/mK]	0,024
Ψ_i [W/mK]	0,063
$f_{Rsi=0,25\ m^2K/W}$	0,77
$U_{w,i}$ [W/m²K]	0,62

FSIW01	
Bodenpl-IW	
Ψ [W/mK]	
$f_{Rsi=0,25\ m^2K/W}$	

BW01	Kellerwand
U [W/(m²K)]	
Dicke [m]	



RO01	Dach
U [W/(m²K)]	0,10
Dicke [m]	0,540

FS01	Bodenplatte
U [W/(m²K)]	0,11
Dicke [m]	0,670

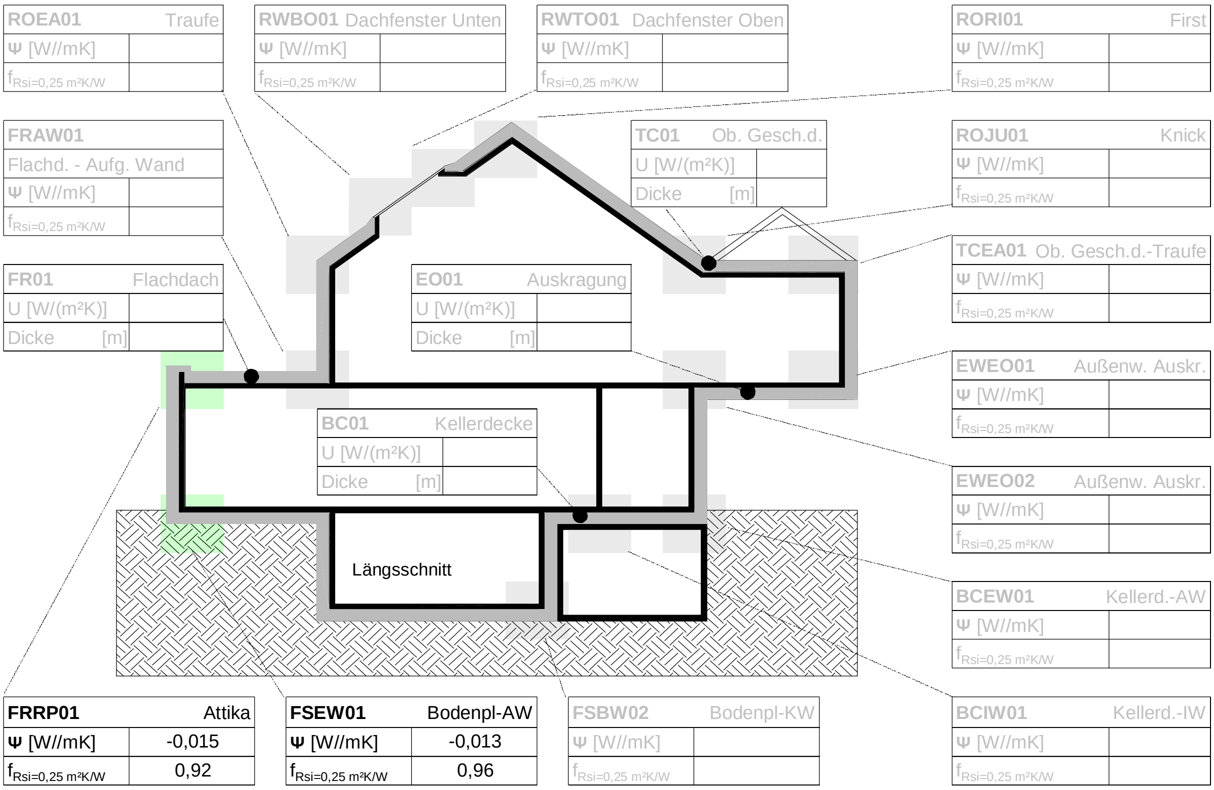
FS02 Bodenplatte	U [W/(m²K)]		Dicke [m]	

WITO			Fenster Oben
Typ	01	02	03
b_f [m]	0,1		
U_f [W/m²K]	0,56		
Ψ_g [W/mK]	0,021		
Ψ_i [W/mK]	0,005		
$f_{Rsi=0,25\ m^2K/W}$	0,84		
WIBO			**Fenster Unten**
b_f [m]	0,1		
U_f [W/m²K]	0,74		
Ψ_g [W/mK]	0,020		
Ψ_i [W/mK]	0,054		
$f_{Rsi=0,25\ m^2K/W}$	0,81		
$U_{w,i}$ [W/m²K]	0,64		

BWBC01	Kellerw.-Kellerd.
Ψ [W/mK]	
$f_{Rsi=0,25\ m^2K/W}$	

BWFS01	Kellerw.-Bodenpl.
Ψ [W/mK]	
$f_{Rsi=0,25\ m^2K/W}$	

FSBW01	Bodenpl-KW
Ψ [W/mK]	
$f_{Rsi=0,25\ m^2K/W}$	



5 Using the results in the PHPP | *Verwendung der Ergebnisse im PHPP*

The following points are relevant for working with the here presented results in the Passive House Planning Package (PHPP):

- For the system being certified here, the thermal bridges in the regular construction of the buildings shell resulting from regularly occurring interruptions are already included in the U-values by using equivalent thermal conductivities for the materials of the interrupted layers. They do not have to be considered further.
- The results of the calculation of the linear thermal transmittance are always determined based on the external dimensions.
- Additional point thermal bridges may have to be taken into account.

Die folgenden Punkte sind für die Arbeit mit den hier zusammengefassten Ergebnissen im Passivhaus Projektierungs-Paket (PHPP:

- *Die im regulären Aufbau der Bauteile vorkommenden Wärmebrücken ist über äquivalente Wärmeleitfähigkeiten der betreffenden Bauteilschichten bereits in den U-Werten der Konstruktionen erfasst und müssen nicht weiter berücksichtigt werden.*
- *Alle linearen Wärmebrücken gelten für den Außenmaßbezug.*
- *Zusätzliche punktförmige Wärmebrücken sind zu berücksichtigen.*

6 Legal information | Rechtliche Hinweise

The following information should be kept in mind when planning and executing the detail solutions documented in this report:

The detail drawings in this documentation are schematic and might be adapted for specific constructions. Sealing of the construction against moisture and the absence of condensation as well as the check of hygrothermal matters was not the subject of this examination. Where necessary, this should be carried out in accordance with the accepted technical standards. The responsibility for checking the above mentioned points lies with the applicant for the certification procedure and/or the user.

The present documentation does not allow conclusions to be drawn regarding other characteristics of the examined construction that may determine its performance and quality. In particular, this documentation is not a substitute for building authority approval.

The scope of the examination and accountability of the certification is limited to the testing routines with regard to compliance with the stated criteria of the Passive House Institute. A legal basis for making any claims against the Passive House Institute Darmstadt Dr. Wolfgang Feist based on the information provided in this report is excluded.

Die folgenden Informationen sind bei der Planung und Ausführung der in diesem Bericht gezeigten Details zu beachten:

Die Detailzeichnungen in diesem Bericht sind schematisch und beispielhaft. Sie müssen evtl. auf die Spezifika auszuführender Gebäude angepasst werden. Hygrothermische Aspekte wurden im Rahmen dieser Zertifizierung nicht betrachtet. Wo nötig sollten diese Betrachtungen entsprechend den gültigen Regeln der Technik vorgenommen werden. Die Verantwortung der Umsetzung oben genannter Punkte obliegt dem Hersteller oder Anwender des Bausystems.

Die vorliegende Dokumentation erlaubt keine Rückschlüsse auf andere, als die überprüften Punkte. Sie stellt insbesondere keinen Ersatz für einen Bauaufsichtliche Zulassung dar.

Aus der Zertifizierung oder diesem Bericht und den darin veröffentlichten Informationen können keine Ansprüche gegen das Passivhaus Institut Darmstadt Dr. Wolfgang Feist abgeleitet werden.

Appendix 1: U-value of building assemblies

VARIANT-HAUS-GROUP ICF Manufacturing & Sales GmbH: VARIANT HAUS ID: 1352cs02 for cold climate

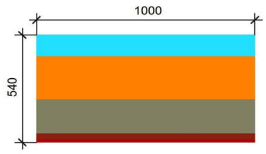
Acronym	Building assembly description	Interior insulation?
RO01	Flat roof	

Heat transmission resistance [m²K/W]

Orientation of building element: 1-Roof | Adjacent to: 1-Outdoor air | interior R_{si}: 0,10 | exterior R_{se}: 0,04

U-value determined by thermal simulation (see appendix 2)

length of model [m]	Δθ [K]	thermal flux [W/m]	U-value [W/(m²K)]
1,000	30	3,1006	0,103



U-value determined according to PHPP

Material of Layer	λ [W/(mK)]	Description	Thickness [mm]
Polyurethane foam	0,027	Or similar with equal or lower lambda value	105
Mineral wool	0,040	Or similar with equal or lower lambda value	220
Concrete 1 % steel	2,300	According to EN ISO 10456 (2007/2009)	170
Organic compound plaster	0,700	According to DIN 4108-4 (2012)	30
Interior plaster	0,570	According to EN ISO 10456 (2007/2009)	15
		Total	54,0 cm

U-value supplement: W/(m²K)

U-value: 0,103 W/(m²K)

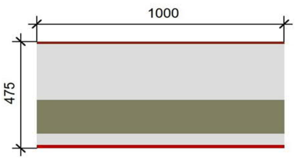
Acronym	Building assembly description	Interior insulation?
EW01	External wall	

Heat transmission resistance [m²K/W]

Orientation of building element: 2-Wall | Adjacent to: 1-Outdoor air | interior R_{si}: 0,13 | exterior R_{se}: 0,04

U-value determined by thermal simulation (see appendix 2)

length of model [m]	Δθ [K]	thermal flux [W/m]	U-value [W/(m²K)]
1,000	30	3,1085	0,104



U-value determined according to PHPP

Material of Layer	λ [W/(mK)]	Description	Thickness [mm]
Exterior plaster	0,700	According to DIN 4108-4 (2012)	10,0
BASF Neopor 032	0,032	Rated value according to PMFN1311FE	250,0
Concrete 1 % steel	2,300	According to EN ISO 10456 (2007/2009)	150
BASF Neopor 032	0,032	Rated value according to PMFN1311FE	50,0
Interior plaster	0,570	According to EN ISO 10456 (2007/2009)	15
		Total	47,5 cm

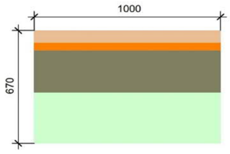
U-value supplement: W/(m²K)

U-value: 0,104 W/(m²K)

Acronym	Building assembly description	Interior insulation?
FS01	**Floor slab**	

Heat transmission resistance [m²K/W]

Orientation of building element	Adjacent to	interior R_{si}	exterior R_{se}
3-Ground	2-Ground	0,17	0,00



U-value determined by thermal simulation (see appendix 2)

length of model [m]	Δθ [K]	thermal flux [W/m]	U-value [W/(m²K)]
1,000	30	3,16675	**0,106**

U-value determined according to PHPP

Material of Layer	λ [W/(mK)]	Description	Thickness [mm]
Cement screed	1,400	According to DIN 4108-4 (2012)	70
Sound insulation	0,040	Or similar with equal or lower lambda value	50
Concrete 1 % steel	2,300	According to EN ISO 10456 (2007/2009)	250
Styrodur 3035 CS	0,038	According to PHI Component ID 0376fs03	300
		Total	**67,0** cm

100%

U-value supplement W/(m²K)

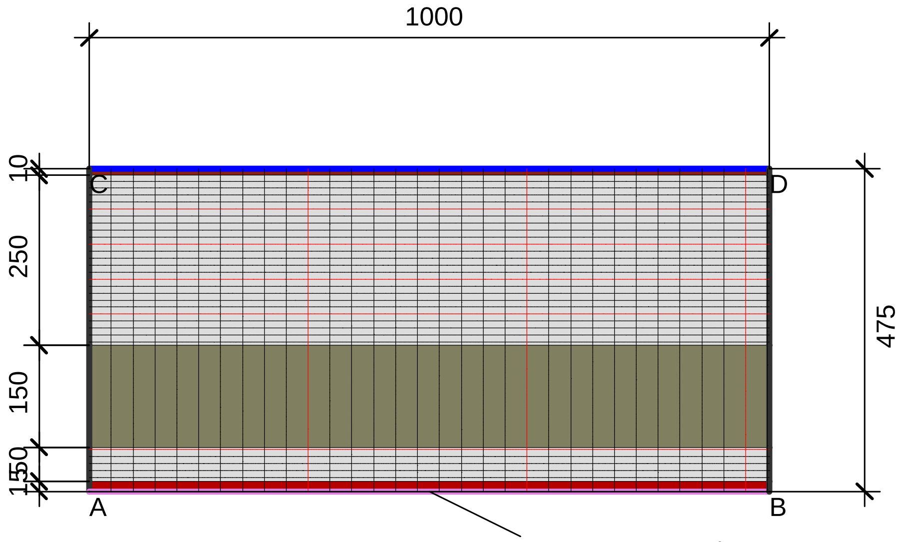
U-value: 0,106 W/(m²K)

Appendix 2: Thermal simulations | Wärmestromsimulationen

Passive House Institute

Wall and roof | Wand und Dach
Constructions to ground | Erdberührte Bauteile
Windows | Fenster

Wall and roof | Wand und Dach

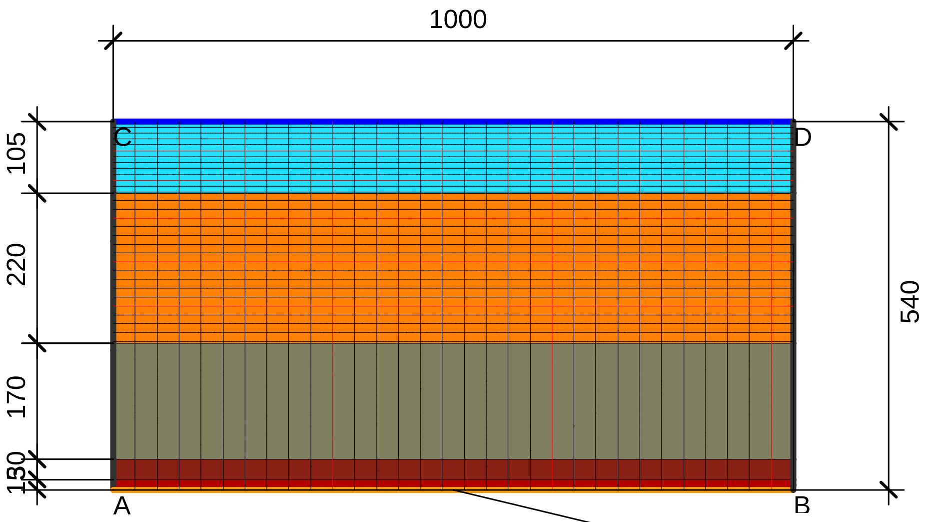


$\Phi_{A\text{-}B}$ = 3,10854 W/m

$$U_{eq\,A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3{,}109}{30{,}000 \cdot 1{,}000} = 0{,}104\ W/(m^2 \cdot K)$$

Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Exterior plaster I Kunstharzputz 4108-4	0,700
Interior plaster I Gipsputz 10456	0,570

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Interior | Innen		20,000	0,130

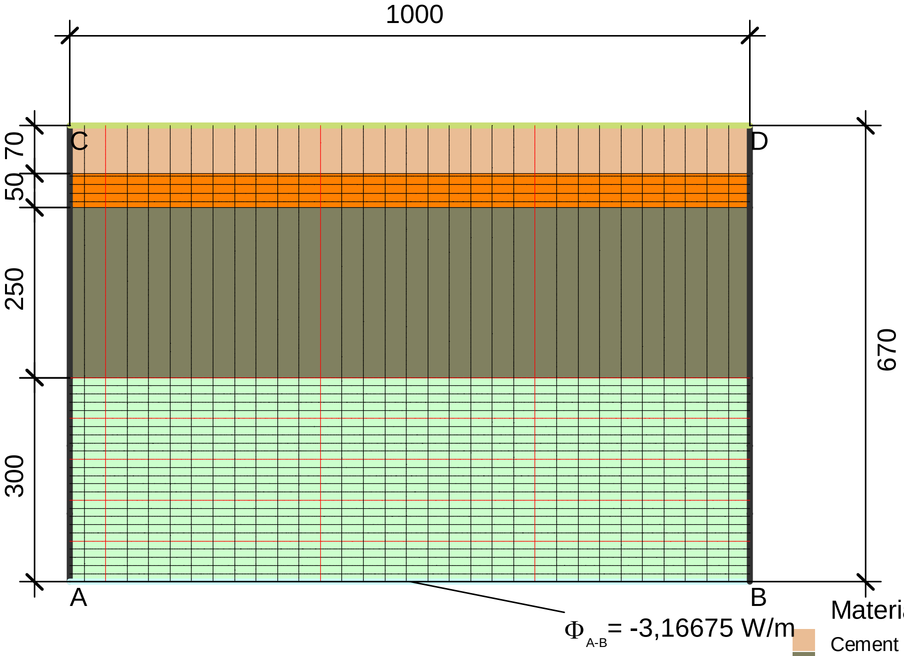


$\Phi_{A\text{-}B}$ = 3,10056

$$U_{eq\,A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3{,}101}{30{,}000 \cdot 1{,}000} = 0{,}103\ W/(m^2 \cdot K)$$

Material	λ[W/(m·K)]
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Insulation I Wärmedämmung 040	0,040
Interior plaster I Gipsputz 10456	0,570
Organic compound plaster I Kunstharzputz 4108-4	0,700
PU foam I PU-Schaum 027	0,027

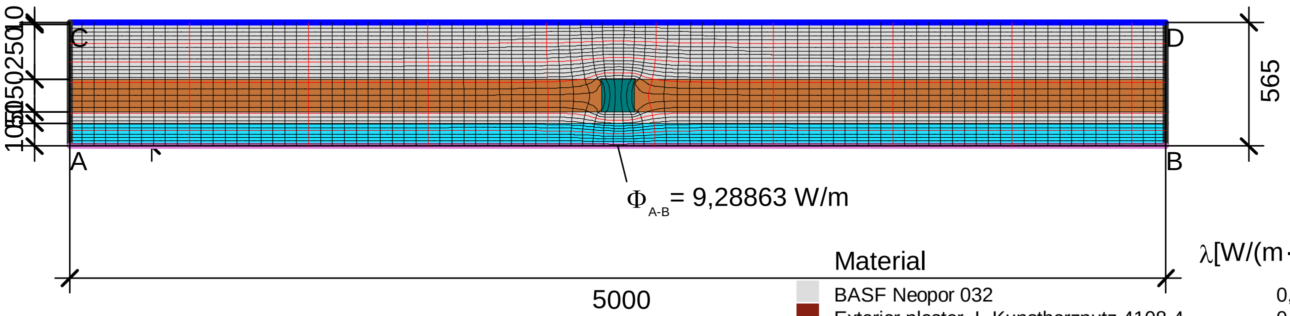
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Interior up. | Innen auf.		20,000	0,100



$$U_{eq\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3,167}{30,000 \cdot 1,000} = 0,106\ W/(m^2 \cdot K)$$

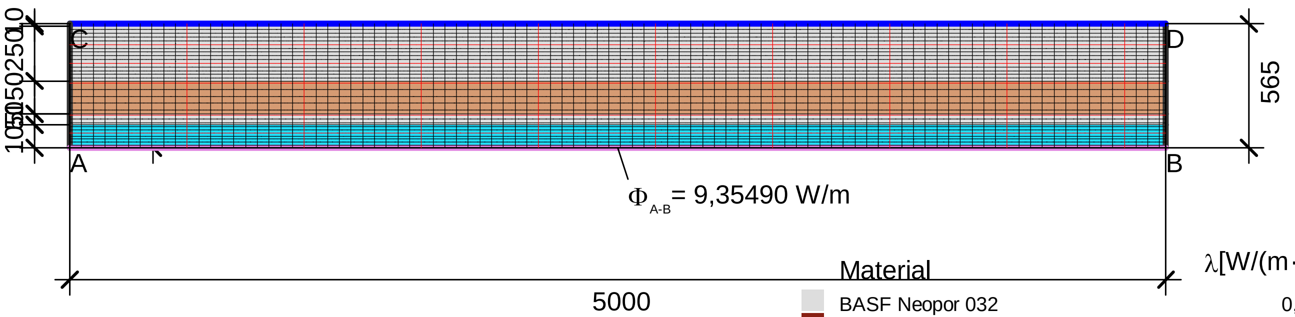
Material	λ[W/(m·K)]
Cement screed I Zement-Estrich 4108	1,400
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Sound insulation I Trittschalldämmung 040	0,040
Styrodur 3035 CS	0,038

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Gorund I Erdreich		-10,000	
Int. flux down I Innen abwärts		20,000	0,170



$$U_{eq\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{9,289}{30,000 \cdot 5,000} = 0,062\ W/(m^2 \cdot K)$$

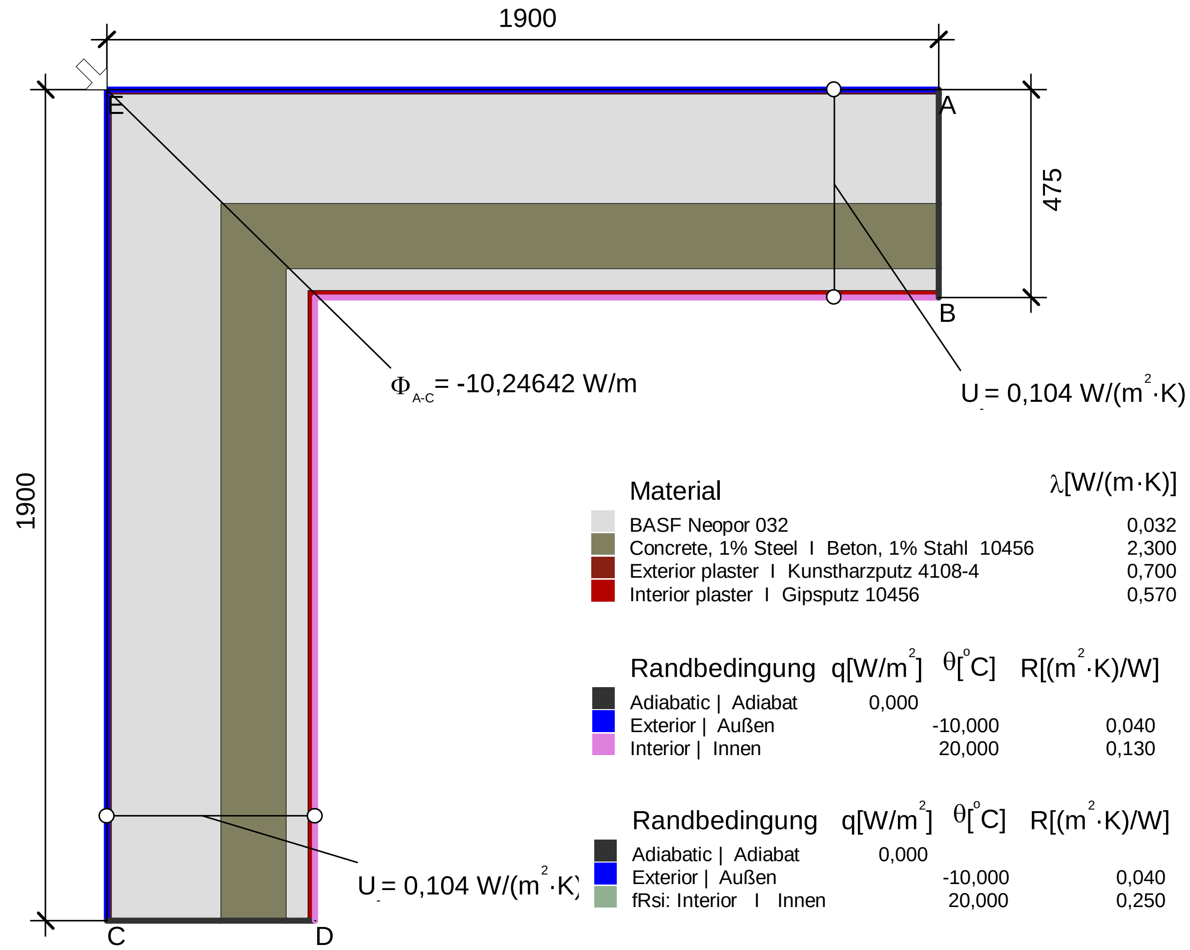
Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Exterior plaster I Kunstharzputz 4108-4	0,700
FOAMGLAS F	0,052
PU foam I PU-Schaum 027	0,027
Steel I Stahl	50,000



$$U_{eq\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{9,355}{30,000 \cdot 5,000} = 0,062\ W/(m^2 \cdot K)$$

Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Exterior plaster I Kunstharzputz 4108-4	0,700
FOAMGLAS+Stahl_Äq	0,058
PU foam I PU-Schaum 027	0,027

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Interior | Innen		20,000	0,130

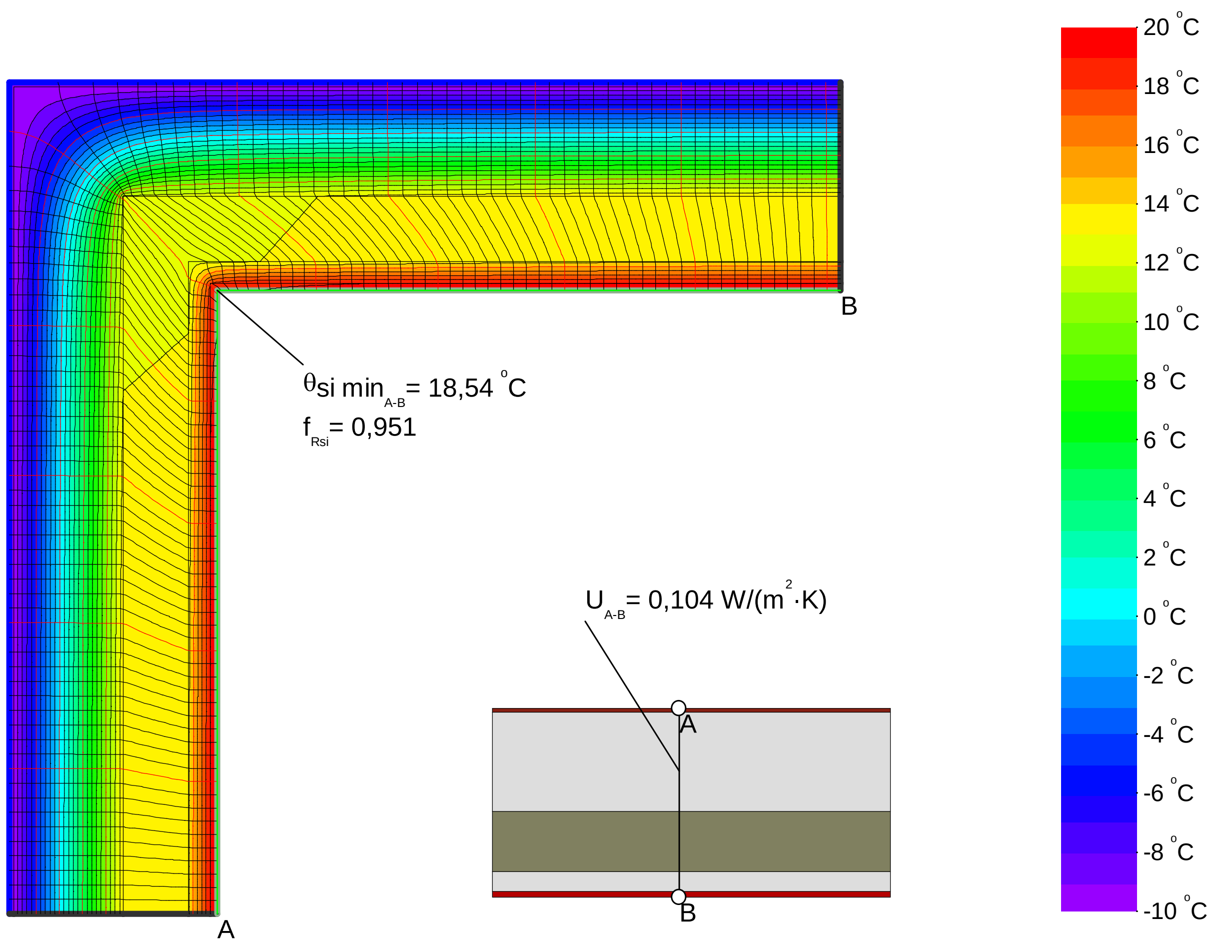


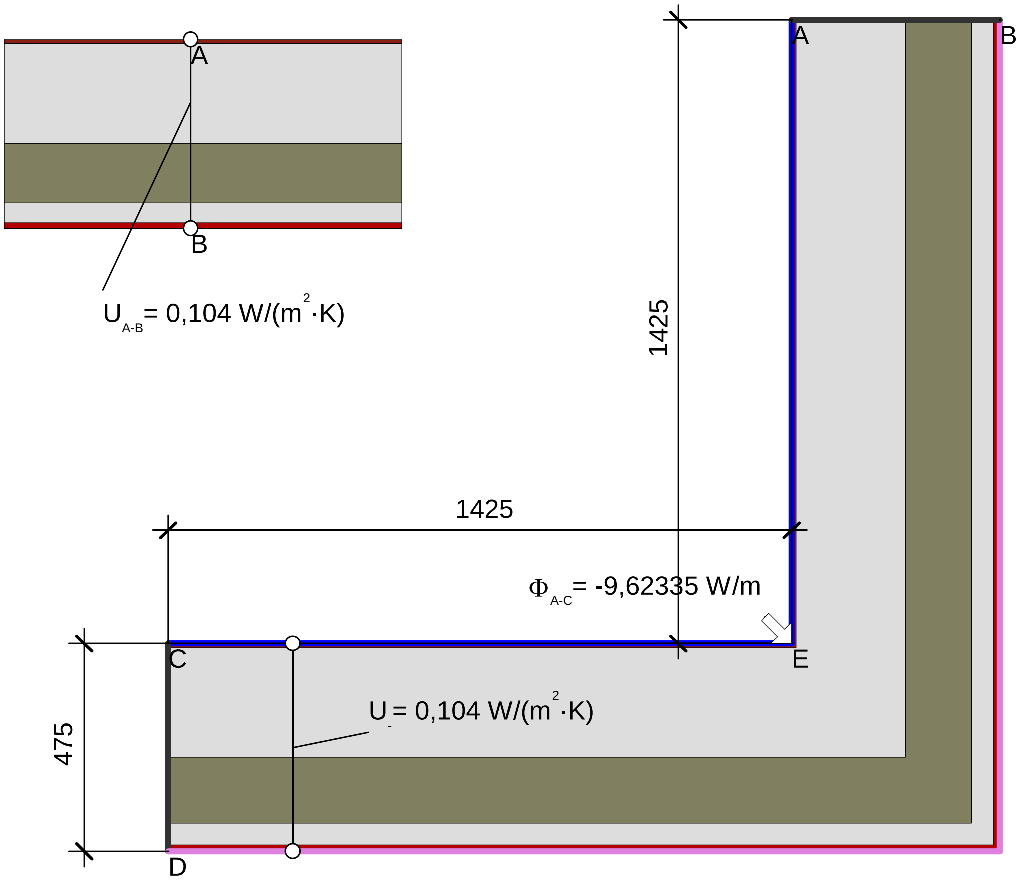
Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Exterior plaster I Kunstharzputz 4108-4	0,700
Interior plaster I Gipsputz 10456	0,570

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Interior | Innen		20,000	0,130

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
fRsi: Interior I Innen		20,000	0,250

$$\psi_{A-E-C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{10,246}{30,000} - 0,104 \cdot 1,900 - 0,104 \cdot 1,900 = -0,052 \text{ W/(m·K)}$$



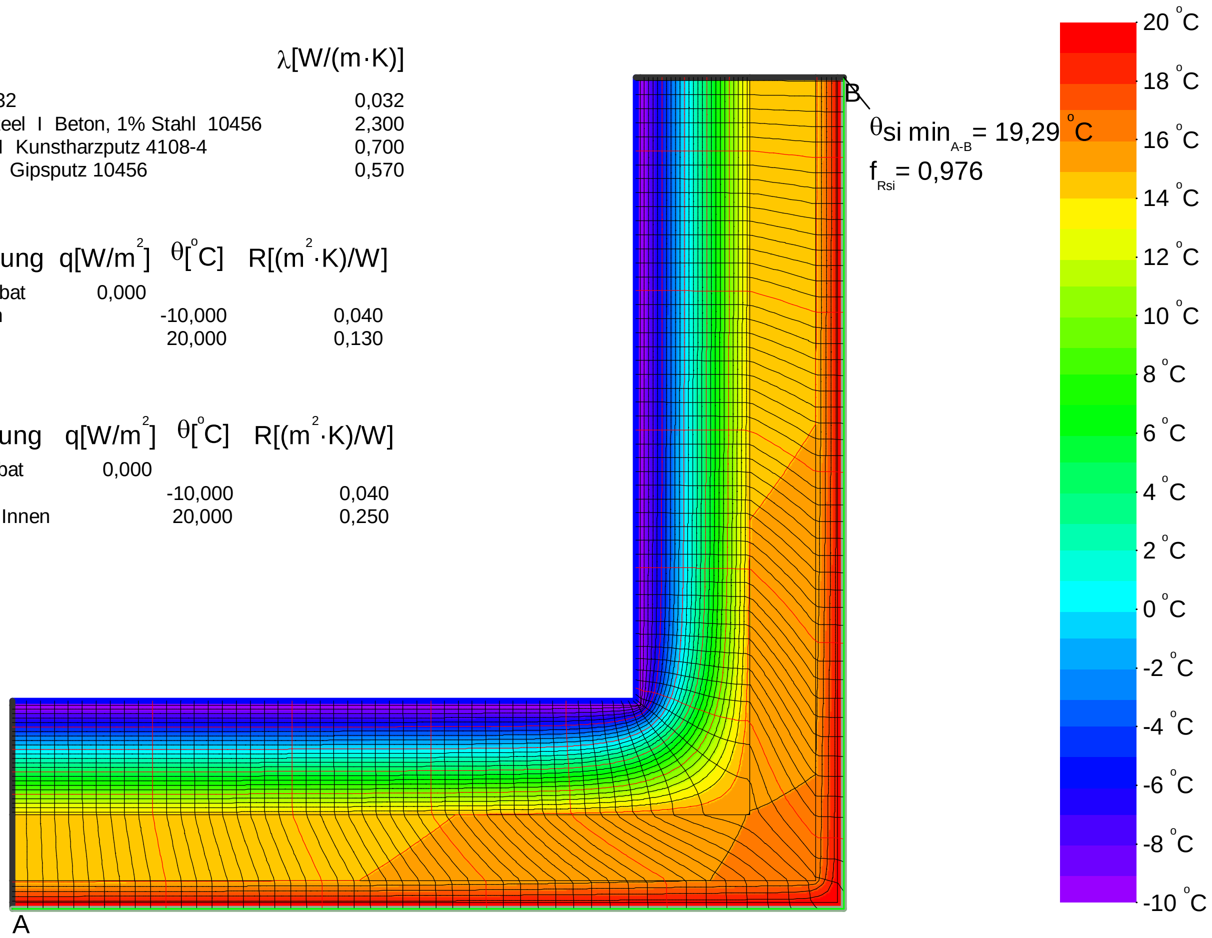


$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{9{,}623}{30{,}000} - 0{,}104 \cdot 1{,}425 - 0{,}104 \cdot 1{,}425 = 0{,}025 \text{ W/(m·K)}$$

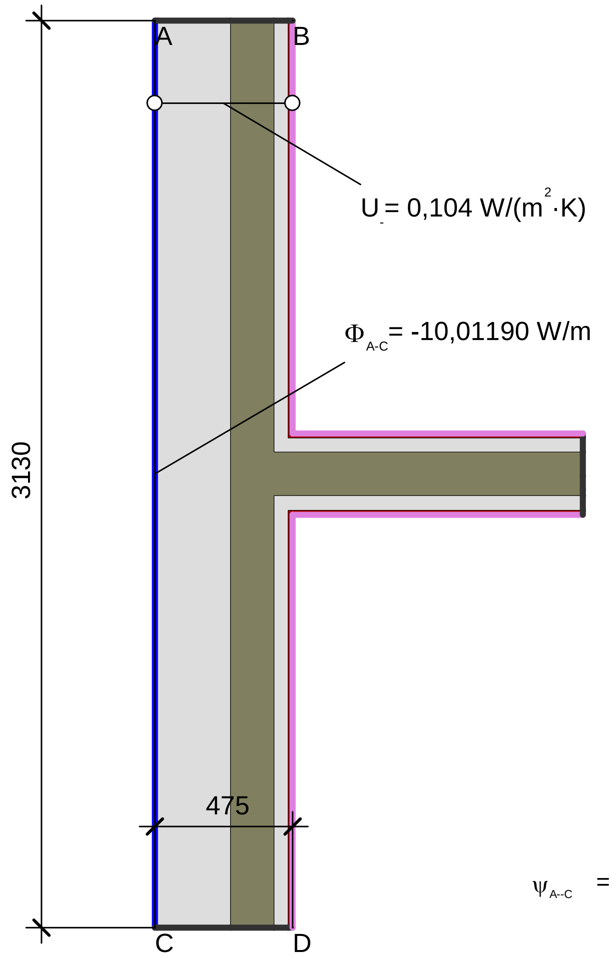
Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Exterior plaster I Kunstharzputz 4108-4	0,700
Interior plaster I Gipsputz 10456	0,570

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Interior | Innen		20,000	0,130

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
fRsi: Interior I Innen		20,000	0,250



EWIC01: WALLINTERIOR CORNER | WAND INNENECKE

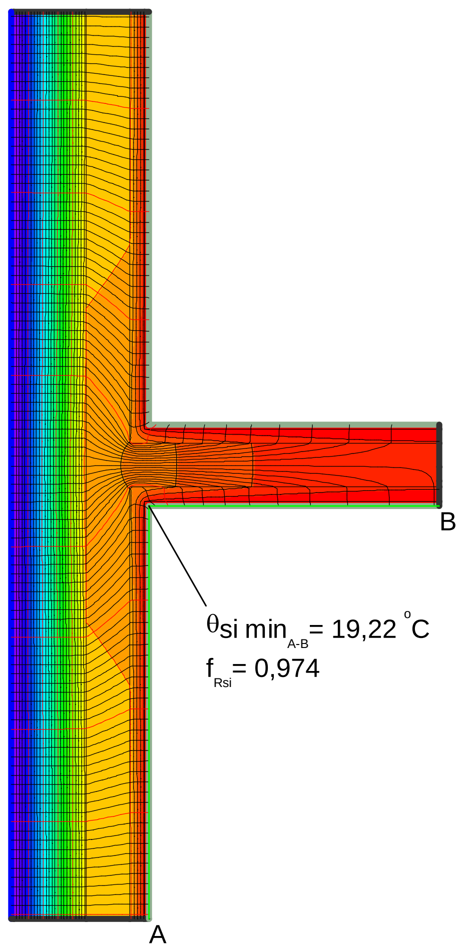


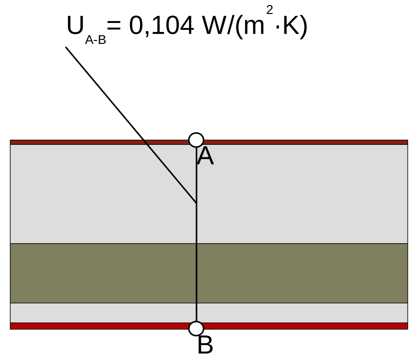
Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Exterior plaster I Kunstharzputz 4108-4	0,700
Interior plaster I Gipsputz 10456	0,570

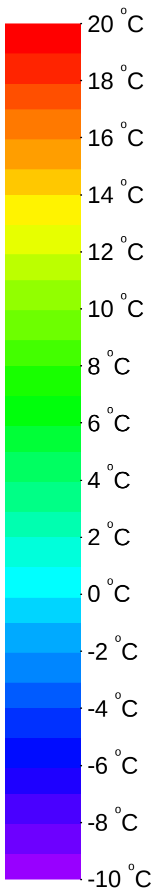
Randbedingung	$q[W/m^2]$	$\theta[^\circ C]$	$R[(m^2 \cdot K)/W]$
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Interior | Innen		20,000	0,130

Randbedingung	$q[W/m^2]$	$\theta[^\circ C]$	$R[(m^2 \cdot K)/W]$
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
fRsi: Interior I Innen		20,000	0,250

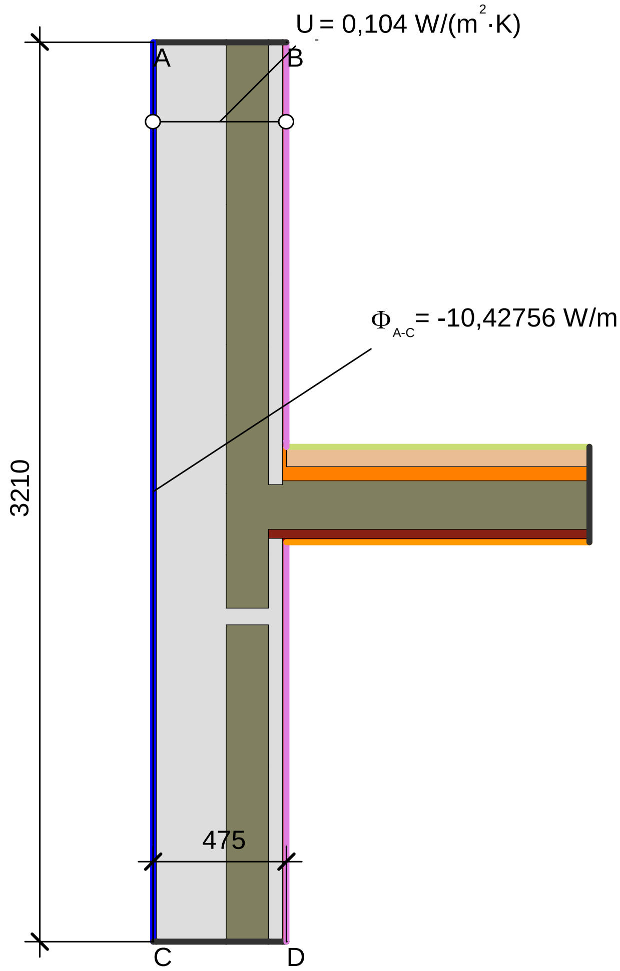
$$\psi_{A-C} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 = \frac{10,012}{30,000} - 0,104 \cdot 3,130 = 0,009 \text{ W/(m·K)}$$







EWIW01: Junction exterior wall - interior wall | Innenwandeinbindung

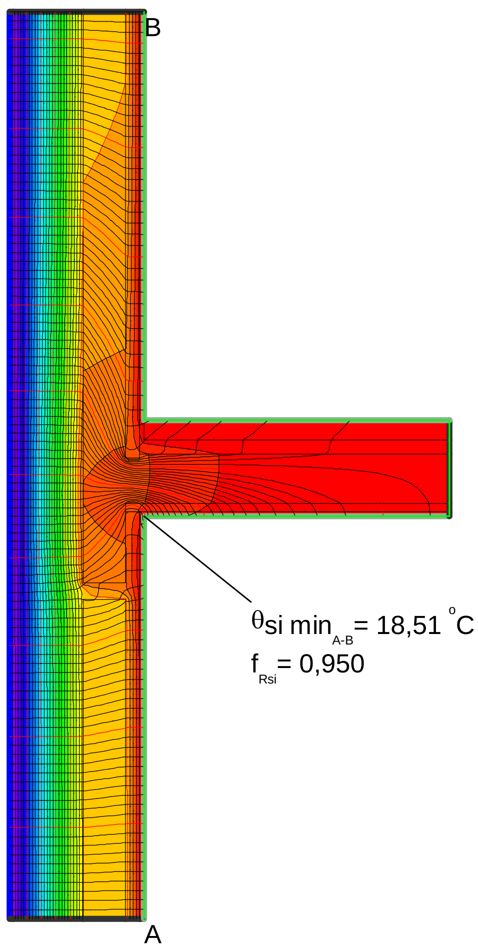


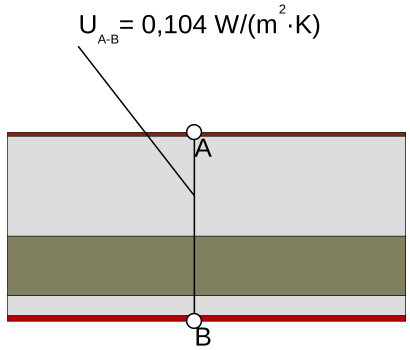
Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Cement screed I Zement-Estrich 4108	1,400
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Exterior plaster I Kunstharzputz 4108-4	0,700
Interior plaster I Gipsputz 10456	0,570
Organic compound plaster I Kunstharzputz 4108-4	0,700
Sound insulation I Trittschalldämmung 040	0,040

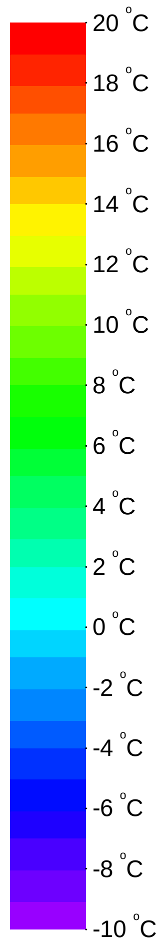
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Int. flux down I Innen abwärts		20,000	0,170
Interior up. | Innen auf.		20,000	0,100
Interior | Innen		20,000	0,130

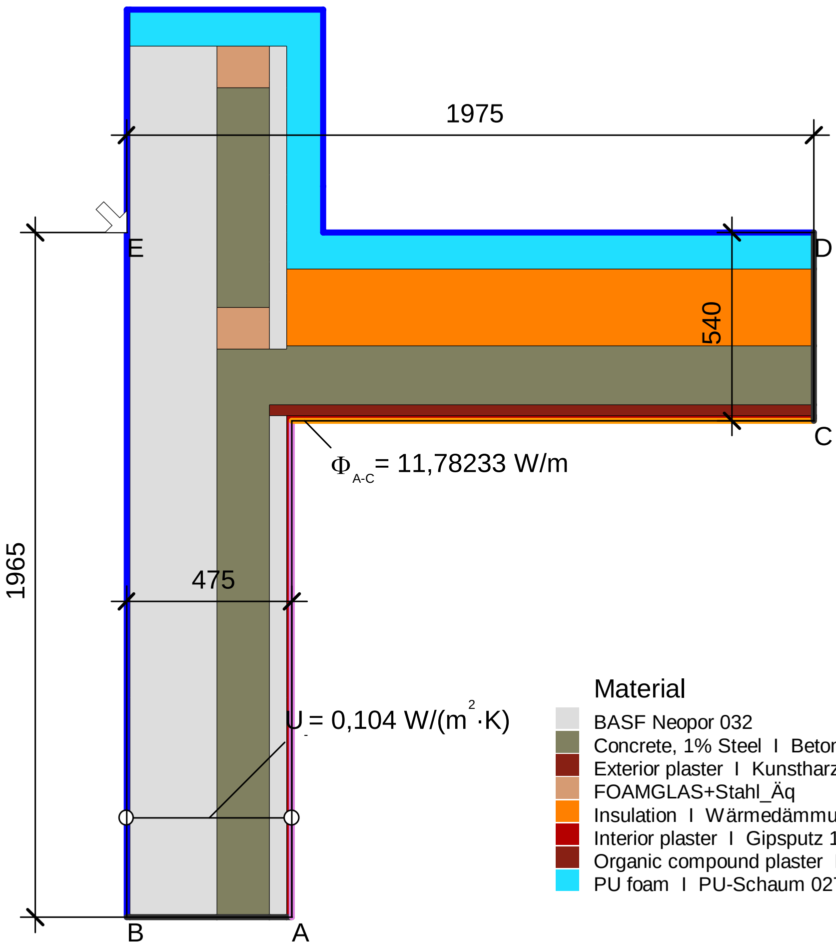
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
fRsi: Interior I Innen		20,000	0,250

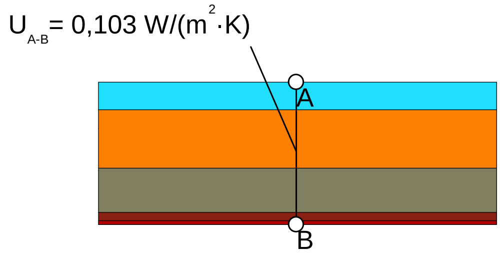
$$\psi_{A-C} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 = \frac{10,428}{30,000} - 0,104 \cdot 3,210 = 0,015 \text{ W/(m·K)}$$

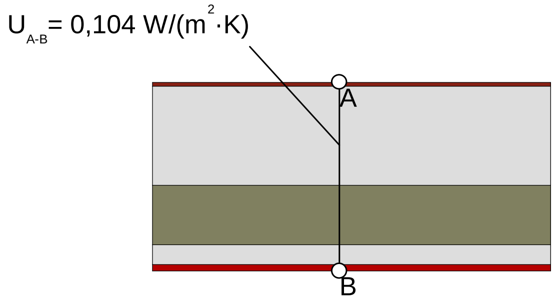






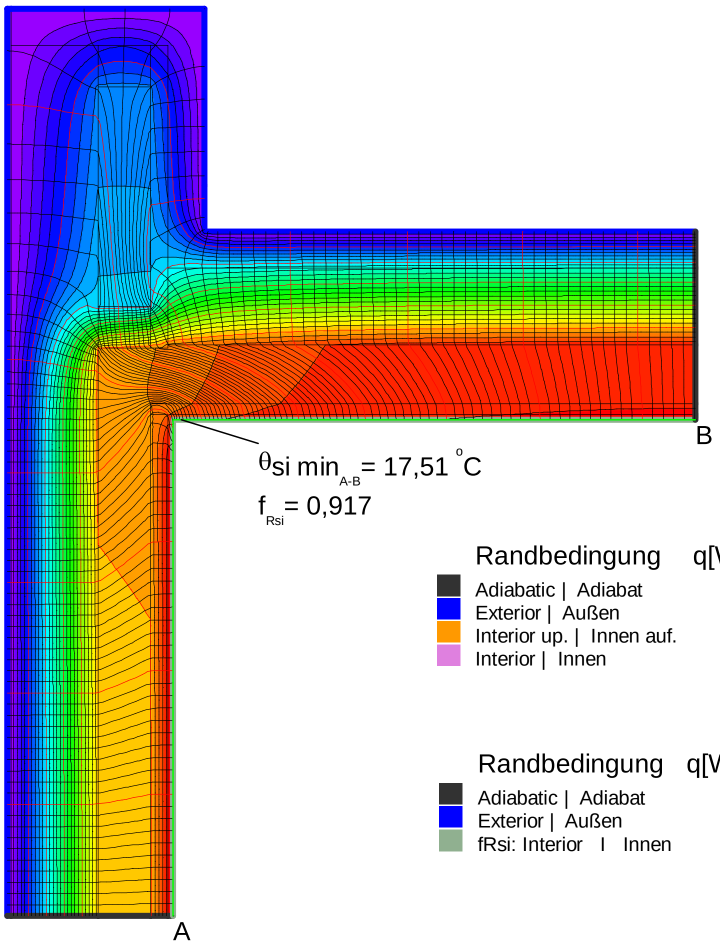






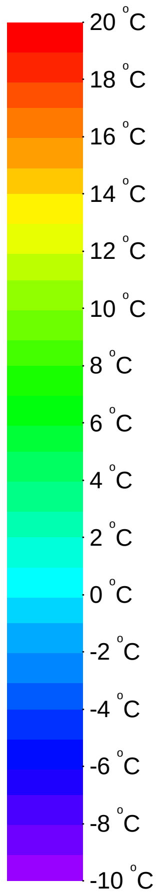
Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Exterior plaster I Kunstharzputz 4108-4	0,700
FOAMGLAS+Stahl_Äq	0,058
Insulation I Wärmedämmung 040	0,040
Interior plaster I Gipsputz 10456	0,570
Organic compound plaster I Kunstharzputz 4108-4	0,700
PU foam I PU-Schaum 027	0,027

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{11{,}782}{30{,}000} - 0{,}104\cdot 1{,}965 - 0{,}103\cdot 1{,}975 = -0{,}015 \text{ W/(m·K)}$$

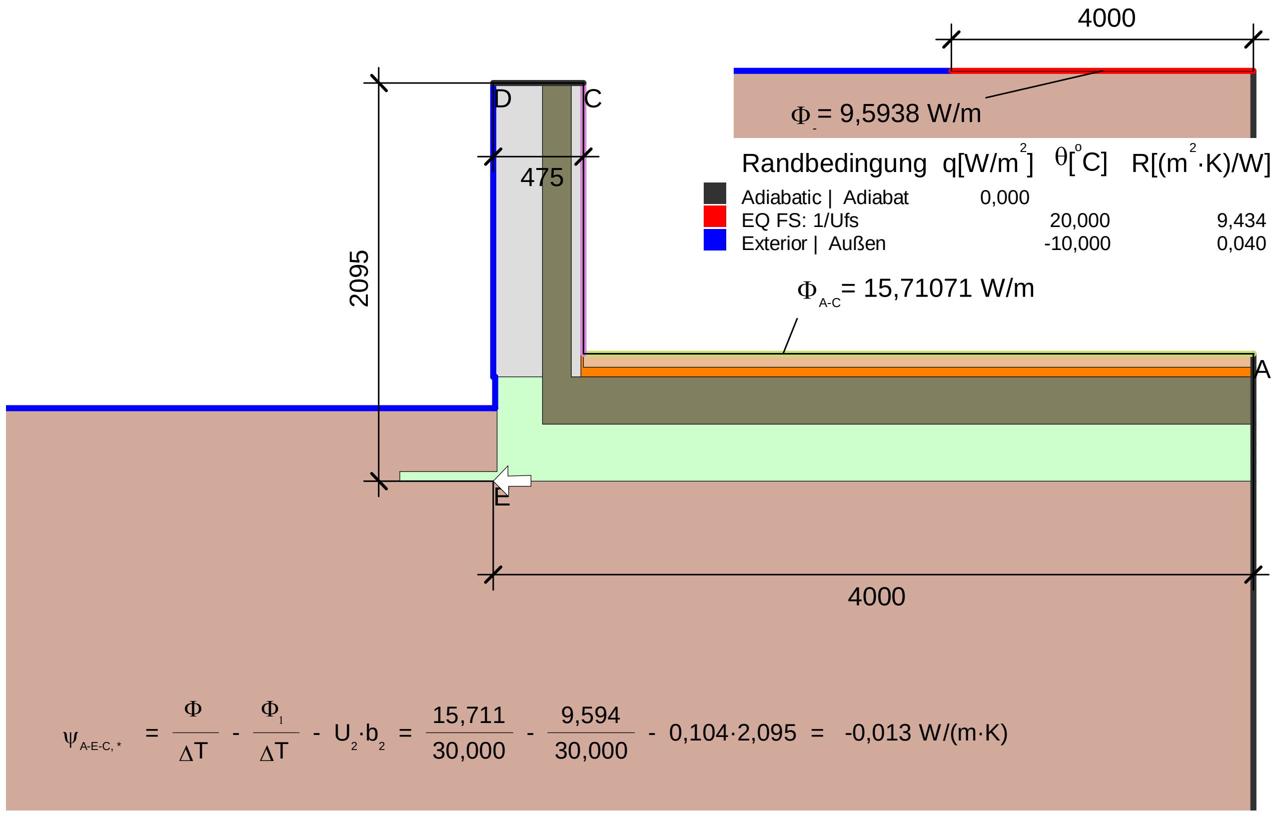


Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Interior up. | Innen auf.		20,000	0,100
Interior | Innen		20,000	0,130

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
fRsi: Interior I Innen		20,000	0,250



Constructions to ground | Erdberührte Bauteile



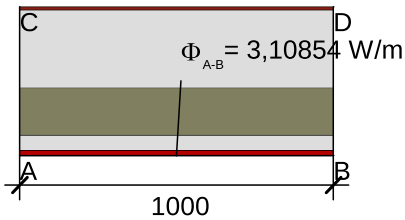
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
EQ FS: 1/Ufs		20,000	9,434
Exterior | Außen		-10,000	0,040

$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{15{,}711}{30{,}000} - \frac{9{,}594}{30{,}000} - 0{,}104 \cdot 2{,}095 = -0{,}013\ \text{W/(m·K)}$$

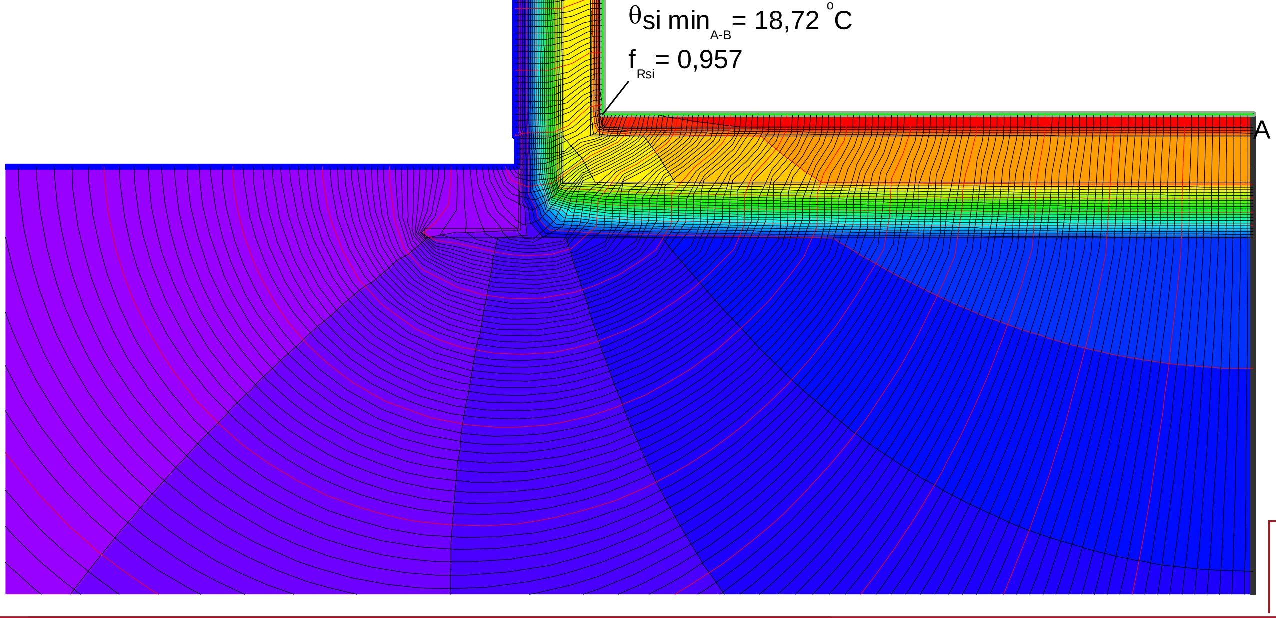
Material	λ[W/(m·K)]
BASF Neopor 032	0,032
Cement screed I Zement-Estrich 4108	1,400
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300
Exterior plaster I Kunstharzputz 4108-4	0,700
Ground I Erdreich	2,000
Interior plaster I Gipsputz 10456	0,570
Sound insulation I Trittschalldämmung 040	0,040
Styrodur 3035 CS	0,038

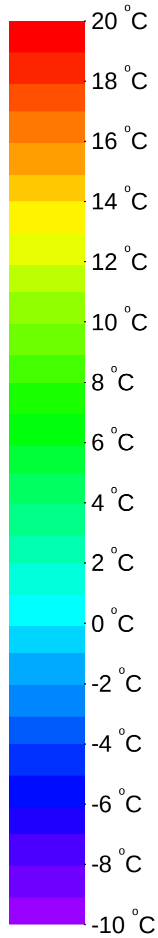
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
Int. flux down I Innen abwärts		20,000	0,170
Interior | Innen		20,000	0,130

$$U_{eq\ A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3{,}109}{30{,}000 \cdot 1{,}000} = 0{,}104\ \text{W/(m}^2\text{·K)}$$



Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
Exterior | Außen		-10,000	0,040
fRsi: Interior I Innen		20,000	0,250





FSEW01: FLOORSLAB-WALL | BODENPLATTE-WAND

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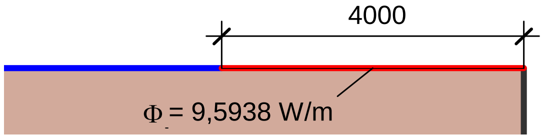
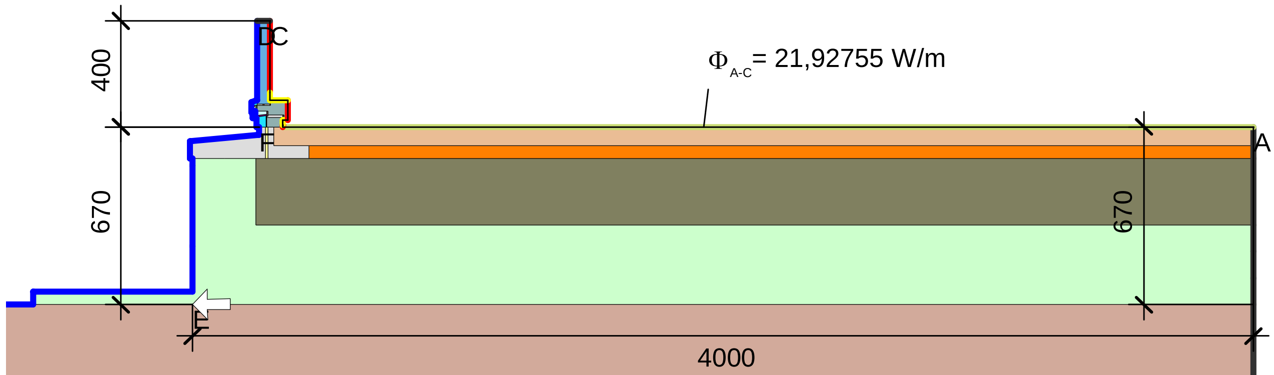
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Int. flux down I Innen abwärts		20,000	0,170	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900



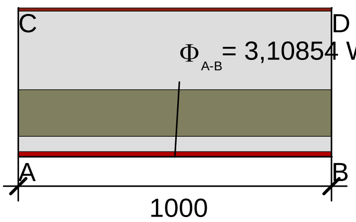
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]
Adiabatic | Adiabat	0,000		
EQ FS: 1/Ufs		20,000	9,434
Exterior | Außen		-10,000	0,040

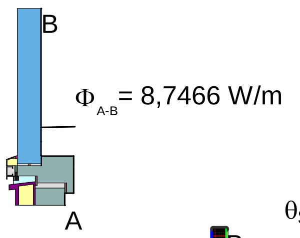


$$\Psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 - \frac{\Phi_3}{\Delta T} = \frac{21,928}{30,000} - \frac{9,594}{30,000} - 0,104 \cdot 0,670 - \frac{8,747}{30,000} = 0,050 \text{ W/(m·K)}$$

$$\Psi_{WITH01} = \Psi_{FSEW1+WITH1} - \Psi_{FSEW1} = 0,050 - -0,013 \text{ W/(mK)} = 0,063 \text{ W/(mK)}$$

$$U_{eq\,A\text{-}B} = \frac{\Phi}{\Delta T \cdot b} = \frac{3,109}{30,000 \cdot 1,000} = 0,104 \text{ W/(m}^2\text{·K)}$$



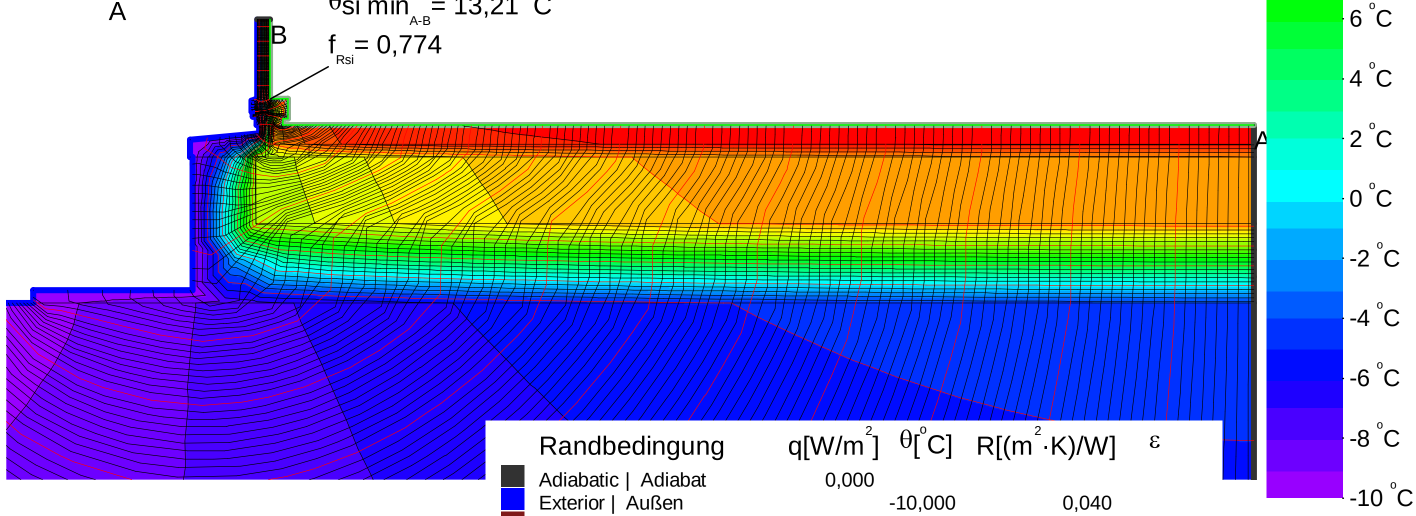


Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
BASF Neopor 032	0,032	
Cement screed I Zement-Estrich 4108	1,400	
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	
EPDM	0,250	0,900
GRP, >50% I GFK >50%	0,630	0,900
Ground I Erdreich	2,000	
Insulation I Wärmedämmung 040	0,040	0,900
PU foam I PU-Schaum 027	0,027	0,900
Panel I Maske	0,035	0,900
Phonotherm RG-700 10	0,100	0,900
Silicone I Silikon	0,350	0,900
Slightly vent. cav. I leicht bel. Hohlr. **		
Sound insulation I Trittschalldämmung 040	0,040	
Spruce, Fir I Fichte, Tanne	0,110	0,900
Styrodur 3035 CS	0,038	0,900
Unvent. cavity I unbel. Hohlr. **		
high dense EPS	0,040	0,900

** EN ISO 10077-2:2017, 6.4.3

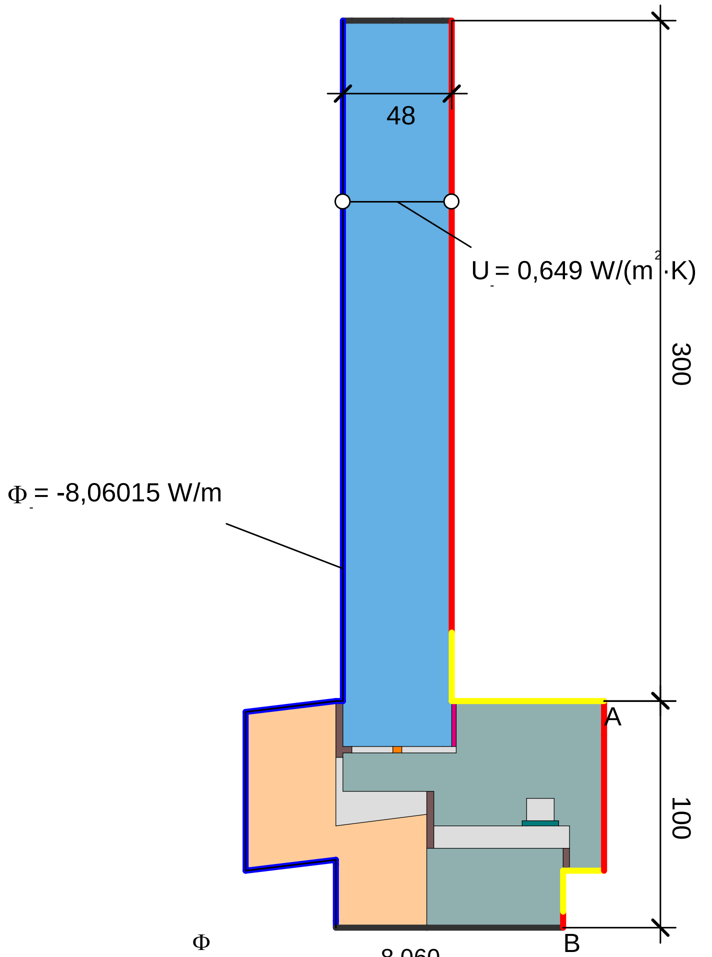
$\theta si\ min_{A\text{-}B} = 13,21\ °C$

$f_{Rsi} = 0,774$



Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior I Innen		20,000	0,250	

Passive House Unit		01			02			03			01
frame values | Rahmenwerte		Bottom	Top	Side	Bottom	Top	Side	Bottom	Top	Side	Bottom barrier-free
		Unten	Oben	Seitl.	Unten	Oben	Seitl.	Unten	Oben	Seitl.	Unten barri-erefrei
Spacer I Abstandhalter: phA Spacer											
Frame width Rahmenbreite	**b_f** [mm]	100	100	100							100
U-value frame Rahmen-U-Wert	**Uf** [W/(m²K)]	0,74	0,56	0,56							0,97
Ψ-glass edge Glasrand-Ψ-Wert	**Ψg** [W/(mK)]	0,020	0,021	0,021							0,024
U-value window Fenster-U-Wert	**Uw** [W/(m²K)] @U_g = 0,52 W/(m²K)	**0,596**									
Passive House effiziency class Passivhaus Effizienzklasse		**phA**									
Installation | Einbau											
	$f_{Rsi=0,25m^2k/W}$	0,806	0,841	0,840							0,774
	$\Psi_{install}$ [W/(mK)]	0,054	0,005	0,003							0,063
	$U_{W, installed}$ [W/(m²K)]	0,64									



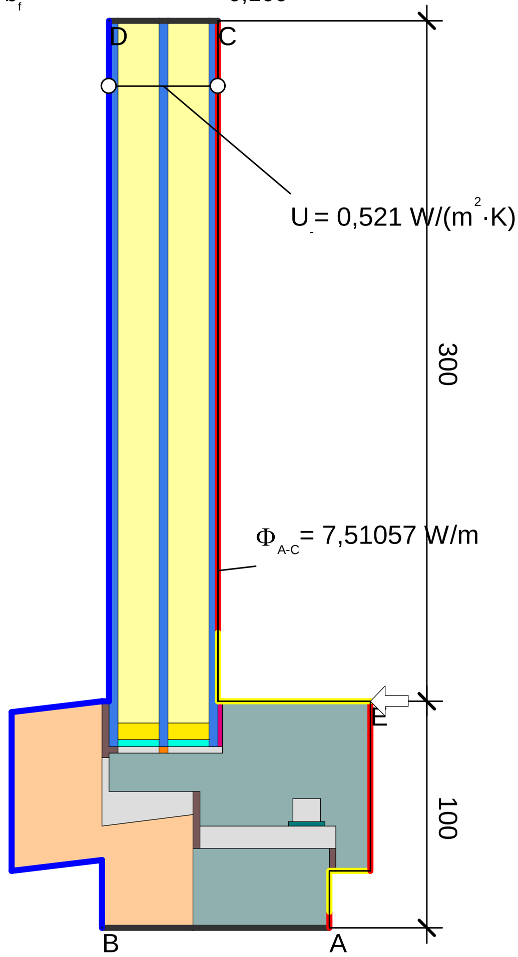
Material	λ[W/(m·K)]	ε
Ar18 in 50 mm U 0,52	0,021	
Butyl	0,240	0,900
EPDM	0,250	0,900
Glass I Glas	1,000	0,900
Insulation I Wärmedämmung 040	0,040	0,900
PVC-Schaum	0,060	0,900
Silicone I Silikon	0,350	0,900
Spruce, Fir I Fichte, Tanne	0,110	0,900
Steel I Stahl	50,000	0,900
SuperSpacer Tri-Seal_Box2	0,150	
Unvent. cavity I unbel. Hohlr. **		

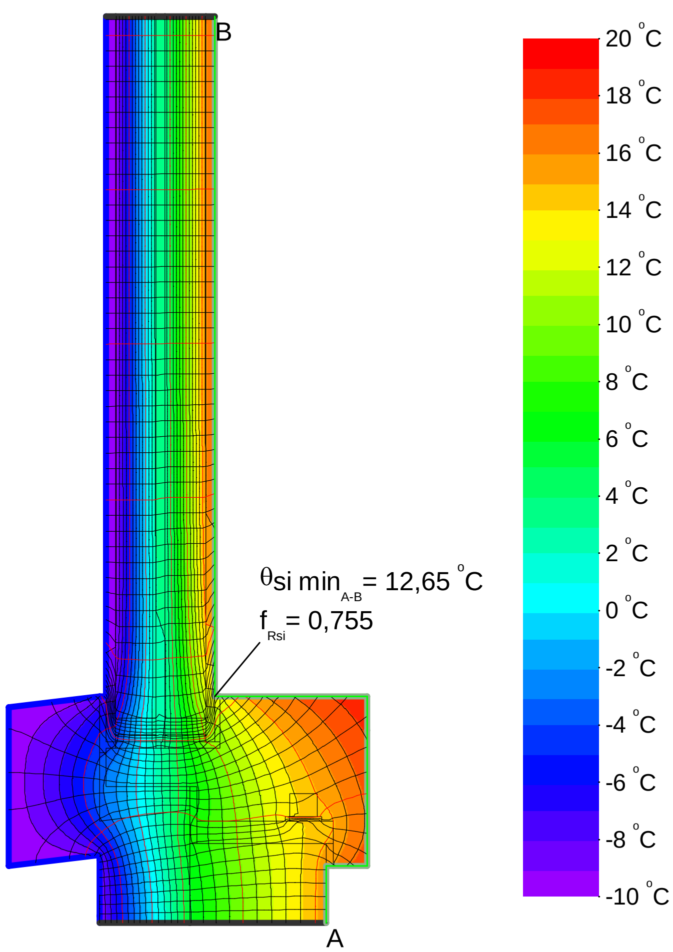
** EN ISO 10077-2:2017, 6.4.3

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior | Innen		20,000	0,250	

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,060}{30,000} - 0,649 \cdot 0,300}{0,100} = 0,740\ W/(m^2 \cdot K)$$





$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{7,511}{30,000} - 0,740 \cdot 0,100 - 0,521 \cdot 0,300 = 0,020\ W/(m \cdot K)$$

BOTTOM I UNTEN

CERTIFIED COMPONENT
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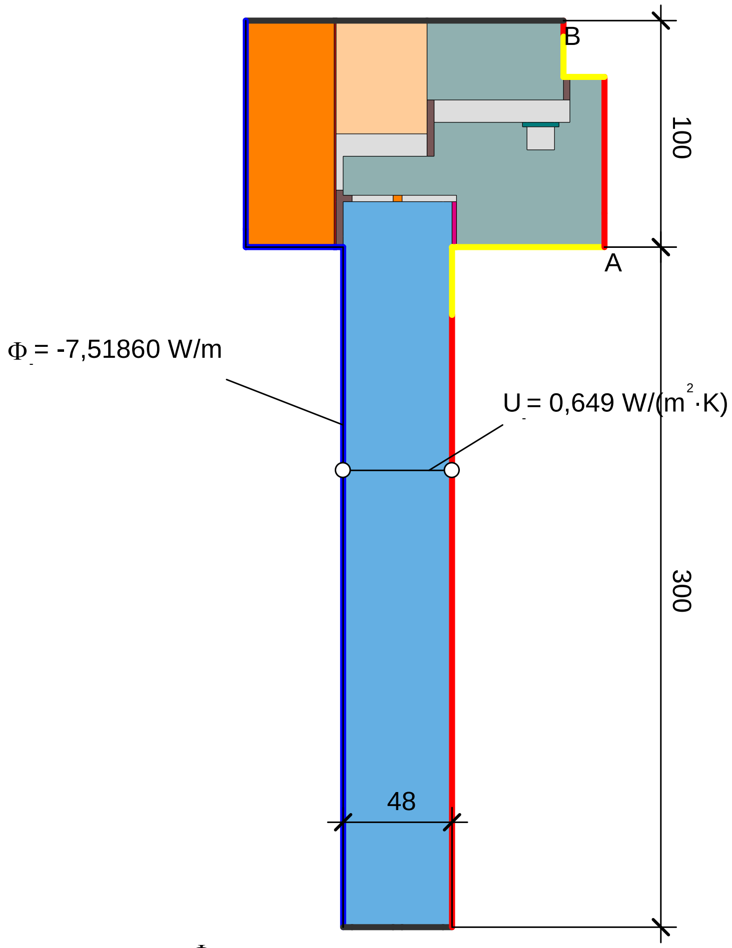


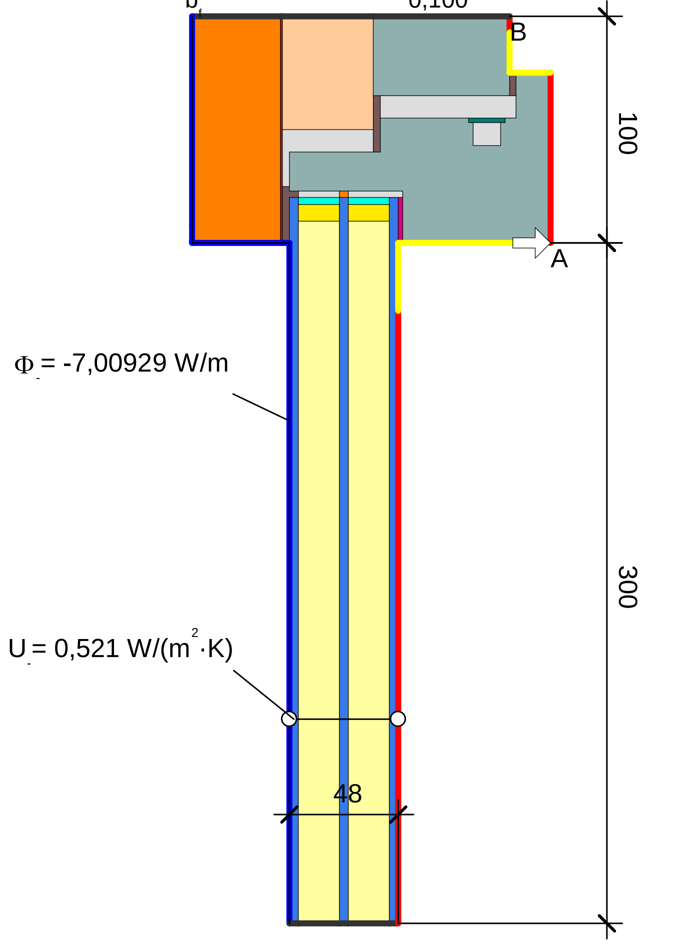
Material	λ[W/(m·K)]	ε
Ar18 in 50 mm U 0,52	0,021	
Butyl	0,240	0,900
EPDM	0,250	0,900
Glass I Glas	1,000	0,900
Insulation I Wärmedämmung 040	0,040	0,900
PVC-Schaum	0,060	0,900
Polyvinylchlorid (PVC)	0,170	0,900
Silicone I Silikon	0,350	0,900
Spruce, Fir I Fichte, Tanne	0,110	0,900
Steel I Stahl	50,000	0,900
SuperSpacer Tri-Seal_Box2	0,150	
Unvent. cavity I unbel. Hohlr. **		

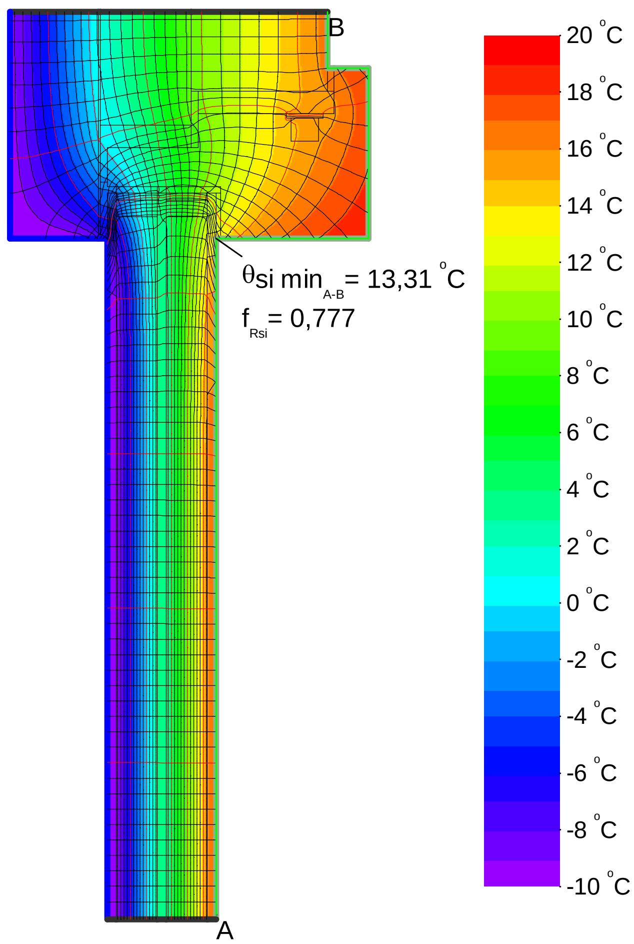
** EN ISO 10077-2:2017, 6.4.3

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

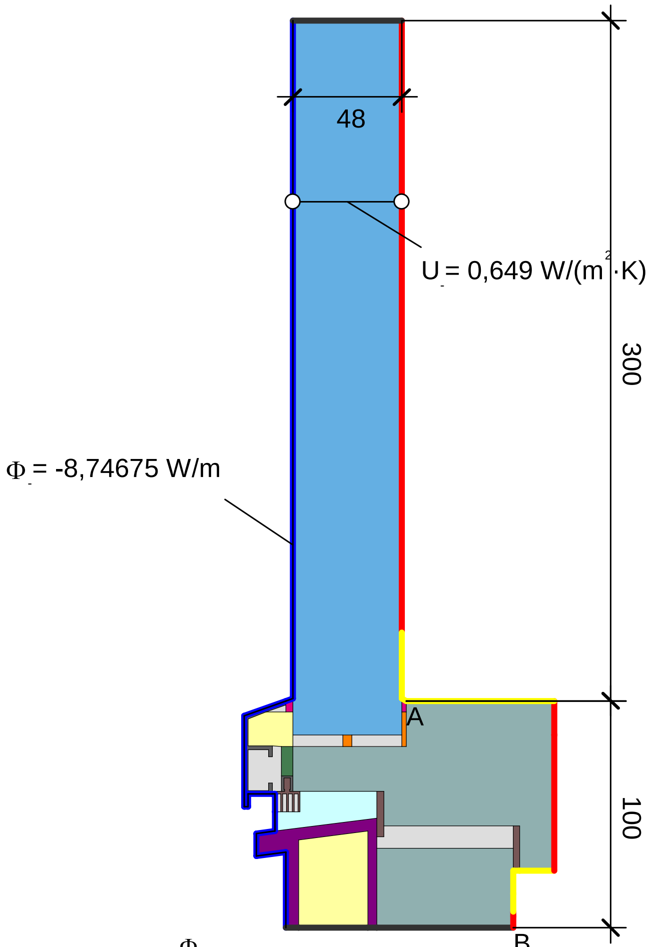
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior | Innen		20,000	0,250	

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{7,519}{30,000} - 0,649 \cdot 0,300}{0,100} = 0,560 \text{ W/(m}^2\cdot\text{K)}$$





$$\psi_A = \frac{\Phi}{\Delta T} - U_g \cdot b_g - U_f \cdot b_f = \frac{7,009}{30,000} - 0,521 \cdot 0,300 - 0,560 \cdot 0,100 = 0,021 \text{ W/(m}\cdot\text{K)}$$



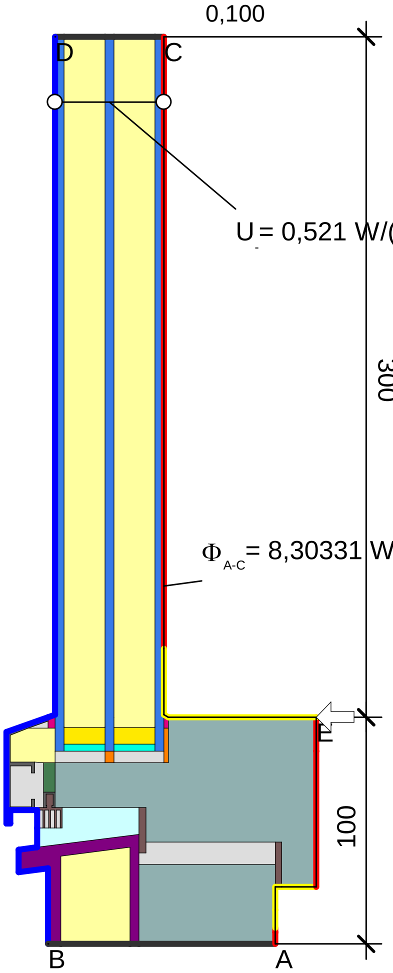
Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Ar18 in 50 mm U 0,52	0,021	
Butyl	0,240	0,900
Compacfoam 100	0,040	0,900
EPDM	0,250	0,900
GRP, >50% I GFK >50%	0,630	0,900
Glass I Glas	1,000	0,900
Insulation I Wärmedämmung 040	0,040	0,900
Kingspan Kooltherm K103 <45mm	0,022	0,900
Silicone I Silikon	0,350	0,900
Slightly vent. cav. I leicht bel. Hohlr. **		
Spruce, Fir I Fichte, Tanne	0,110	0,900
SuperSpacer Tri-Seal_Box2	0,150	
Unvent. cavity I unbel. Hohlr. **		

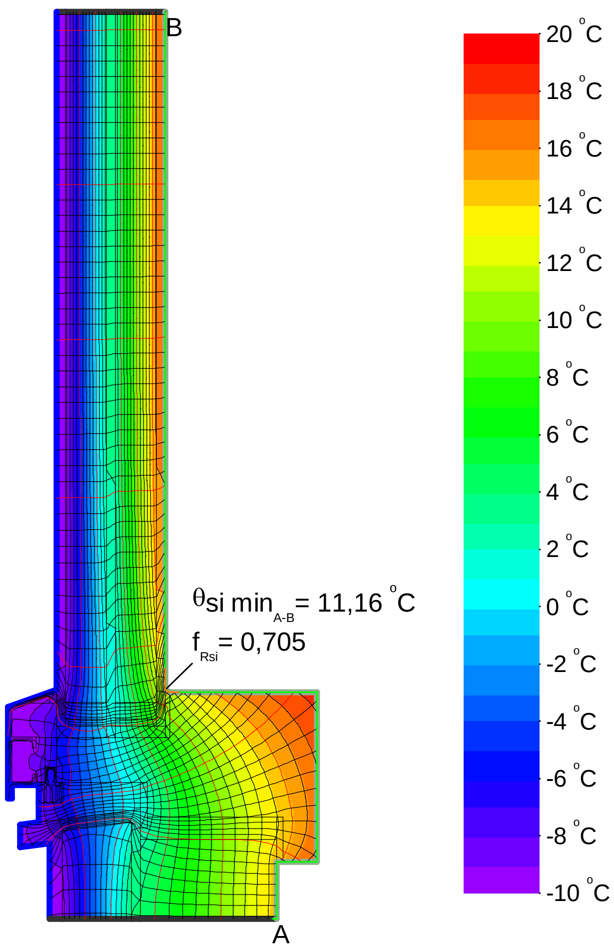
** EN ISO 10077-2:2017, 6.4.3

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior | Innen		20,000	0,250	

$$U_{f\,A,B} = \frac{\frac{\Phi}{\Delta T} - U_p \cdot b_p}{b_f} = \frac{\frac{8,747}{30,000} - 0,649 \cdot 0,300}{0,100} = 0,969\ W/(m^2 \cdot K)$$





$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{8,303}{30,000} - 0,969 \cdot 0,100 - 0,521 \cdot 0,300 = 0,024\ W/(m \cdot K)$$

THRESHOLD I SCHWELLE

CERTIFIED COMPONENT
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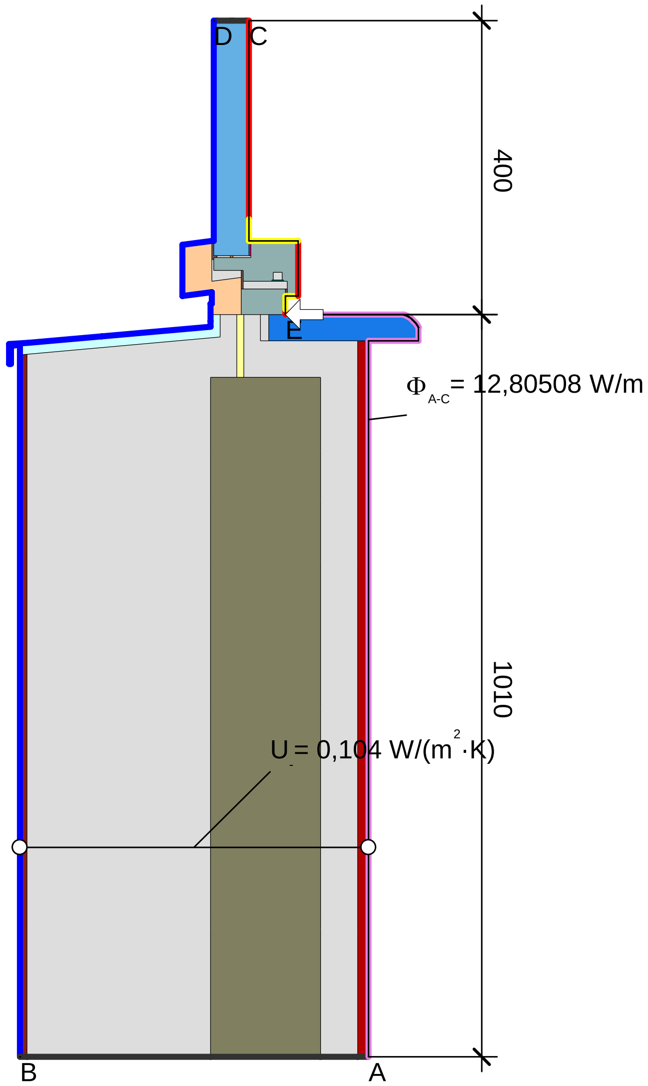
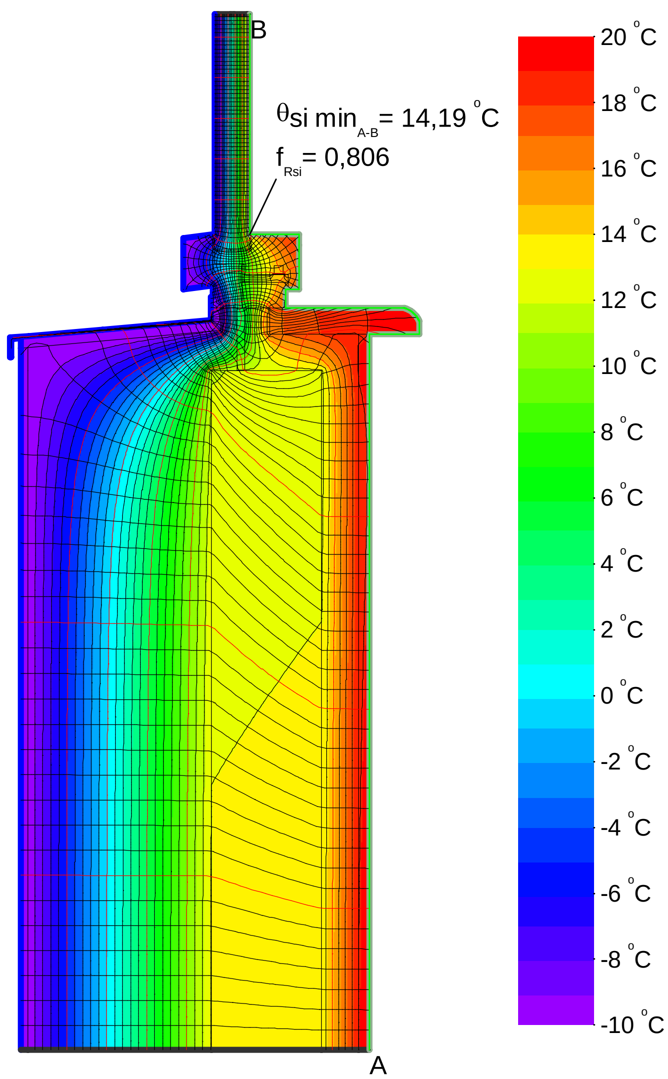
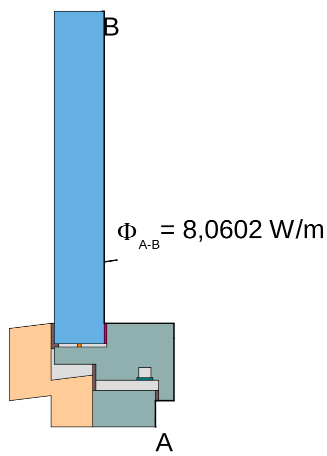




$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{12{,}805}{30{,}000} - 0{,}104 \cdot 1{,}010 - \frac{8{,}060}{30{,}000} = 0{,}054 \text{ W/(m·K)}$$

Material	λ[W/(m·K)]	ε
Aluminum I Aluminium 10456	160,000	0,900
Artificial stone I Kunststein 10456	1,300	0,900
BASF Neopor 032	0,032	0,900
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	
EPDM	0,250	0,900
Exterior plaster I Kunstharzputz 4108-4	0,700	0,900
Insulation I Wärmedämmung 040	0,040	0,900
Interior plaster I Gipsputz 10456	0,570	
PVC-Schaum	0,060	0,900
Panel I Maske	0,035	0,900
Phonotherm RG-700 10	0,100	0,900
Silicone I Silikon	0,350	0,900
Slightly vent. cav. I leicht bel. Hohlr. **		
Spruce, Fir I Fichte, Tanne	0,110	0,900
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr. **		

** EN ISO 10077-2:2017, 6.4.3

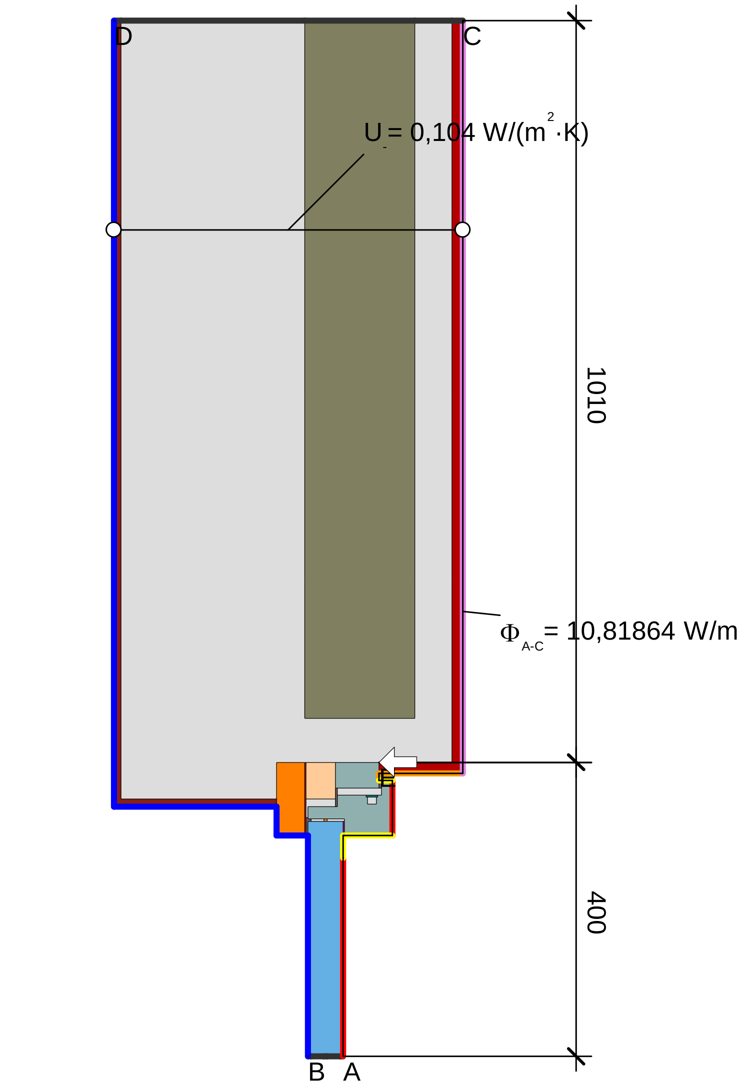


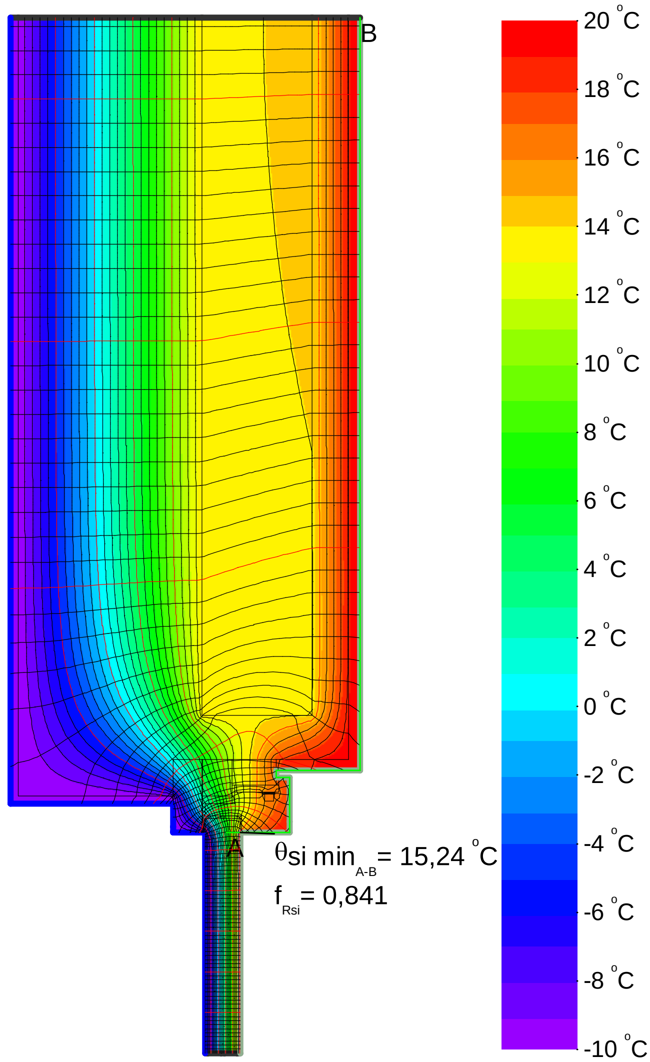
Randbedingung	$q[W/m^2]$	θ[°C]	$R[(m^2·K)/W]$	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior | Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

Randbedingung	$q[W/m^2]$	θ[°C]	$R[(m^2·K)/W]$	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior | Innen		20,000	0,250	

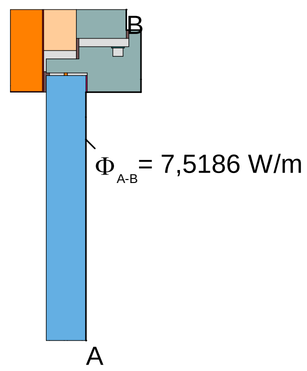
CERTIFIED COMPONENT
Passive House Institute

INSTAL. BOTTOM | EINBAU UNTEN WIBO01





$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - \frac{\Phi_1}{\Delta T} - U_2 \cdot b_2 = \frac{10{,}819}{30{,}000} - \frac{7{,}519}{30{,}000} - 0{,}104 \cdot 1{,}010 = 0{,}005\ \text{W/(m·K)}$$



Material	λ[W/(m·K)]	ε
BASF Neopor 032	0,032	
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	
EPDM	0,250	0,900
Exterior plaster I Kunstharzputz 4108-4	0,700	
Insulation I Wärmedämmung 040	0,040	0,900
Interior plaster I Gipsputz 10456	0,570	
PVC-Schaum	0,060	0,900
Panel I Maske	0,035	0,900
Polyvinylchlorid (PVC)	0,170	0,900
Silicone I Silikon	0,350	0,900
Spruce, Fir I Fichte, Tanne	0,110	0,900
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr. **		

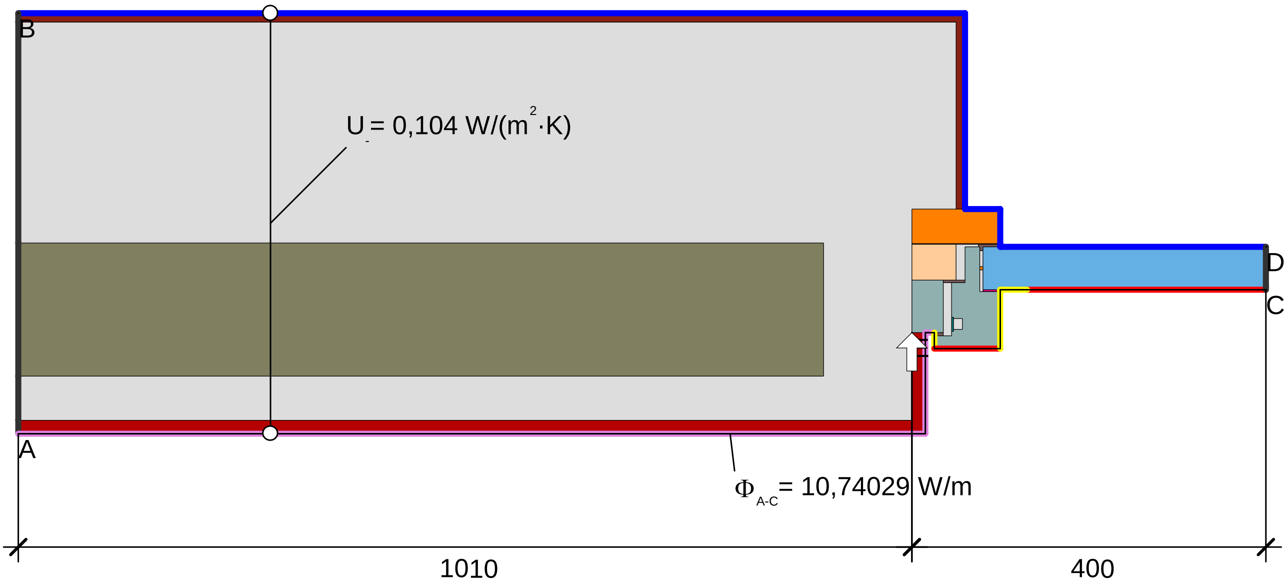
** EN ISO 10077-2:2017, 6.4.3

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior up. | Innen auf.		20,000	0,100	
Interior | Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900

Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior | Innen		20,000	0,250	

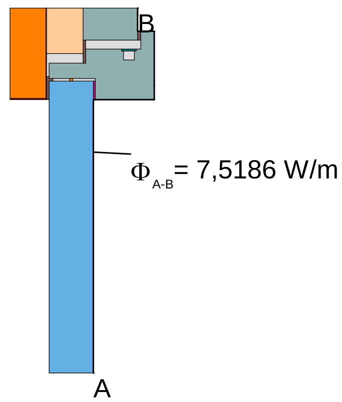
INSTAL. TOP | EINBAU OBEN WITO01

CERTIFIED COMPONENT
Passive House Institute



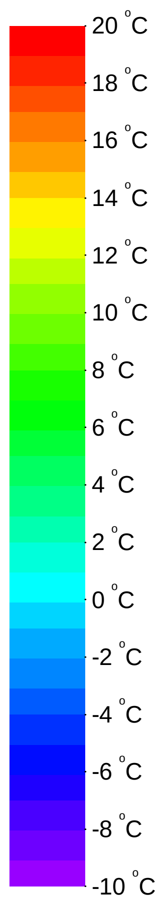
$$\psi_{A\text{-}E\text{-}C,*} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - \frac{\Phi_2}{\Delta T} = \frac{10{,}740}{30{,}000} - 0{,}104 \cdot 1{,}010 - \frac{7{,}519}{30{,}000} = 0{,}003\ \text{W/(m·K)}$$

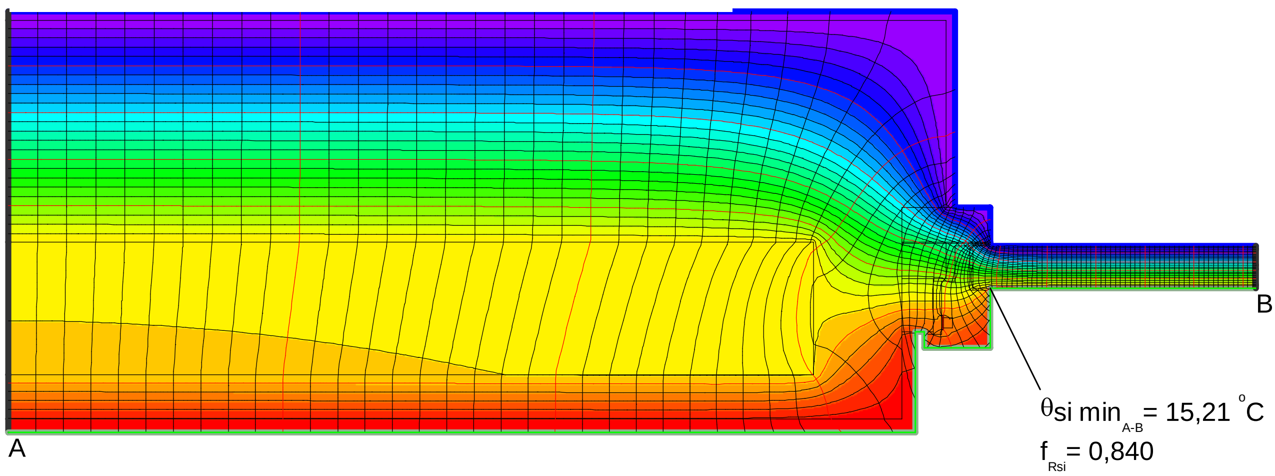
Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
Interior | Innen		20,000	0,130	
Interior, frame, normal		20,000	0,130	
Interior, frame, reduced		20,000	0,200	
e 0,9 Cavity I Hohlraum				0,900



Material	λ[W/(m·K)]	ε
BASF Neopor 032	0,032	
Concrete, 1% Steel I Beton, 1% Stahl 10456	2,300	
EPDM	0,250	0,900
Exterior plaster I Kunstharzputz 4108-4	0,700	
Insulation I Wärmedämmung 040	0,040	0,900
Interior plaster I Gipsputz 10456	0,570	
PVC-Schaum	0,060	0,900
Panel I Maske	0,035	0,900
Polyvinylchlorid (PVC)	0,170	0,900
Silicone I Silikon	0,350	0,900
Spruce, Fir I Fichte, Tanne	0,110	0,900
Steel I Stahl	50,000	0,900
Unvent. cavity I unbel. Hohlr. **		

** EN ISO 10077-2:2017, 6.4.3





Randbedingung	q[W/m²]	θ[°C]	R[(m²·K)/W]	ε
Adiabatic | Adiabat	0,000			
Exterior | Außen		-10,000	0,040	
e 0,9 Cavity I Hohlraum				0,900
fRsi: Interior | Innen		20,000	0,250	

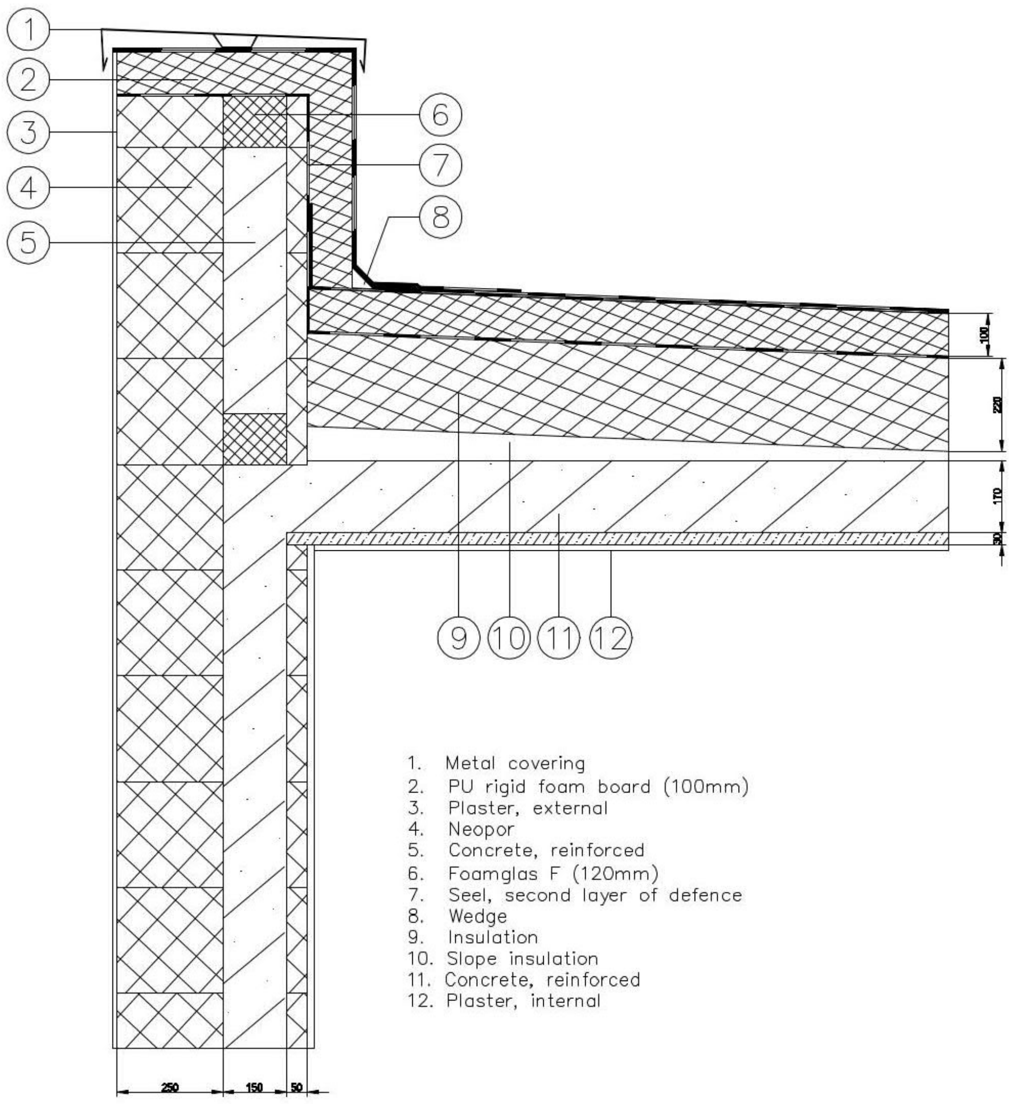
CERTIFIED COMPONENT
Passive House Institute

INSTAL. SIDE | EINBAU SEITLICH WISI01

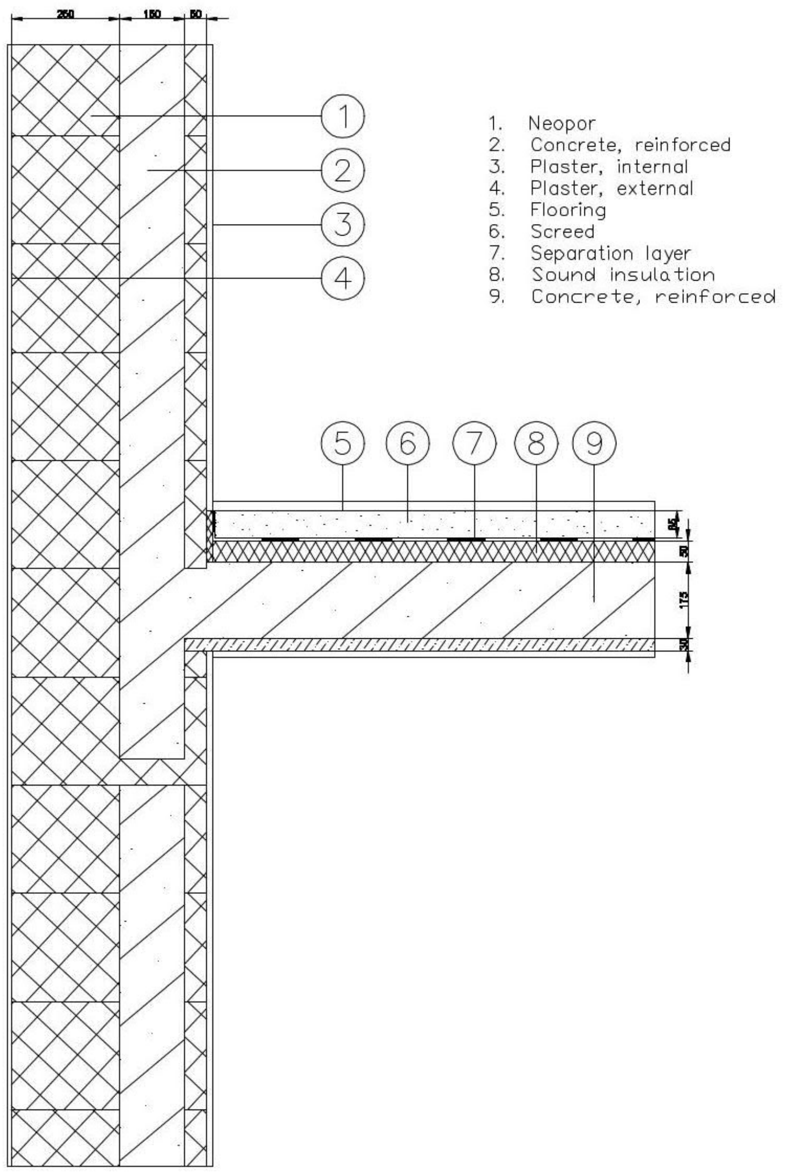
Appendix 3: Manufacturers drawings | Zeichnungen des Herstellers

Betonschalungsstein-Bausystem Attikaanschluss - FRRP	VARIANTHAUS®-GROUP

Konstruktionszeichnung – Vertikalschnitt

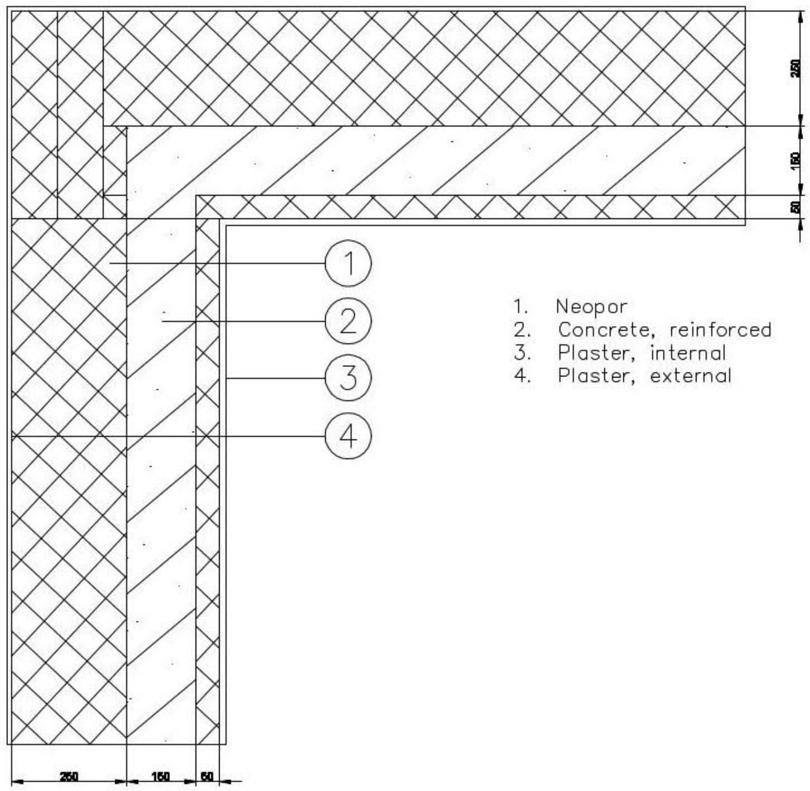


Betonschalungsstein-Bausystem **Deckeneinbindung - EWCE**	VARIANTHAUS®-GROUP
Konstruktionszeichnung – Vertikalschnitt	

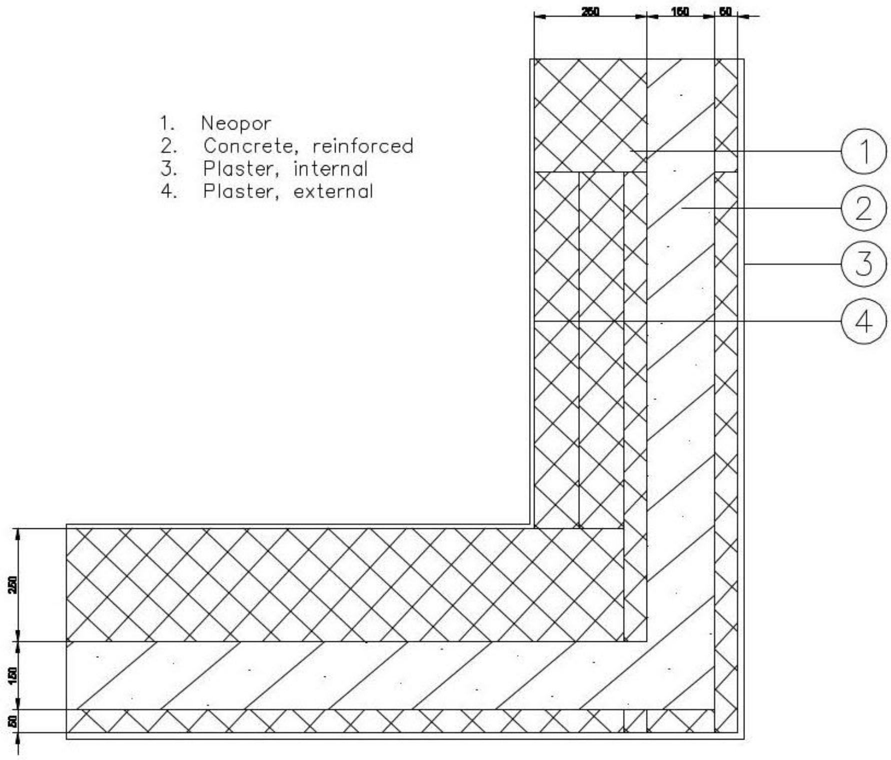


Betonschalungsstein-Bausystem Außenwand/Außenecke - EWEC	VARIANTHAUS®-GROUP

Konstruktionszeichnung – Horizontalschnitt

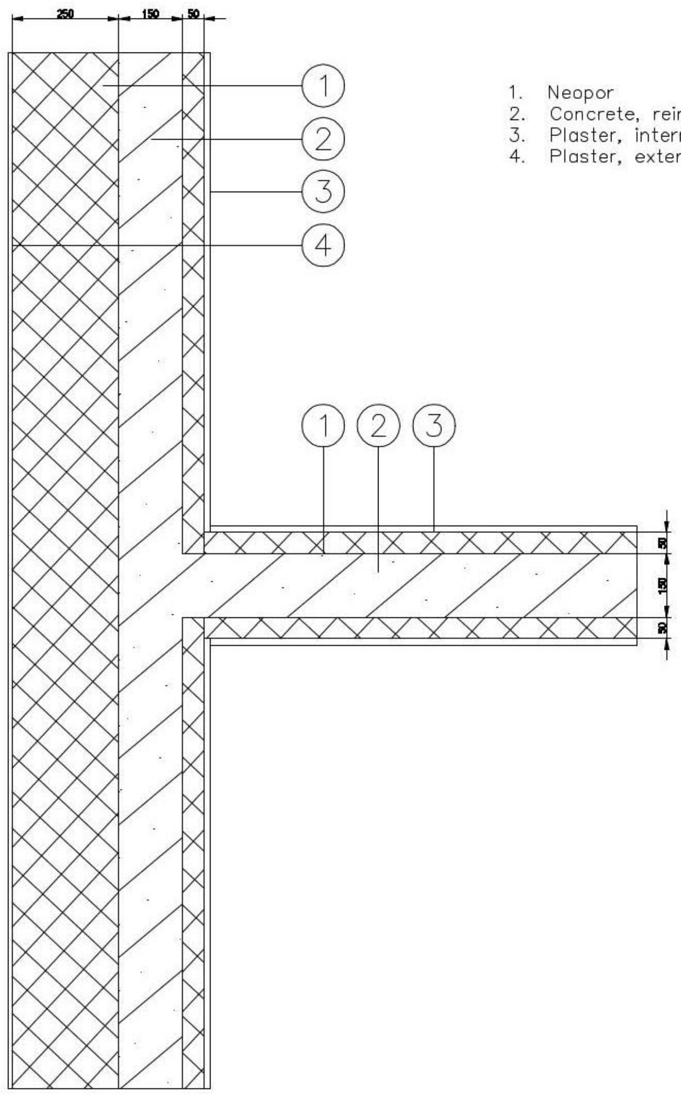


Betonschalungsstein-Bausystem **Außenwand/Innenecke - EWIC**	VARIANTHAUS®-GROUP
Konstruktionszeichnung – Horizontalschnitt	



Betonschalungsstein-Bausystem Innenwandeinbindung - EWIW	VARIANTHAUS®-GROUP

Konstruktionszeichnung – Horizontalschnitt

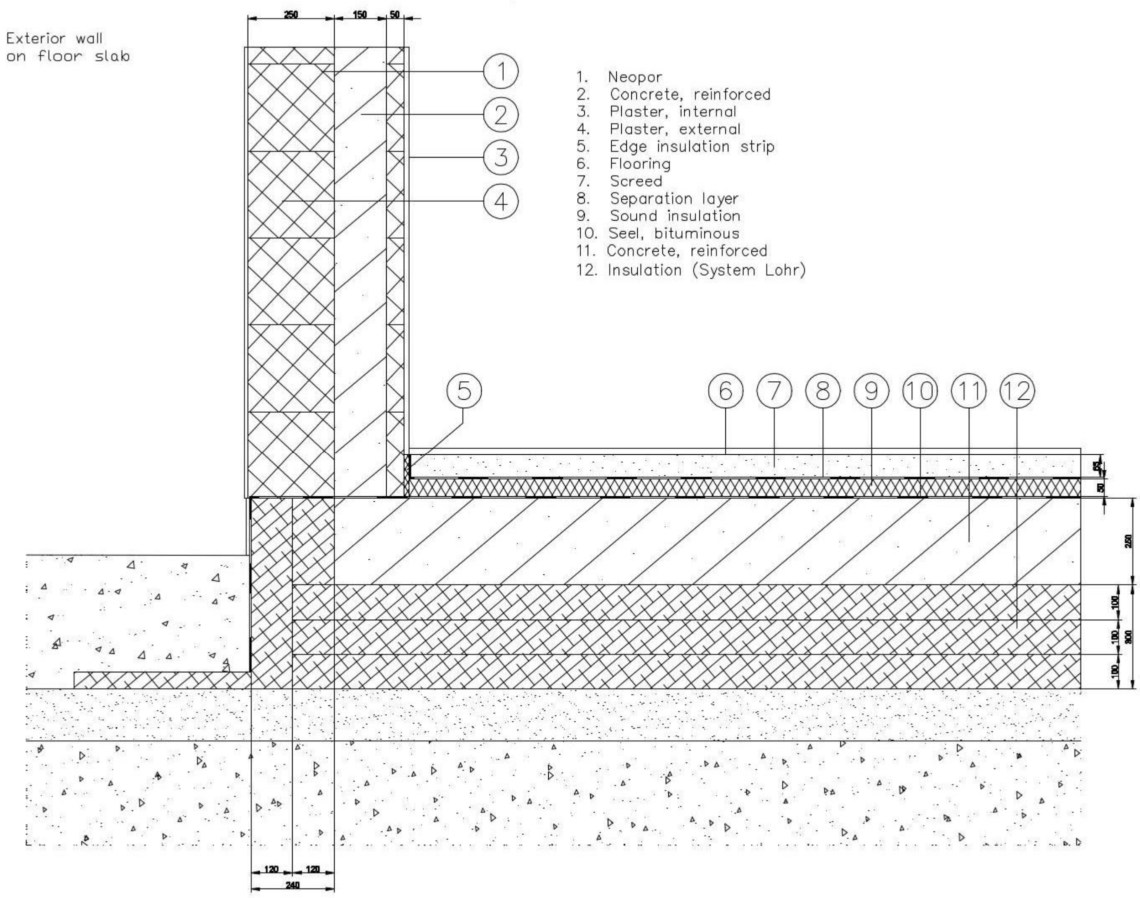


Betonschalungsstein-Bausystem

Bodenplatte/Außenwand - FSEW

VARIANTHAUS®-GROUP

Konstruktionszeichnung – Vertikalschnitt

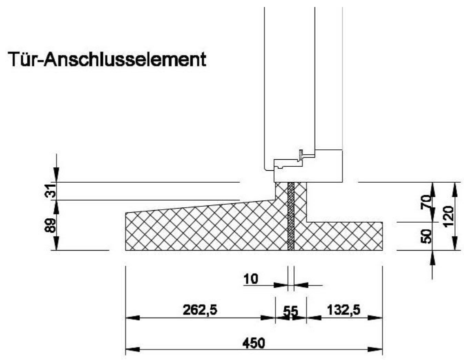


Betonschalungsstein-Bausystem

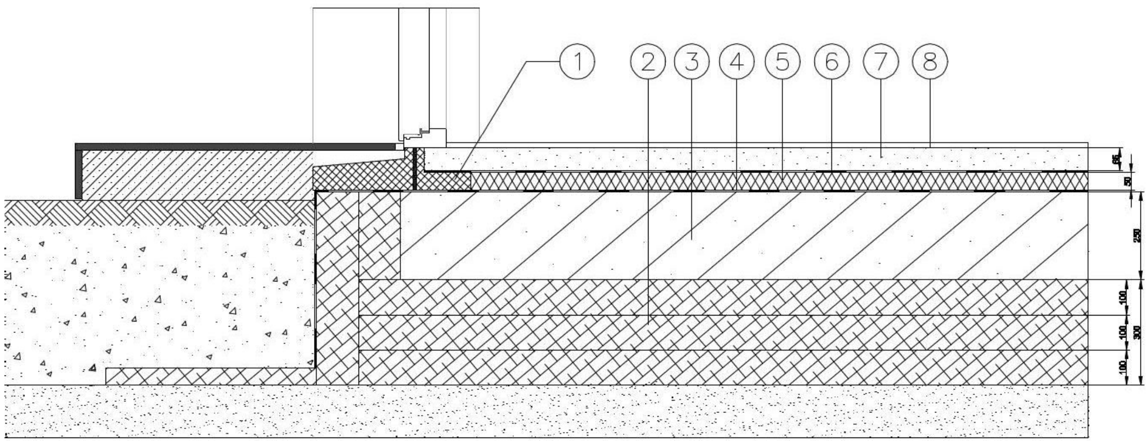
Bodenplatte/Schwelle - WITH

VARIANTHAUS-GROUP

Konstruktionszeichnung – Vertikalschnitt

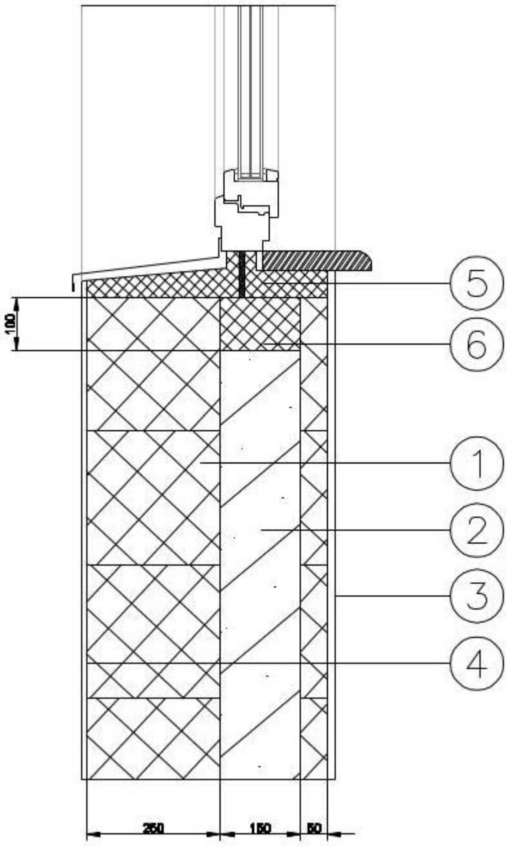


1. Neopor, door-element
2. Insulation (System Lohr)
3. Concrete, reinforced
4. Seel, bitumious
5. Sound insulation
6. Separation layer
7. Screed
8. Flooring



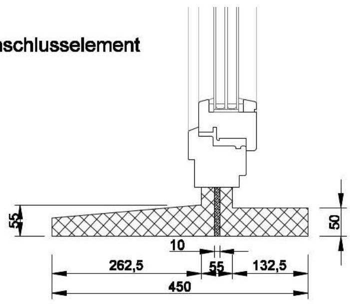
Betonschalungsstein-Bausystem Fenstereinbau/Unten - WIBO	VARIANTHAUS-GROUP

Konstruktionszeichnung – Vertikalschnitt



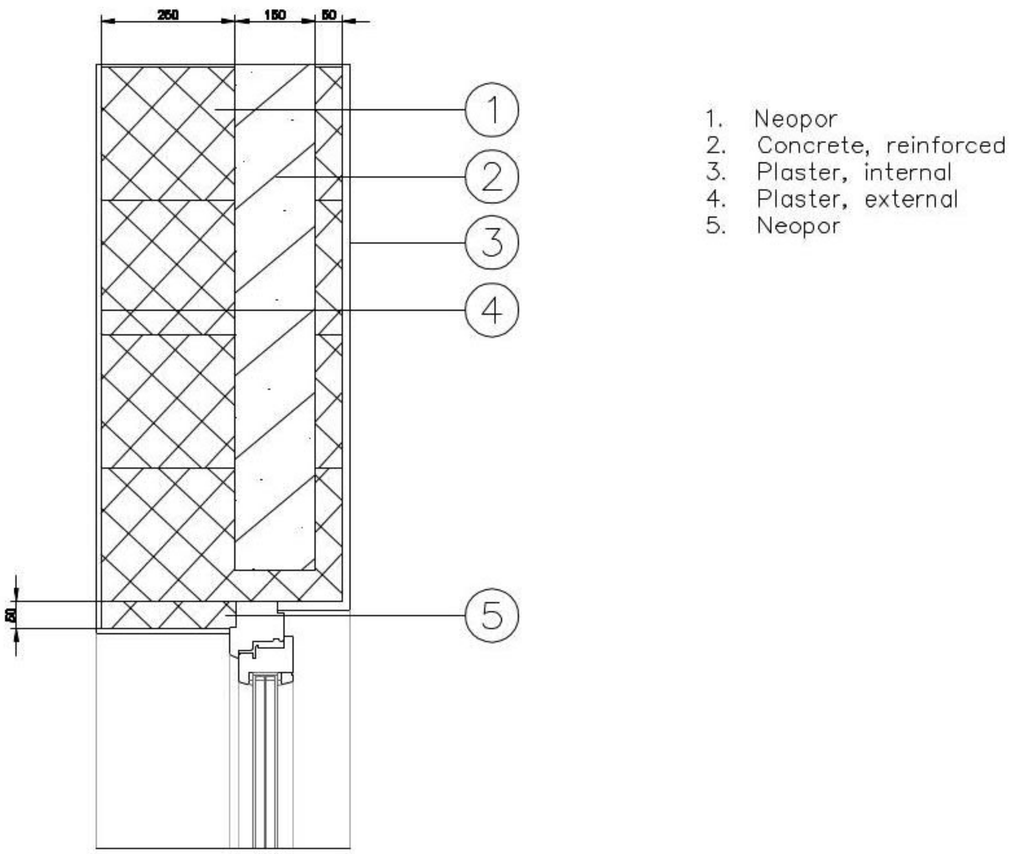
1. Neopor
2. Concrete, reinforced
3. Plaster, internal
4. Plaster, external
5. Neopor, window element
6. PU rigid foam board (100mm)

Fenster-Anschlusselement



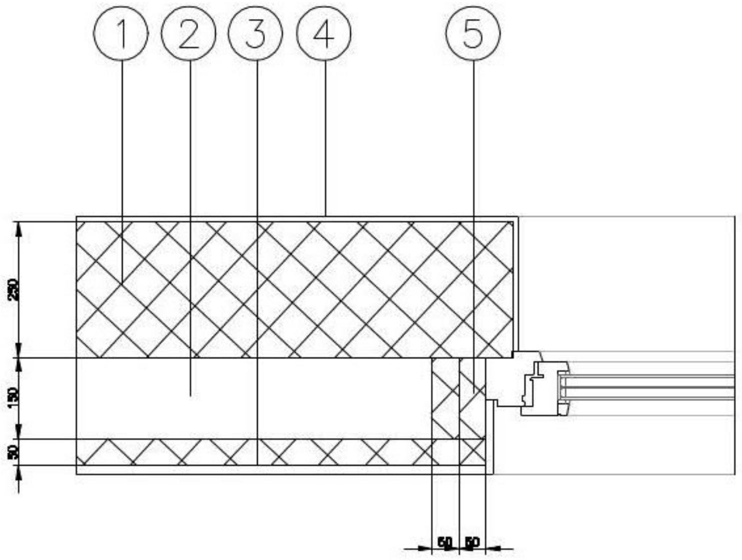
Betonschalungsstein-Bausystem Fenstereinbau/Oben - WITO	VARIANTHAUS®-GROUP

Konstruktionszeichnung – Vertikalschnitt



Betonschalungsstein-Bausystem Fenstereinbau/Seitlich - WISI	VARIANTHAUS-GROUP

Konstruktionszeichnung – Horizontalschnitt



1. Neopor
2. Concrete, reinforced
3. Plaster, internal
4. Plaster, external
5. Neopor (2x50mm)