Handling of typical constructions

WUFI[®] Tutorial Version: April 2018

Auf Wissen bauen





Content

Flat roof (slide 3 ff.)

Pitched roof (slide 11 ff.)

Exterior wall with ETICS (slide 20 ff.)

Exterior wall with interior insulation (slide 28 ff.)

Ventilated timber frame construction (slide 42 ff.)

Basement wall without ground water (slide 54 ff.)





- 1 Roofing membrane
- 2 Exterior insulation
- 3 Vapor retarder
- 4 Wooden sheathing
- 5 Insulation
- 6 Rafter
- 7 Vapor retarder
- 8 Installation layer
- 9 Gypsum board
- 10 Simulated cross-section

Construction in WUFI





Please note



- Insert an air infiltration source at the cold side of the construction (at the position where condensation would occur) → source strength depending on the air tightness and height of the connected air column
- Orientation/ Inclination according to planning
- Heat transfer resistance "roof"
- Roofing membrane can be taken in account by using an s_d-value on the outer surface (numerical more favorable)
 → if doing so, use no roofing membrane in the construction setup
 - \rightarrow rain water absorption then has to be set to zero ("adhering fraction of rain")
- Short wave radiation absorptivity depending on color of roof surface
- Long wave emissivity depending on the material of the surface
- Switch explicit radiation balance on



Moisture source setup



*) Material in which the condensate is expected due to convection which can not be simulated in a 1D program. The infiltration source is either in the inner 5 mm of the wooden sheathing or – if there is no sheathing – in the outer 5 mm of the insulation between the rafters.



Moisture source setup

3. Select "New Moisture Source"

Hygrothermal Sources				
Layer/Material Name Oriented Strand Board (density 615 kg/m ^s)				
Hygrothermal Sources	New Her t Source			
Nr. Type Name	-			
	New Moisture Source			
	🧟 🛃 New Air Change Source			
	Edit			
	Delete			
✓ OK X Abort ? Help				



Moisture source setup

Air Infiltration Model

Moisture Source	
Name Air Infiltration	
Spread Area One Element Several Elements	Start Depth in Layer [m] 0.01
Whole Layer	End Depth in Layer [m] 0.015
Source Type	⊂Source Term Cut-Off [kg/m³] © No Cut-Off
© Fraction of Driving Rain	© Cut-Off at Max. Water Content
Air Infiltration model IBP	Cut-Off at Free Water Saturation
Constant Monthly Moisture Load	© User Defined
Envelope Infiltration q50 [m³/m²h]	
3 Air Tightness Class B	•
Mechanical Ventila	Stack Height [m] 5 tion Overpressure [Pa] 0
ОК	Cancel ? <u>H</u> elp



Result analysis*



- Check total water content (accumulation of moisture in whole construction); must not keep increasing
- Check water content in wooden sheathing
- In a construction without wood-based or moisture sensitive materials: Examination of amount of dew water (max. 500 g/m² / 200 g/m² according to DIN 4108 / EN ISO 13788 which equals max. 50 kg/m³ / 20 kg/m³ in outer centimeter of insulation)

Further check influence of moisture content on the thermal conductivity in the material data table "thermal conductivity, moisture-dependent"

You may check moisture accumulation in the exterior insulation

*) Note: List not necessarily complete. Depending on boundary conditions additional critical positions may occur \rightarrow Check in film display



Additional information



- Be careful with bright roofing membranes, the drying potential of the construction is greatly reduced
- Shading / green roof can be treated by using more elaborate models (more information in the paper <u>Verschattung von Holzflachdächern</u> (only German) and in <u>Guideline for the calculation of extensive green roofs</u>)
- In case of modeling the roofing membrane as s_d-value on the exterior surface, this only models the vapor-retarding property of the membrane, not its rain-tightness → don't forget to switch off rain!
- Considering an insulated roof with rafters, usually the cross section through the insulation is relevant
- Metal roof: Metal layer is taken into account as sd-value at the exterior surface, absorptivity and emissivity according to material
 - unsealed seams: effective sd-value around 25 m 75 m
 - sealed seams: effective sd-value > 300 m



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Ventilated timber frame construction (slide 42 ff.)

Basement wall without ground water (slide 54 ff.)







Please note



- Insert an air infiltration source at the cold side of the construction (at the position where condensation would occur) → source strength depending on the air tightness and height of the connected air column
- Relevant orientation: usually north
- Ventilated roofing is omitted for the calculation
 → rain water absorption has to be set to zero ("adhering fraction of rain")
- Weather-protection layer can be taken into account by using an s_d-value on the outer surface (selectable in the surface transfer coefficient dialog, numerical more favorable)

 \rightarrow if doing so use no roofing membrane in the construction setup



Please note



- Heat transfer coefficients according to table on slide 14 from "<u>Hygrothermal</u> <u>Simulation of ventilated pitched roofs</u>", value for the long-wave radiation parts is 0 W/m²K.
- Short-wave radiation absorptivity depending on color of roofing tiles, if applicable reduction according to table on slide 14
- Long-wave radiation emissivity depending on the material of roofing tiles
- Switch on explicit radiation balance



Please note



	Eaves Position (coldest)	Middle Position	Ridge Position (warmest)
Strong		a _{k,e} = 30 [W/m²K]	
ventilation	a _e = a · 0.7	$a_e = a \cdot 0.9$	a _e = a
Normal		a _{k,e} = 19 [W/m²K]	
ventilation	a _e = a · 0.7	$a_e = a \cdot 0.9$	a _e = a a
Low		a _{k,e} = 13.5 [W/m²K]	nhofer
ventilation	a _e = a · 0.75	a _e = a · 0.9	a _e = a _◎

with $a_{k,e}$: convective heat transfer coefficient and a_e : effective short-wave coefficient of absorption

Strongly ventilated	Eaves open without any grid etc.	Ridge open with a low flow resistance	nofer IBP
Normal ventilated	Eaves openings with insect protection grid or eave comb	Ridge closed with ridge / arris role	© Fraun
Low ventilated	Small openings at the eaves	Small openings at the ridge	No counter battens



Moisture source setup

Air Infiltration Model

Moisture Source		×
Nam	e Air Infiltration	
Spread Area	t	Start Depth in Laver [m] 0.01
Several Eler	nents	
O Whole Laye	r	End Depth in Layer [m] 0.015
Source Type		Source Term Cut-Off [kg/m³]
C Transient fro	m File	◎ No Cut-Off
Fraction of D	riving Rain	Cut-Off at Max. Water Content
Air Infiltration	model IBP	Out-Off at Free Water Saturation
Constant Mo	nthly Moisture Load	© User Defined
Envelop	e Infiltration q50 [m ^e /m ^e h]	
3	Air Tighthess Class B	D Y
		Stack Height [m] 5
	Mashaniaal Vantila	
	Mechanical venua	
	🗸 ОК	X Cancel ? Help





Surface Transfer setup

Assembly/Monitor Positions Orientation/Inclina	ation/Height	Surface Transfer Coeff.	Initial Conditions	
Exterior Surface (Left Side)				Heat transfer coefficient "User Defined"
Heat Transfer Coefficient [W/m ² K]	19	User Defined		here: 19 W/m²K for normal ventilation
includes long-wave radiation parts [W/m²K]	0			Long-wave radiation parts: 0 W/m ² K
wind-dependent]		
Sd-Value [m]	0,2	Benutzerdefiniert	-	s _d -value of the weather-protection layer
		Note: This setting does not affect	t rain absorption	here: s _d = 20 cm
Short-Wave Radiation Absorptivity [-]	0.47	User Defined	Ŧ	Color of roofing tiles $(a = 0.67)$
Long-Wave Radiation Emissivity [-]	0,9			Eaves position ($a_e = a \cdot 0.7 = 0.47$)
Explicit Radiation Balance	v	Note: This option takes radiative emission into account. Sensitive	cooling due to long-wave cases may require sufficiently	
		accurate counterradiation data in	n the weather file.	Switch on explicit radiation balance
Ground Short-Wave Reflectivity [-]	0.20	Standard value		
Adhering Fraction of Rain [-]		No absorption	-	
-Interior Surface (Pight Side)				
Heat Transfer Coofficient DM/m2/C	0	(Llass Dafined)		
	ŏ	(User Defined)		
Sd-Value [m]		No coating	•	



Result analysis*



- Check total water content (accumulation of moisture in whole construction); must not keep increasing
- Check water content in wooden sheathing
- In a construction without wood-based or moisture sensitive materials: Examination of amount of dew water (max. 500 g/m² / 200 g/m² according to DIN 4108 / EN ISO 13788 which equals max. 50 kg/m³ / 20 kg/m³ in outer centimeter of insulation)

Further check influence of moisture content on the thermal conductivity in the material data table "thermal conductivity, moisture-dependent"

*) Note: List not necessarily complete. Depending on boundary conditions additional critical positions may occur \rightarrow Check in film display



Additional information



- Heat transfer coefficient according to the latest research results by Kölsch (<u>Hygrothermal Simulation of ventilated pitched roofs</u>)
- In case of modeling the roofing membrane as s_d-value on the exterior surface, this only models the vapor-retarding property of the membrane, not its rain-tightness → don't forget to switch off rain!
- Metal roof: Metal layer is taken into account as s_d-value at the exterior surface, absorptivity and emissivity according to material
 - unsealed seams: effective $s_{\rm d}\mbox{-value}$ around 25 m 75 m
 - sealed seams: effective s_d -value > 300 m



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Basement wall without ground water (slide 54 ff.)











Please note



- Moisture source behind ETICS: 1 % of driving rain
- Relevant orientations: Prevailing direction of driving rain and north
- Short wave radiation absorptivity depending on color of exterior plaster
- Long wave radiation emissivity for plaster (if not known: 0.9)
- If the short-term hygrothermal behavior of the outer surface is to be evaluated (e.g. dew position), turn on explicit radiation balance
- "Adhering Fraction of Rain" according to inclination and construction type (vertical wall: 0.7)



Moisture source setup



*) Driving Rain source is inserted in the outer 5 mm of the layer behind the insulation.



Moisture source setup

3. Select "New Moisture Source"

Hygrothermal Sources			
Layer/Material Name	Cement Lime Plaster (stucco, A-value: 1	.0 kg/m2h0.5)	
Hygrothermal Sources		💡 New He	t Source
Nr. Type	Name	- Nov Moist	
		🧟 🔄 New Air Cha	inge Source
		Ē	Edit
		D	Delete
		1	
	✓ OK X Abort	? <u>H</u> elp	



Moisture source setup

Fraction of driving rain

Moisture Source	
Name fraction of driving rain	
 One Element Several Elements Whole Laver 	Start Depth in Layer [m] 0 End Depth in Layer [m] 0,005
Source Type Transient from File Fraction of Driving Rain Air Infiltration model IBP	Source Term Cut-Off [kg/m³] No Cut-Off Cut-Off at Max. Water Content Cut-Off at Free Water Saturation
Constant Monthly Moisture Load	O User Defined
<u> </u>	Cancel ? Help



Result analysis*



- Check total water content (accumulation of moisture in whole construction); must not keep increasing
- Check water content in the insulation
 → Possible reduction of insulating capability
- Relative humidity at the interface between exterior plaster and insulation during winter time → risk of frost damage
- At warm and humid sites check relative humidity between insulation and wall (dew water and failure of adhesive may occur)

*) Note: List not necessarily complete. Depending on boundary conditions more critical positions may occur => Check in film display



Additional information



- The prevailing direction of driving rain can be found by using the Climate Analysis dialog (usually west in Middle Europe)
- The moisture source of 1% of the driving rain behind the ETICS is regulated in the ASHRAE Standard 160 and represents critical positions e.g. in the area of window frames



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Construction

in WUFI

Please note



- Relevant orientations: Prevailing direction of driving rain and north
- Short-wave radiation absorptivity depending on color of exterior surface
- Long-wave radiation emissivity for exterior surface (if not known: 0.9)
- Explicit radiation balance usually not necessary
- "Adhering fraction of rain" according to inclination and construction type (vertical wall: 0.7)
- If needed: Water-repellent treatment of the exterior surface to reduce rain water absorption



Water-repellent treatment of façades

Modification of the A-value without influencing other material properties (e.g. s_d-value)

Step by step:

- Split the exterior layer into a surface layer (0.5 1.0 cm depending on penetration depth of treatment) and the remaining layer. To do this, duplicate the original layer and then adjust the two thicknesses as needed.
- 2) Edit the material properties of the new exterior layer:
 - Unlock the material
 - For materials with a default moisture storage function: switch "Moisture Storage Function" to "Approximate"
 - Switch "Liquid Transport Coefficients" for suction and redistribution to "generate"
 - Adjust "Water absorption coefficient"

Be careful with the units: $[kg/m^2\sqrt{s}]$ is the A-value in $[kg/m^2\sqrt{h}]$ divided by 60 !!!



Assembly/Monitor Positions	Orientation/Inclination/Height Surface Transfer Coeff	Initial Conditions	1. Select exterior laver
Layer Name Solid Brick Masonry	Thickn. [m]		
Solid Brick Masonry Exterior (Left Side) 0	0.4 4 0.02 0.14 0.0125 4 0.02 0.14 0.0125 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	 Material Data Sources, Sinks New Layer Duplicate Delete Edit Assembly by: Graph Table 	2. Duplicate layer
Thickness: 0,574 m	R-Value: 4,17 m²K/W	U-Value: 0,23 W/m²K	











Assembly/Monitor Positions	Orientation/Inclination/Height Surface Transfer	Coeff. Initial Conditions	
Layer Name	Thickn. [m]	
Solid Brick Masonry	0.01	B Material Data	1
Exterior (Left Side) 0,01 0,4	Interior (Right Side 0.02 0.14 (0.0) 125	
		🧟 🚰 Sources, Sinks	
		∵ New Layer	1
		🛱 Duplicate	1
		Delete	1
è		Edit Assembly by:	
		⊚ Graph Table	
•			
			7. Double click on layer
Assign from	Grid		(or click "Material data")
Material Database	Automatic (II)]	
Example Cases	70 Medium		
Total Thickness			
Thickness: 0,584 m	R-Value: 4,18 m²K/W	U-Value: 0,229 W/m²K	



🕜 Layer/Material Data		
Layer/Material Name: Solid Brick Masonry - un	alocked 8. Unlock materia	al
Bulk density [kg/m³]:	1900 Typical Built-In Moisture [kg/m²]: 100	
Porosity [m³/m³]:	0.24 Layer Thickness [m]: 0.01	
Spec. Heat Capacity [J/kgK]:	850 Thermal Conductivity, Design Value [W/mK]:	
Thermal Conductivity [W/mK]:	0.6 Color:	
Water Vapour Diffusion Resistance Factor [-]:	10	
Hygrothermal Functions Material Information Moisture Storage Function Liquid Transport Coefficient, Suction Liquid Transport Coefficient, Redistribution Water Vapour Diffusion Resistance Factor, moister, Thermal Conductivity, moisture-dependent Thermal Conductivity, temperature-dependent Enthalpy, temperature-dependent © Generate	No. Water Cont DWS 1 0 00 2 10 1.5E-10 3 190 1.7E-6 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 10 00.00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <	
Paste into Database Import	Export OK Cancel Help	
	9. Select "Liquid Transport Coefficient, Suction"	



🕡 Layer/Material Data		×
Layer/Material Name: Solid Brick Masonry - unl	ocked	
Bulk density [kg/m³]: Porosity [m³/m³]: Spec. Heat Capacity [J/kgK]: Thermal Conductivity [W/mK]:	1900 Typical Built-In Moistu 0.24 Layer Thic 850 Thermal Conductivity, Design Value 0.6	rre [kg/m³]: 100 kness [m]: 0.01 Je [W/mK]: Color:
Water Vapour Diffusion Resistance Factor [-]:	10	
Hygrothermal Functions Material Information Moisture Storage Function Liquid Transport Coefficient, Suction Liquid Transport Coefficient, Redistribution Water Vapour Diffusion Resistance Factor, moistu Thermal Conductivity, moisture-dependent Thermal Conductivity, temperature-dependent Enthalpy, temperature-dependent Enthalpy, temperature-dependent	No. [kg/m ³] DWS [kg/m ³] [m ² /s] 1 0 0 0 2 18 2.45E-9 3 190 1.27E-6	alized Water Content [-] 0.4 0.6 0.8 1
✓ Generate Approximation H _a ameters: Reference Water Content [kg/m²]: 18 Free Water Saturation [kg/m²]: 190 Water Absorption Coefficient [kg/m²√s]:	10-09.00 0 50 W	100 150 200 ater Content [kg/m ³]
Paste into Database Impo	ixport	OK Cancel Help
	0. Check "Generate"	



Layer/Material Data Layer/Material Name: Solid Brick Masonry - uni Bulk density [kg/m³]: Porosity [m³/m³]: Spec. Heat Capacity [J/kgK]: Thermal Conductivity [W/mK]: Water Vapour Diffusion Resistance Factor [-]:	locked 1900 0.24 850 0.6 10	Th	Typical Built-In Moisture [kg/m [#]]: 100 Layer Thickness [m]: 0.01 hermal Conductivity, Design Value [W/mK]: Color:	
Hygrothermal Functions Material Information Moisture Storage Function Liquid Transport Coefficient, Suction Liquid Transport Coefficient, Redistribution Water Vapour Diffusion Resistance Factor, moistu Water Vapour Diffusion Resistance Factor, moistu Water Vapour Diffusion Resistance Factor, moistu Whermal Conductivity, moisture-dependent Thermal Conductivity, temperature-dependent Enthalpy, temperature-dependent Image: Senerate Approximation Parameters: Reference Water Content [kg.n²]; Reference Water Saturation [kg/m³]; 100 Water Absorption Coefficient 0.11	No. Water Cont [kg/m ³] 1 00 2 18 3 190	DWW [m²/s] 0 2.45E-9 1.27E-7	Normalized Water Content [-] 0 0.2 0.4 0.6 0.8 1 10-07.00 10-07.50 10-08.50 10-08.50 0 50 100 150 200 Water Content [kg/m]	
Paste into Database Import Export OK Cancel Help 11. Select "Liquid Transport Coefficient, Redistribution"				



🕜 Layer/Material Data					×		
Layer/Material Name: Solid Brick Masonry - ur	llocked						
Bulk density [kg/m³] Porosity [m³/m³] Spec. Heat Capacity [J/kgK] Thermal Conductivity [W/mK] Water Vapour Diffusion Resistance Factor [-] Hyorothermal Functions	1900 0.24 850 0.6 10	Ther	Typical Built- L: rmal Conductivity, De	In Moisture [kg/m³]: [ayer Thickness [m]: [sign Value [W/mK]: [Color:	0.01		
Moisture Storage Function Liquid Transport Coefficient, Suction Liquid Transport Coefficient, Redistribution Water Vapour Diffusion Resistance Factor, moistu Thermal Conductivity, moisture-dependent Thermal Conductivity, temperature-dependent Enthalpy, temperature-dependent Image: Conductivity, temperature-de	No. Water Cont [kg/m³] 1 0 2 18 3 190	DWW [m ⁺ /s] 0 2.45E-9 1.27E-7	0 10-07.00 10-07.50 10-07.50 10-08.00 10-08.00 10-08.50 0	Normalized Water (0,2 0,4 0 0 0 50 100 0 0 0 50 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Content [-] .6 0.8 1 		
Paste into Database Import	Export			ОК	Cancel Help	13	 B. Enter A-value In this case: 0.5 kg/m²√h / 60 = 0.00833 kg/m²√s



Result analysis*



- Check total water content (accumulation of moisture in whole construction); must not keep increasing
- Relative humidity at the interface between interior plaster and interior insulation < 95 % r.F.
 - \rightarrow risk of frost damage
 - \rightarrow or: frost-resistance of materials necessary
 - (Insulation system plaster, wall materials)

*) Note: List not necessarily complete. Depending on boundary conditions adittional critical positions may occur \rightarrow Check in film display



Additional information



- An interior insulation reduces the drying potential of a construction due to a lower over-all temperature and a higher diffusion-resistance to the interior side
- The moisture content at the interface interior plaster / interior insulation usually can be reduced by an enhancement of the protection against driving rain (e.g. by water-repellent treatment, new exterior plaster, paint coat)
- Water-repellent treatment according to WTA:
 - A-value < 0.1 kg/m²√h
 - 50 % increase of the $\mathrm{s_d}\text{-value}$
- Investigations of an exposed masonry need the knowledge of effective material properties, combining the properties of bricks and mortar
- A gypsum plaster at the interior surface usually has to be removed before applying an interior insulation
- Smart vapor retarders are favorable since the drying potential to the inside mainly remains unaffected.



Content

Flat roof (slide 3 ff.) Pitched roof (slide 11 ff.) Exterior wall with ETICS (slide 20 ff.) Exterior wall with interior insulation (slide 28 ff.) Ventilated timber frame construction (slide 42 ff.) Basement wall without ground water (slide 54 ff.)

Construction drawing



- 1 Planking
- 2 Battens
- 3 Counter battens
- 4 External cladding
- 5 Insulation
- 6 Internal Cladding
- 7 Vapour retarder
- 8 Gypsum board

Construction in WUFI





Please note



- Insert Air Change Source in air layer
 - \rightarrow The exchange rate is dependent on construction, surface color and ventilation openings
- Insert an air infiltration source at the cold side of the construction (at the position where condensation would occur) → source strength depending on the air tightness and height of the wall head
- Relevant orientation: usually north
- Short wave radiation absorptivity depending on color of surface
- Long wave radiation emissivity depending on material of surface
- If the short-term hygrothermal behavior of the outer surface is to be evaluated (e.g. dew position), turn on explicit radiation balance
- "Adhering fraction of rain" according to inclination and construction type (vertical wall: 0.7)



Air change source setup





Air change source setup

Hygrothermal Sources		X
Layer/Material Name Air Layer 40 mm; without additional moisture	e capacity	
Nr Type Name	Vev 😡	v Heal Source
	Sa New M	loist tre Source
	🧟 🛃 New Air	Change Source
		Edit
	書	Delete
✓ OK X Abort	? <u>H</u> elp	

3. Select "New Air Change Source"



Air change source setup

Air Change Source	
Name Air Change Source]
⊂Spread Area	_
One Element	
Several Elements	
Whole Layer	
Source Type	51
Constant In the second secon	
○ Transient from File ○ right-hand side	
Air Changes [1/h] 10	
✓ OK X Cancel ? Help	



Moisture source setup





Moisture source setup

Hygrothermal Sources				
Layer/Material Name	particle board V100			
Nr. Type	Name	 	New Her t Source	
		 ଡୁର୍	New Air Change Source	
		T I I I I I I I I I I I I I I I I I I I	Edit	
		1	Delete	
✓ OK X Abort ? Help				

3. Select "New Moisture Source"



Moisture source setup

Moisture Source	—X —		
Name Moisture Source			
Spread Area One Element Several Elements Whole Layer	Start Depth in Layer [m] 0,008 End Depth in Layer [m] 0,013		
Source Type Transient from File Fraction of Driving Rain Air Infiltration model IBP Constant Monthly Moisture Load	 Source Term Cut-Off [kg/m³] No Cut-Off Cut-Off at Max. Water Content Cut-Off at Free Water Saturation User-Defined 		
Envelope Infiltration q50 [m³/m²	²h]		
3 Air Tightness	Class B		
Mechan	Stack Height [m] 5 ical Ventilation Overpressure [Pa] 0		
✓ OK	Cancel ? Help		



Result analysis*



- Check total water content (accumulation of moisture in whole construction); must not keep increasing
- Check water content in the external cladding
- If necessary check moisture content of the insulation

*) Note: List not necessarily complete. Depending on boundary conditions additional critical positions may occur \rightarrow Check in film display



Additional information



As the occurring air exchange rates are often not known, it may be useful to vary the air exchange rate to see its influence on the hygrothermal behavior of the construction.

(Air exchange rates are usually between 10 and 200 1/h)



Additional information

 Examples for air change rates for ventilated facades



Guide values for air changes	Flow rate [(m³/h)/m²]	Gap [mm]	ACH [1/h]
Wood Siding	≈ 1,83	≈ 5	20
Vinyl Siding	≈ 9,14	≈ 5	200
Facing brick	≈ 2,74	≈ 25	10
Stucco (vented)	≈ 1,83	≈ 10	10
Sheathing flanking flow*	≈ 0,91	≈ 5	10 © Building Science Press

*The flank flow refers to the leaks in the area on the outer panel.



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Construction drawing

Soil
 Perimeter insulation
 Concrete wall
 Interior plaster







Please note



- Material data "Soil (Christian) DIN" (see Generic Materials) Thickness about 0.5 m
- The XPS perimeter insulation is build up three layers: core and outer surface skins (thickness 1 cm).
- Heat transfer resistance "Basement"
- No radiation absorptivity / emissivity
- No rain water absorption
- Outdoor climate:
 - Soil temperature from the climate "Holzkirchen-IBP Year 1991"
 - Sinus curve according to the diagram on slide 56 with constant relative humidity of 99 % or 100 % RH
- Set interior climate depending on utilization



Soil temperature setup (from climate Holzkirchen)





Soil temperature setup (from climate Holzkirchen)

 Select ground temperature at 50 cm or 1 m depth 	EN15026 Temperature Shift [K]: 0.0 Nighttime radiation cooling Switch off simplified radiation cooling (recommended) WET-File Temperature
4 Enter Constant Deletive	 Air Temperature Black surface White surface Ground surface 50 cm below ground surface 1 m below ground surface
Humidity of 99 % or 100 %	Relative Humidity Constant Relative Humidity [%] 99 Radiation
	No Radiation Rain No Rain OK Cancel Help



x

Detailed Options

Soil temperature setup (from diagram)

Average soil temperature for each month depending on the depth of the soil



Minimum of about 7 °C in March and Maximum of about 12 °C in September

<u>Ref:</u> Heidreich, U.: Nutzung oberflächennaher Geothermie zum Heizen und Kühlen eines Bürogebäudes. Symposium Energetische Sanierung von Schul- und Verwaltungsgebäuden, FH Münster 2006.



Soil temperature setup (from diagram)



Result analysis*



- Check total water content (accumulation of moisture in whole construction); must not keep increasing
- Check water content of insulation
- Check water content in masonry / concrete

*) Note: List not necessarily complete. Depending on boundary conditions additional critical positions may occur \rightarrow Check in film display



Additional information



The climate file from Holzkirchen 1991 contains measured temperatures in the ground at 50 cm and 100 cm depth.

Furthermore one can use temperature values from the literature and implement them as sinusoidal curve (slide 56).

 By inserting a soil layer, the interaction between construction and soil can be taken into account in the simulation



Additional information



Consideration of water in the soil:

- Material data containing moisture storage function and moisture transport coefficients "Soil (Christian) FSP" must be used. Further soil materials can be found in the "North American Database in the "Soil" section.
- The soil has to be saturated during the calculation period (check water content after calculation).
- Create a climate file, which contains rain for each time step (with CreateClimateFile.xls).
- Adhering Fraction of Rain (in "Surface Transfer Coefficient") must be set to 1.
- Pressurized water can not be taken into account!



Handling of typical constructions

Auf Wissen bauen



