BASIC HYGRO-THERMAL EVALUATION OF THE BUILDING CONSTRUCTION (1D HEAT AND MOISTURE TRANSFER)

according to EN ISO 13788, EN ISO 6946 and CSN 730540

Teplo 2014

Project name : **HALL EXTENSION**
User : ALESSIO AMODIO
Order :
Date : 06.01.2020

ASSEMBLY OF THE CONSTRUCTION AND BOUNDARY CONDITIONS:

Type of analysed construction : Floor on ground
Correction of U-value dU : 0.020 W/m2K

Assembly of the construction (from interior) :

No.	Name	D [m]	Lambda [W/(m.K)]	C [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]	
1	CERAMIC TILES	0,0150	1,0100	840,0	2000,0	200,0	0.0000	
2	REINFORCED CON		0,0850	1,5800	1020,0	2400,0	29,0	0.0000
3	XPS	0,1000	0,0300	2060,0	28,0	130,0	0.0000	
4	PE HD FOIL	0,0016	0,3500	1470,0	900,0	144000,0	0.0000	
5	LEVELL. GRAVEL		0,0500	0,9500	960,0	1750,0	4,0	0.0000
6	CRUSH AGGR.	0,3000	0,6500	800,0	1650,0	15,0	0.0000	

Note: D is thickness of layer, Lambda is design thermal conductivity of layer, C is specific thermal capacity, Ro is bulk density of layer, Mi is vapor resistance factor of layer and Ma is initial built-in moisture in layer.

No.	Complete name of layer	Internal calculation of thermal conductivity
1	CERAMIC TILES	---
2	REINFORCED CONCRETE	---
3	XPS	---
4	PE HD FOIL	---
5	LEVELL. GRAVEL	---
6	CRUSH AGGR.	---

Calculation will be executed using moisture redistribution.

Assembly of the construction (from interior) :

No.	Name	Coefficient K [W/(m.K)]	u,23/80 [%]	W,c [kg/m2]	W,m [kg/m2]	Redistribution	
1	CERAMIC TILES	---	0.00	0.00	0.00	NO	
2	REINFORCED CON		---	0.00	0.00	0.00	NO
3	XPS	---	0.00	0.00	0.00	NO	
4	PE HD FOIL	---	0.00	0.00	0.00	NO	
5	LEVELL. GRAVEL		---	0.00	0.00	0.00	NO
6	CRUSH AGGR.	---	0.00	0.00	0.00	NO	

Note: Lambda,m is th.conductivity of layer fully saturated by moisture, u23/80 is character. gravimetric moisture content, W,c is critical moisture content (limit for beginning of liquid phase transport), W,m is max.possible amout of moisture and redistribution indicates the liquid phase transport possibility.

Boundary conditions :

Internal surface thermal resistance Rsi : 0.17 m2K/W
dtto for calculation of temperature factor Rsi : 0.25 m2K/W
External surface thermal resistance Rse : 0.00 m2K/W
dtto for calculation of temperature factor Rse : 0.00 m2K/W

Design external temperature Te : 8.6 C
Design internal air temperature Tai : 15.0 C
Design relative humidity of external air RHe : 100.0 %
Design relative humidity of internal air RHi : 45.0 %

Month	Dur.[days]	Ti[C]	RHi[%]	Pi[Pa]	Te[C]	RHe[%]	Pe[Pa]
1	31	15.0	76.2	1298.8	4.0	100.0	812.8
2	28	15.0	80.7	1375.5	3.1	100.0	762.8
3	31	15.0	81.9	1395.9	4.2	100.0	824.4
4	30	15.0	85.5	1457.3	6.2	100.0	947.6
5	31	15.0	92.1	1569.8	8.8	100.0	1132.0
6	30	15.0	97.7	1665.2	11.3	100.0	1338.4
7	31	15.0	99.0	1687.4	12.8	100.0	1477.5
8	31	15.0	99.8	1701.0	13.6	100.0	1556.7
9	30	15.0	92.8	1581.7	13.4	100.0	1536.6
10	31	15.0	85.6	1459.0	11.5	100.0	1356.3
11	30	15.0	81.7	1392.5	8.9	100.0	1139.7
12	31	15.0	80.0	1363.5	6.1	100.0	941.1

Note: Tai, RHi and Pi are mean monthly parameters of internal air (temperature, rel. humidity and partial vapor pressure) anf Te, RHe and Pe are mean monthly parameters in environment on external side (temperatur, rel. humidity and partial vapor pressure).

Mean monthly external temperature Te was calculated according to EN ISO 13788 (influence of thermal capacity of the ground).

To increase the safety, internal relative humidity was increased for: 5.0 %

The first month of calculation was determined according to EN ISO 13788.
Number of calculated years : 1

RESULTS OF CALCULATION :

Thermal resistance and thermal transmittance according to EN ISO 6946 :

Thermal resistance of construction R : 3.611 m2K/W
Thermal transmittance of construction U : **0.264 W/m2K**

U-value of built-in construction U,kc : 0.28 / 0.31 / 0.36 / 0.46 W/m2K
These informational values are valid for various design level of thermal bridges expressed by means of increment according to clause B.9.2 in ČSN 730540-4.

Diffusion resistance and thermal accumulation:

Vapor diffusion resistance of construction ZpT : 1.3E+0012 m/s

Decrement factor of construction Ny* : 828.2
Time shift of temperature oscillation Psi* : 17.9 h

Internal surface temperature and temperature factor according to EN ISO 13788 :

Internal surface temperature for design conditions Tsi,p : 14.59 C
Temperature factor in design conditions f,Rsi,p : **0.935**

Month no.	Minimum required values for max. internal surface relative humidity				Calculated values		
	--------- 80% ---------		-------- 100% ---------				
	Tsi,m[C]	f,Rsi,m	Tsi,m[C]	f,Rsi,m	Tsi[C]	f,Rsi	RHsi[%]
1	14.2	0.931	10.8	0.622	14.3	0.935	79.8
2	15.1	1.011	11.7	0.724	14.2	0.935	84.8
3	15.4	1.034	11.9	0.716	14.3	0.935	85.7
4	16.0	1.118	12.6	0.726	14.4	0.935	88.7
5	17.2	1.356	13.7	0.795	14.6	0.935	94.5
6	18.1	1.850	14.6	0.902	14.8	0.935	99.2
7	18.4	2.525	14.8	0.929	14.9	0.935	99.9
8	18.5	3.488	15.0	0.978	14.9	0.935	100.0
9	17.3	2.454	13.8	0.278	14.9	0.935	93.4
10	16.1	1.302	12.6	0.316	14.8	0.935	86.9
11	15.3	1.054	11.9	0.492	14.6	0.935	83.8
12	15.0	1.000	11.6	0.616	14.4	0.935	83.0

Note: RHsi is relative humidity at the internal surface, Tsi is int.surface temperature and f,Rsi is temp.factor.

Vapor diffusion in design conditions and annual balance according to CSN 730540:

(without influence of built-in moisture and sun radiation)

Pressure and temperature distribution in design conditions:

interface:	i	1-2	2-3	3-4	4-5	5-6	e
theta[C]:	14.7	14.7	14.6	9.5	9.4	9.4	8.6
p [Pa]:	767	771	775	793	1114	1114	1121
p,sat [Pa]:	1676	1673	1664	1183	1183	1176	1121

Note: theta is temperature on interfaces of layers, p is expected partial vapor pressure on interfaces of layers and p,sat is saturated partial vapor pressure on interfaces.

No condensation occurs in the design conditions.

Vapor diffusion flow rate Gd : -2.789E-0010 kg/(m2.s)

Annual moisture balance according to EN ISO 13788:

Annual cycle no. 1

Interstitial condensation occurs in construction during the model year.

Condensation zone no. 1

Month	Cond.zone boundary left [m]	right	Act.cond./evap. Gc [kg/m2s]	Accum.moisture Ma [kg/m2]
2	0.2000	0.2000	5.64E-0009	0.0136
3	0.2000	0.2016	1.80E-0009	0.0185
4	0.2000	0.2016	1.51E-0009	0.0224
5	0.2000	0.2016	1.47E-0009	0.0263
6	0.2000	0.2016	1.30E-0009	0.0297
7	0.2000	0.2016	8.30E-0010	0.0319
8	0.1066	0.2016	-4.21E-0010	0.0308
9	0.0746	0.2016	-5.65E-0009	0.0170
10	0.2000	0.2000	6.41E-0010	0.0007
11	0.2000	0.2000	2.03E-0009	0.0022
12	0.2000	0.2016	5.45E-0010	0.0037
1	0.2000	0.2016	8.46E-0010	0.0059

Maximum amount of condensated water vapor Mc,a: **0.0319 kg/m2**
Amount of evaporable water vapor Mev,a: **0.0260 kg/m2**

The zone is still wet at the end of the model year (i.e. Mc,a > Mev,a).

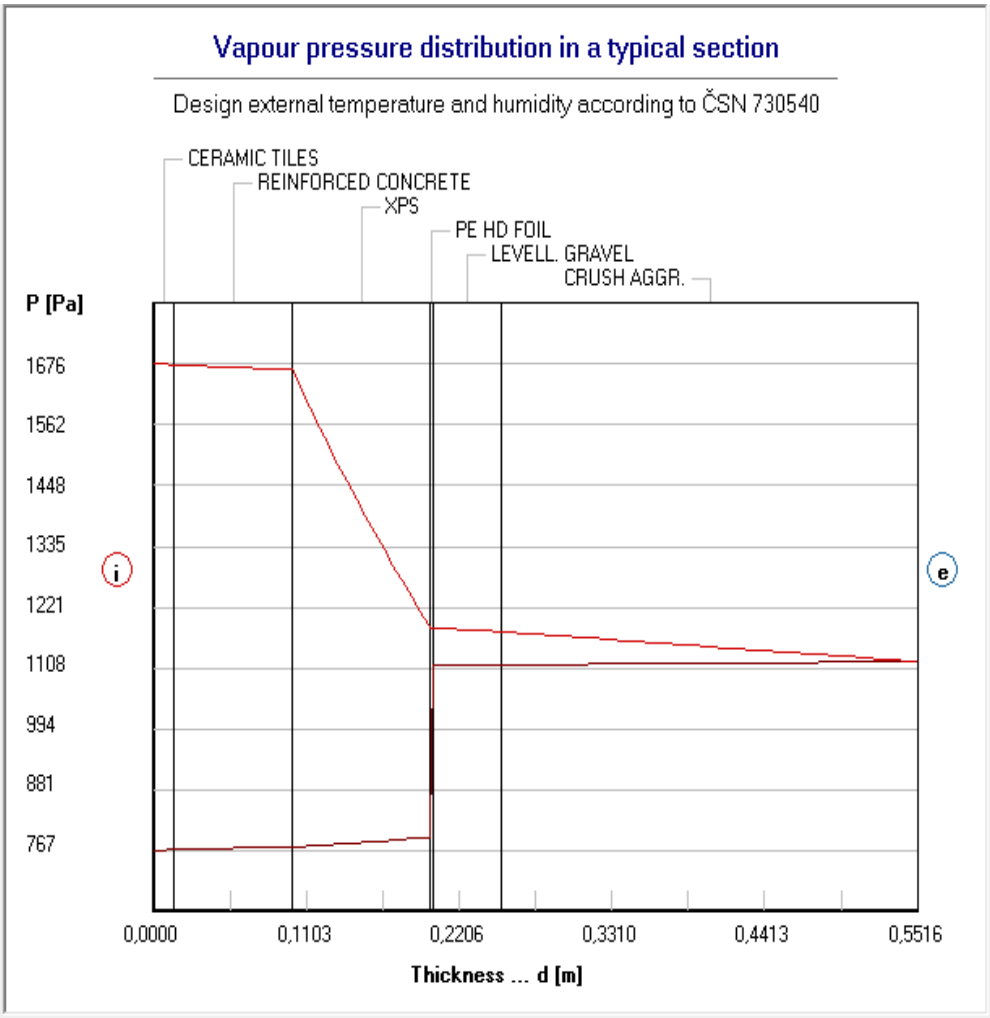
Condensation zone no. 2

Month	Cond.zone boundary left [m]	right	Act.cond./evap. Gc [kg/m2s]	Accum.moisture Ma [kg/m2]
2	---	---	---	---
3	---	---	---	---
4	---	---	---	---
5	---	---	---	---
6	---	---	---	---
7	---	---	---	---
8	0.0000	0.0000	5.87E-0010	0.0016
9	---	---	-1.75E-0008	0.0000
10	---	---	---	---
11	---	---	---	---
12	---	---	---	---
1	---	---	---	---

Maximum amount of condensated water vapor Mc,a: **0.0016 kg/m2**
Annual amount of evaporable vapor Mev,a is at least: **0.0016 kg/m2**

The zone is dry at the end of the model year (i.e. Mc,a < Mev,a).

Note: Calculation of water vapor diffusion was performed with the assumption of 1D vapor flow through prevailing assembly of the construction. The result is just informational for components with significant thermal bridges. More exact values can be obtained using 2D analysis.



LEGEND:

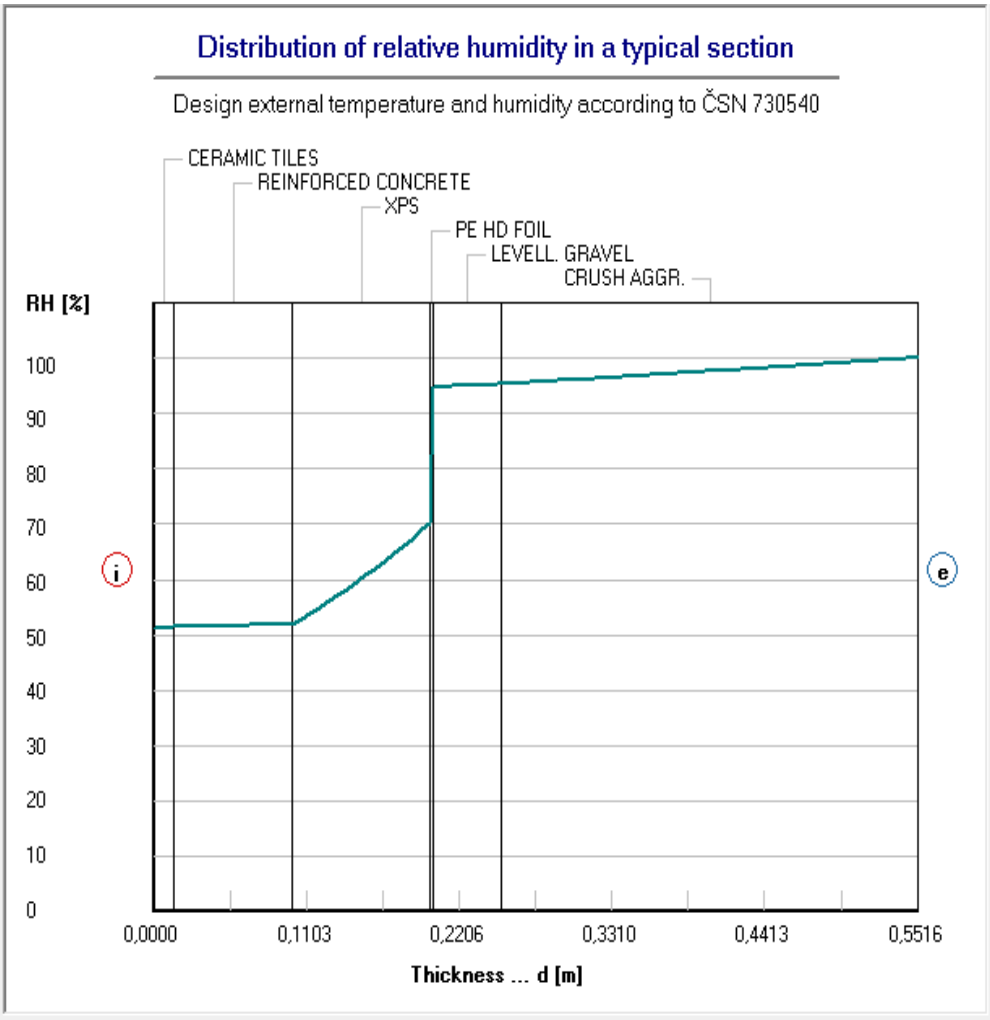
HALL EXTENSION

Vapour pressures:

Bound.conditions:

Interior	15,0 C
	45,0 %
Exterior	8,7 C
	100,0 %

satur. pressure
theor. pressure
real pressure
condens. zone



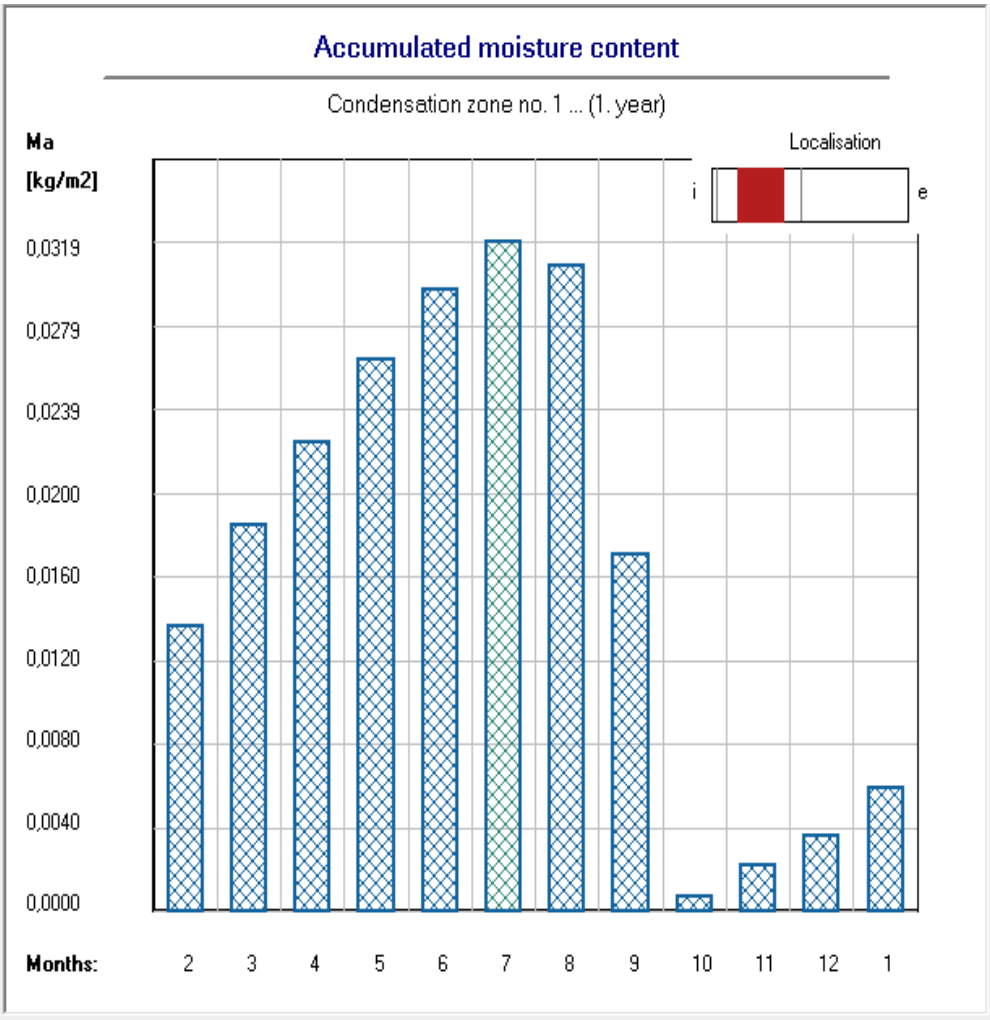
LEGEND:

HALL EXTENSION

Rel.humidity distribution:

Bound.conditions:

Interior	15,0 C
	45,0 %
Exterior	8,7 C
	100,0 %



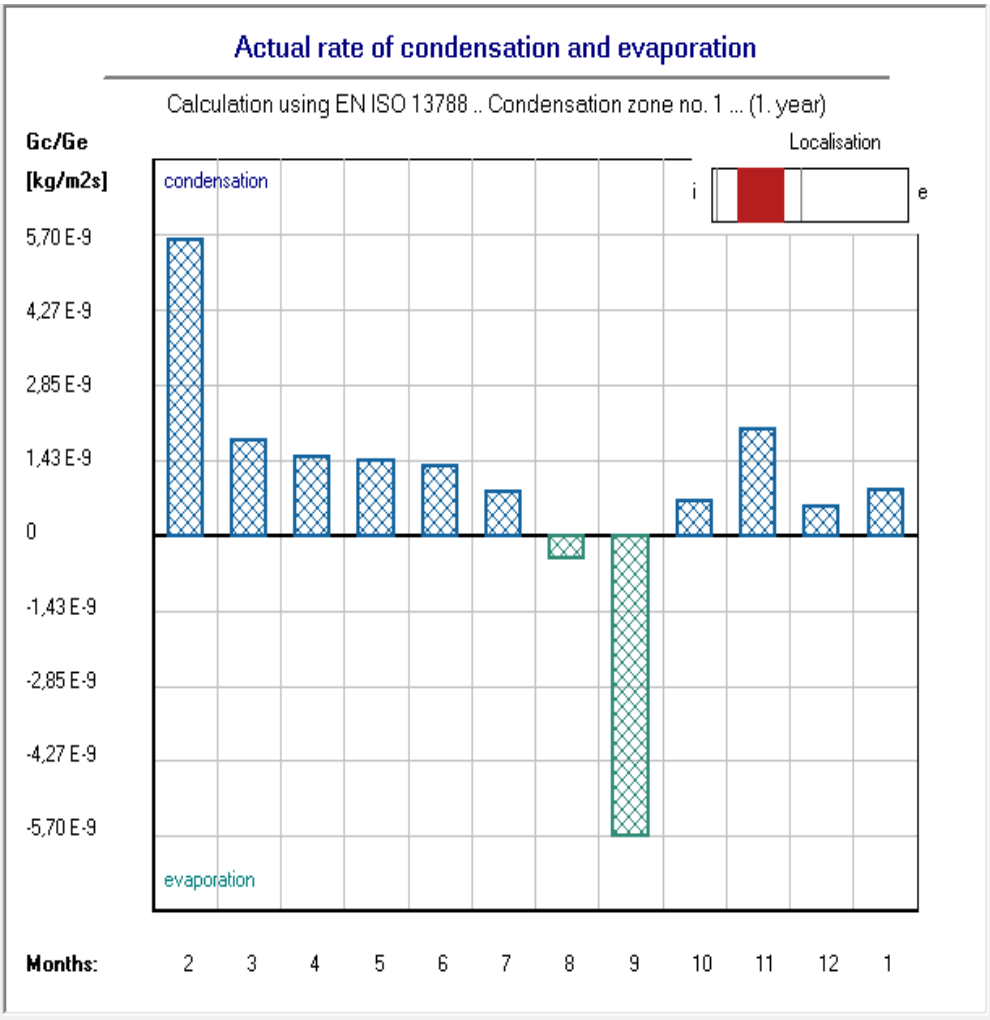
LEGEND:

HALL EXTENSION

Accumulated moisture:

Calculation year no. 1
Condensation zone no. 1

At the end of a model year, zone is still wet.



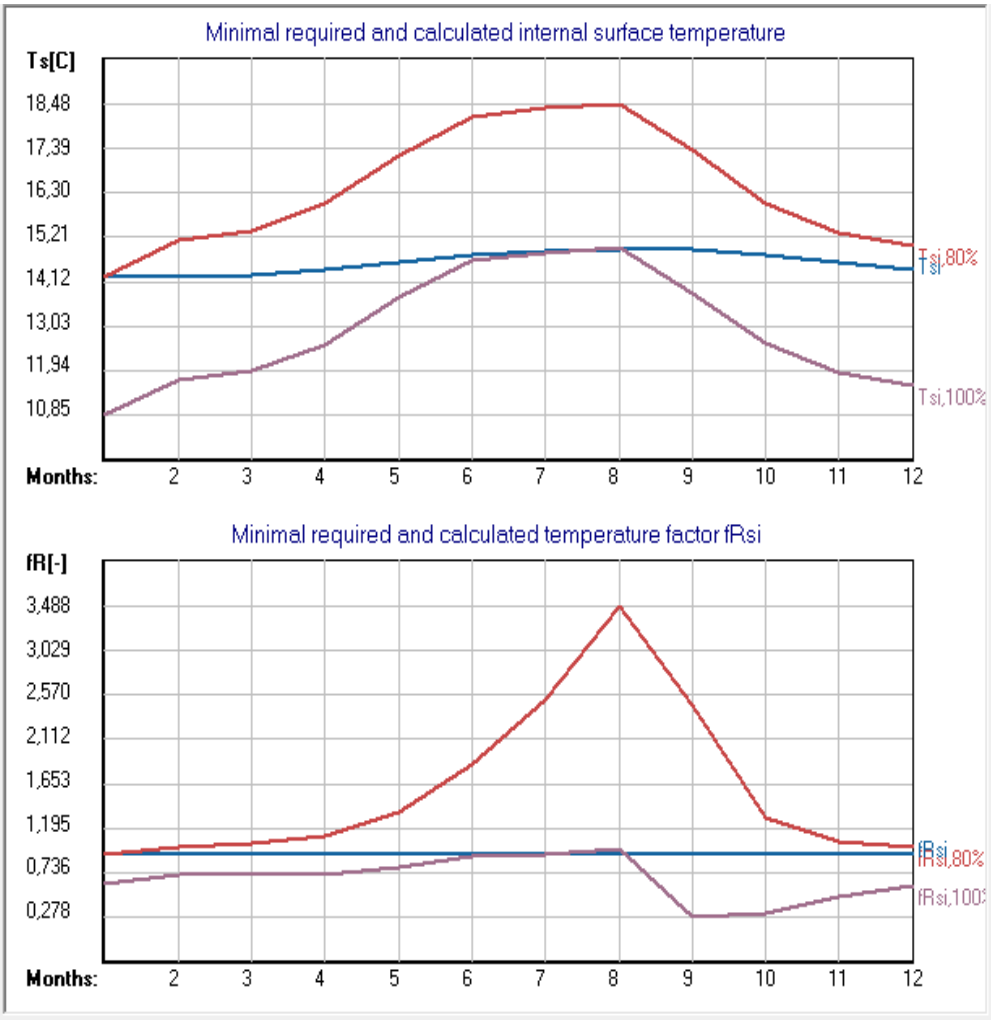
LEGEND:

HALL EXTENSION

Actual rate of condensation + evaporation:

Calculation year no. 1
Condensation zone no. 1

At the end of a model year, zone is still wet.



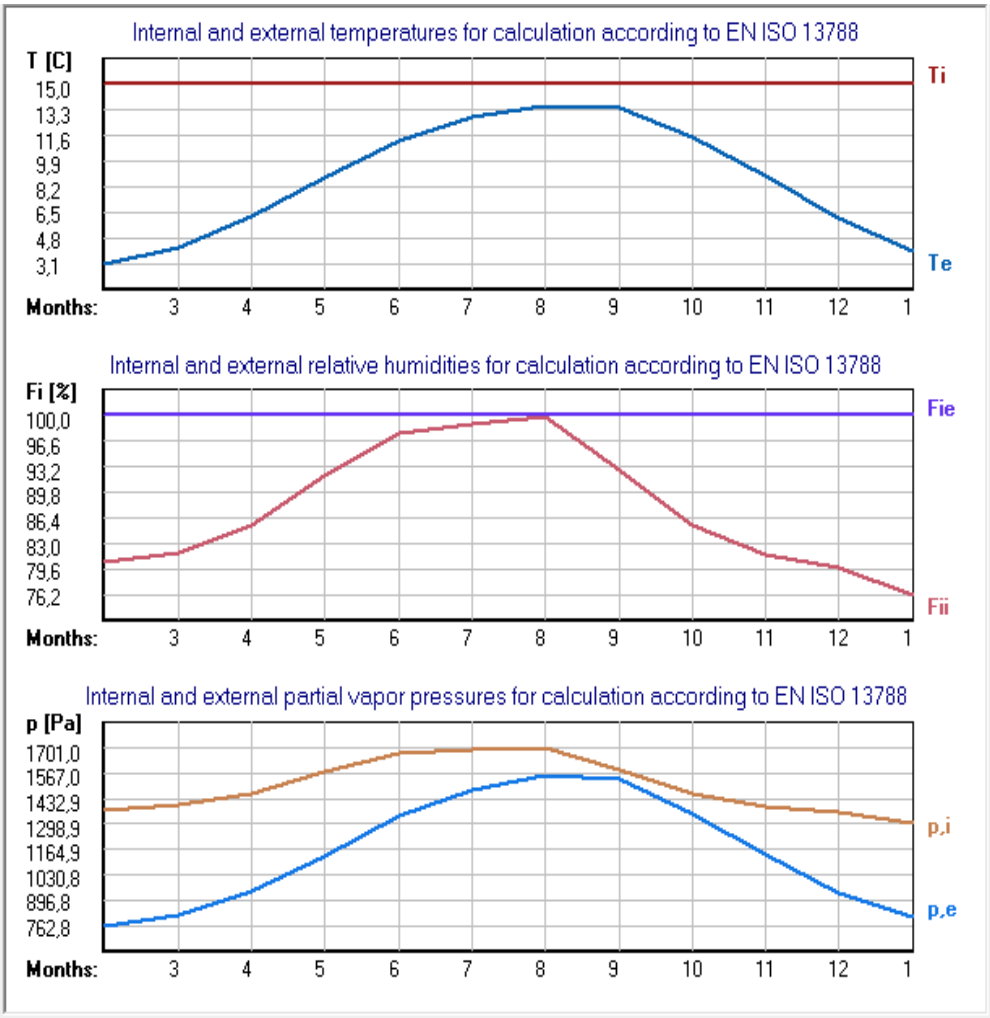
LEGEND:

HALL EXTENSION

Surf.temperatures and temp. factor:

Values for maximum surface relative humidity:

- 80% (preventing mould growth)
- 99% (preventing surface condensation)
- Calculated values

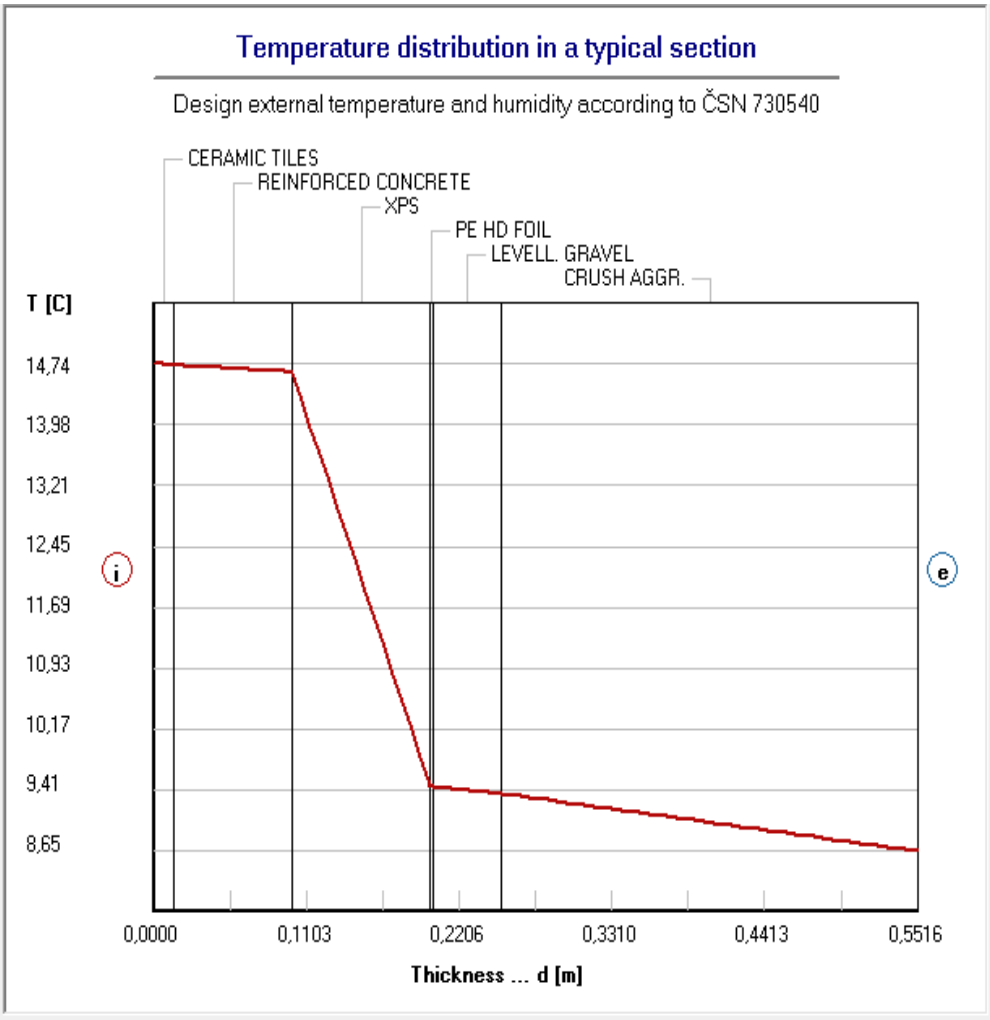


LEGEND:

HALL EXTENSION

Bound.conditions:

Number of years: 1
Starting month: 2



LEGEND:

HALL EXTENSION

Temperatures:

Bound.conditions:

Interior	15,0 C 45,0 %
Exterior	8,7 C 100,0 %