Faculty of Applied Sciences
ArGEnCo Department (Architecture, Geology, Environment & Constructions) – Sector Arkhê (Architecture)
Laboratory of Architecture: Performances & Techniques (LAP&T)
Director: Dr. Eng. Jean-Marie HAUGLUSTAINE, Associate Professor

Cold bridges on the building site of the European Bank of Investment at Luxemburg – Report 01

I the undersigned,

Jean-Marie HAUGLUSTAINE, civil engineer in architecture, doctor in applied sciences, Associate Professor at the ArGEnCo Department (Architecture, Geology, Environment and Construction) of the University of Liège,

Director of the Laboratory of Architecture: Performances & Techniques,

have been put in charge by the Joint venture CFE-VINCI, of assessing the cold bridges identified on the building site and of studying the ways to reduce their importance.

The present report is devoted to the three following cold bridges:

- Node 1: at the foot of the wall between the cafeteria and the visitors' parking;
- Node 2: concrete beams supporting the roof of the visitors' parking and resting on the wall close to the cafeteria;
- Node 3: at the foot of the external wall of the technical room.
- Node 4: the corridor near the outdoor staircase and the parking.

This report includes this flyleaf and 52 pages of calculations and conclusions.

So written in LIEGE, the 7th of August, 2007,

J.-M. HAUGLUSTAINE.

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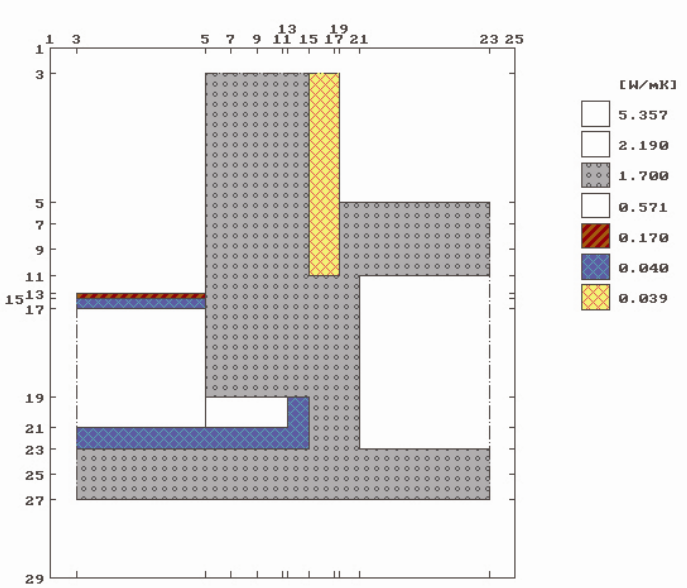
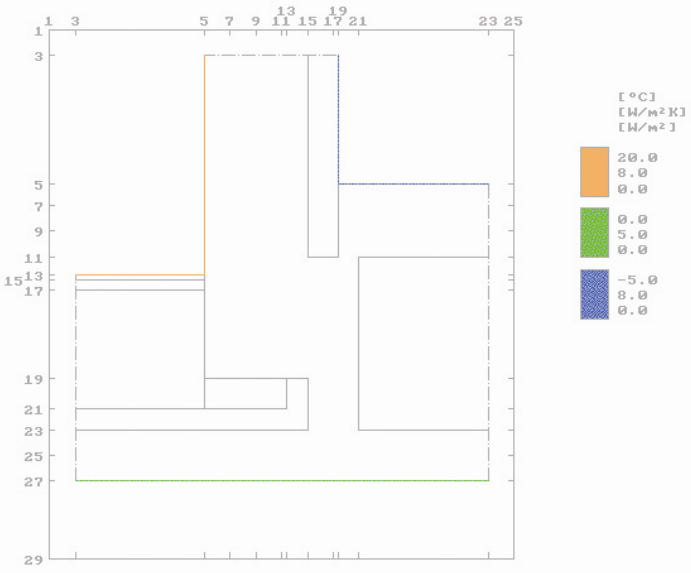
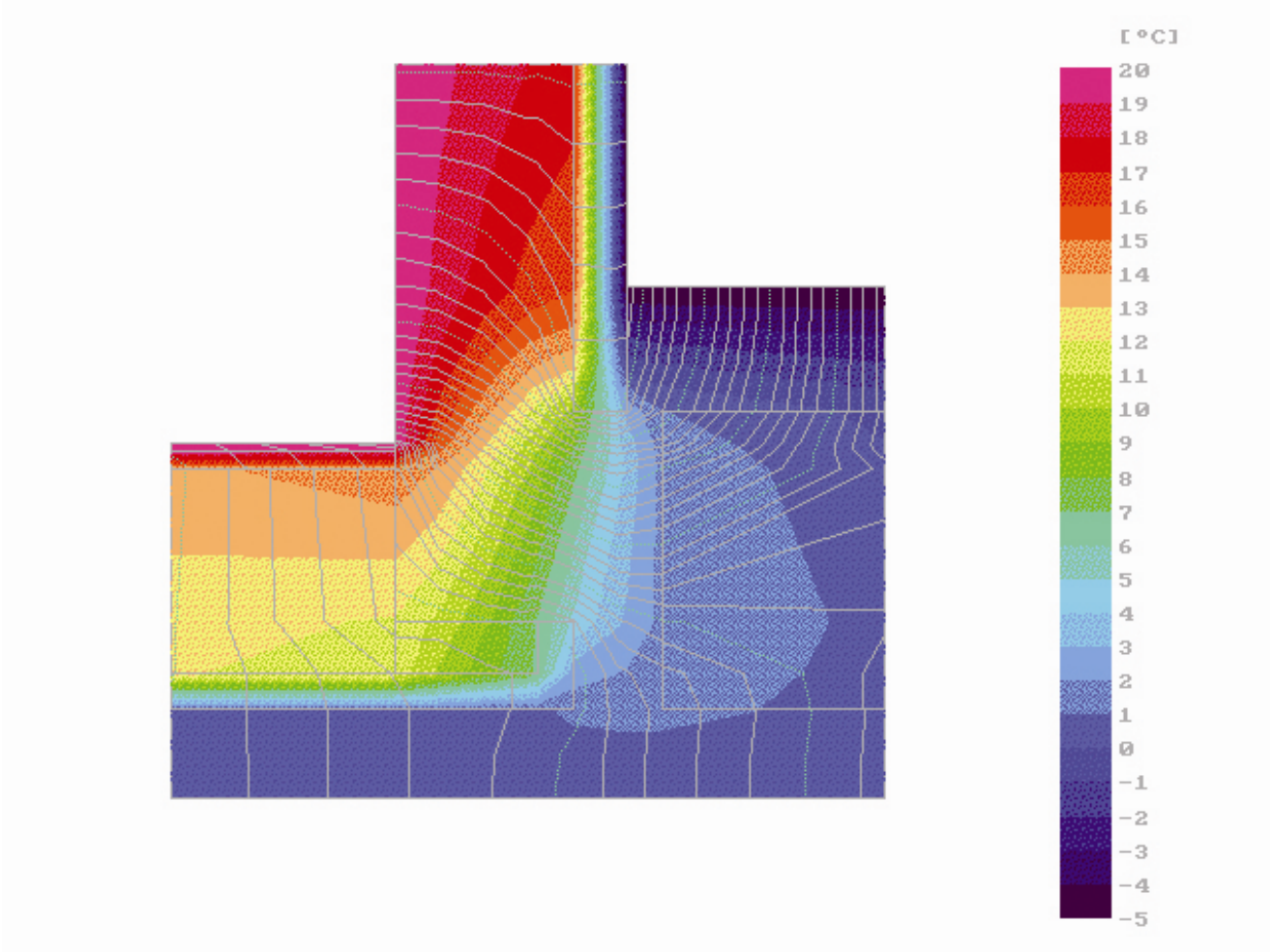
STUDY OF THERMAL BRIDGES – RAPPORT 01

1. NODE 1 – Foot of the wall between the cafeteria and the visitors' parking – Solution A

1.1 Graphical data and results:







NET DATA

Reference Unit [m] 1.0000
max. of lines 29
Width of lines 10.000 50.000 8.000 10.000 10.000 7.000
2.000 4.000 34.000 12.000 8.000 10.000
10.000 30.000
Total 205.000
Total edges deduced 165.000
max. of columns 25
Width of columns 10.000 50.000 10.000 10.000 10.000 2.000
8.000 10.000 2.000 8.000 50.000 10.000
Total 180.000
Total edges deduced 160.000

GEOMETRY OF MATERIALS

	Material name	pat. no.	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	3	5	19	7
2	reinforced concrete	37	1.700	3	7	19	9
3	reinforced concrete	37	1.700	3	9	19	11
4	reinforced concrete	37	1.700	3	11	19	15
5	reinforced concrete	37	1.700	11	15	23	17
6	reinforced concrete	37	1.700	11	17	23	21
7	reinforced concrete	37	1.700	5	19	7	23
8	reinforced concrete	37	1.700	7	19	9	23
9	reinforced concrete	37	1.700	9	19	11	23
10	mineral wool	67	0.039	3	15	11	19
11	extruded polystyrene	73	0.040	21	3	23	15
12	extruded polystyrene	73	0.040	19	13	21	15
13	timber	59	0.170	13	3	15	5
14	extruded polystyrene	73	0.040	15	3	17	5
15	reinforced concrete	37	1.700	23	3	25	23
16	reinforced concrete	37	1.700	25	3	27	23
17	air space H ≥ 2cm	1	0.571	19	5	21	13
18	air space H ≥ 2cm	1	2.190	17	3	21	5
19	air space H ≥ 2cm	1	5.357	11	21	23	23

LIMIT SURFACE CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	cafeteria	13	3	3	5	20	8	0
2	BC_SIMPL	parking	3	19	5	23	-5	8	0
3	BC_SIMPL	cave	27	23	27	3	0	5	0

1.2 Numerical results:

KOBRU86 RESULTS NODE 1A Node temperatures [°C]

	3	5	7	9	11	13	15	17	19	21	23
3		19.99	19.27	18.60	18.00	17.89	17.51	-1.24	-4.99		
5		19.97	18.71	17.58	16.68	16.54	16.10	-1.40	-4.98	-4.95	-4.97
7		19.97	18.33	16.89	15.74	15.56	15.06	0.05	-2.94	-3.16	-3.60
9		19.95	17.69	15.75	14.16	13.90	13.12	1.77	-0.54	-1.00	-1.91
11		19.93	16.71	14.28	12.07	11.59	9.44	3.89	2.62	1.04	-0.30
13	20.02	19.92	15.55	13.13	10.81	10.30	8.06	4.25	3.55	1.43	0.02
15	19.35	18.31	15.04	12.79	10.49	9.98	7.76	4.30	3.67	1.52	0.10
17	13.74	14.71	13.91	12.11	9.88	9.39	7.26	4.34	3.79	1.69	0.25
19	12.42	11.88	10.72	9.19	7.31	6.89	4.87	3.16	2.85	1.71	0.77
21	12.07	11.46	9.86	8.42	7.06	6.85	2.40	1.98	1.88	1.44	0.74
23	0.68	0.64	0.62	0.63	0.76	0.82	1.22	1.30	1.30	1.25	0.68
25	0.34	0.33	0.33	0.35	0.42	0.45	0.57	0.63	0.63	0.63	0.35
27	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01

KOBRU86 RESULTS NODE 1A Node temperatures (corners) [°C]

	3	5	19	23
3		19.99	-4.99	
5			-4.98	-4.97
13	20.02	19.92		
27	0.01			0.01

KOBRU86 RESULTS NODE 1A Temperatures (limit surface conditions) [°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 cafeteria	19.92	(13, 5)	20.02	(13, 3)
2 parking	-4.99	(3, 19)	-4.95	(5, 21)
3 cellar	0.01	(27, 23)	0.02	(27, 21)

KOBRU86 RESULTS NODE 1A Node not dimensional temperatures

	3	5	7	9	11	13	15	17	19	21	23
3		1.000	0.971	0.944	0.920	0.916	0.901	0.150	0.000		
5		0.999	0.949	0.903	0.867	0.862	0.844	0.144	0.001	0.002	0.001
7		0.999	0.933	0.876	0.830	0.823	0.802	0.202	0.082	0.073	0.056
9		0.998	0.907	0.830	0.766	0.756	0.725	0.271	0.178	0.160	0.123
11		0.997	0.868	0.771	0.683	0.664	0.578	0.355	0.305	0.242	0.188
13	1.001	0.997	0.822	0.725	0.632	0.612	0.522	0.370	0.342	0.257	0.201
15	0.974	0.933	0.802	0.712	0.619	0.599	0.510	0.372	0.347	0.261	0.204
17	0.750	0.788	0.756	0.685	0.595	0.576	0.490	0.374	0.351	0.267	0.210
19	0.697	0.675	0.629	0.567	0.492	0.476	0.395	0.326	0.314	0.268	0.231
21	0.683	0.658	0.595	0.537	0.482	0.474	0.296	0.279	0.275	0.258	0.230
23	0.227	0.226	0.225	0.225	0.230	0.233	0.249	0.252	0.252	0.250	0.227
25	0.214	0.213	0.213	0.214	0.217	0.218	0.223	0.225	0.225	0.225	0.214
27	0.200	0.200	0.200	0.200	0.201	0.201	0.201	0.201	0.201	0.201	0.200

KOBRU86 RESULTATS NOEUD1A Node not dimensional temperatures (corners)

	3	5	19	23
3		1.000	0.000	
5			0.001	0.001
13	1.001	0.997		
27	0.200		0.200	

KOBRU86 RESULTS NODE 1A Not dimensional temperatures (limit surface conditions)

Name of limit condition	at min	(X, Y)	at max	(X, Y)
1 cafeteria	0.997	(13, 5)	1.001	(13, 3)
2 parking	0.000	(3, 19)	0.002	(5, 21)
3 cave	0.200	(27, 23)	0.201	(27, 21)

KOBRU86 RESULTS NODE 1A Heat losses [W/m]

Entering heat losses	35.23
Exiting heat loses	35.23

KOBRU86 RESULTS NODE 1A Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 cafeteria	35.23	
2 parking		23.87
3 cellar		11.36

KOBRU86 RESULTS NODE 1A Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
5	19	5	23		19.09
13	3	13	5	12.75	
27	3	27	23		11.36
3	5	13	5	22.47	
3	19	5	19		4.78

KOBRU86 RESULTS NODE 1A Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses 1.409
Exiting heat losses 1.409

KOBRU86 RESULTS NODE 1A Heat losses at limit conditions for temperature difference of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 cafeteria	1.409	
2 parking		0.955
3 cellar		0.454

KOBRU86 RESULTS NODE 1A Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	19	5	23		0.763
13	3	13	5	0.510	
27	3	27	23		0.454
3	5	13	5	0.899	
3	19	5	19		0.191

KOBRU86 RESULTS NODE 1A U-values and R-values (complete analysis)

X1	Y1	X2	Y2	U-value [W/m2K]	R-value [m2K/W]	Length [m]
4	5	4	19	0.003	331.222	50.000
13	4	27	4	0.003	344.534	50.000
5	20	27	20	0.015	67.647	8.000
5	22	27	22	0.024	40.742	50.000

KOBRU86 RESULTS NODE 1A U-values and R-values (adiabatic edges)

X1	Y1	X2	Y2	U-value [W/m2K]	R-value [m2K/W]	Length [m]
3	5	3	19	0.003	331.222	50.000
13	3	27	3	0.003	344.534	50.000
5	23	27	23	0.024	40.742	50.000

1.3 Conclusions

Hypotheses of room temperatures: 20°C in the cafeteria; -5°C in the visitors' parking
The calculations of U1-value (= U-value of the wall between the cafeteria and the visitors' parking) and of U2-value (= U-value of the floor of the cafeteria) have been calculated separately.

Heat losses through the wall itself, excluding the cold bridge (by current meter)
= U-value of the wall (= U1 sheet) * Room height * ΔT between cafeteria and parking
= 0,282 * 3,8 * 25
= 26,79 W/m

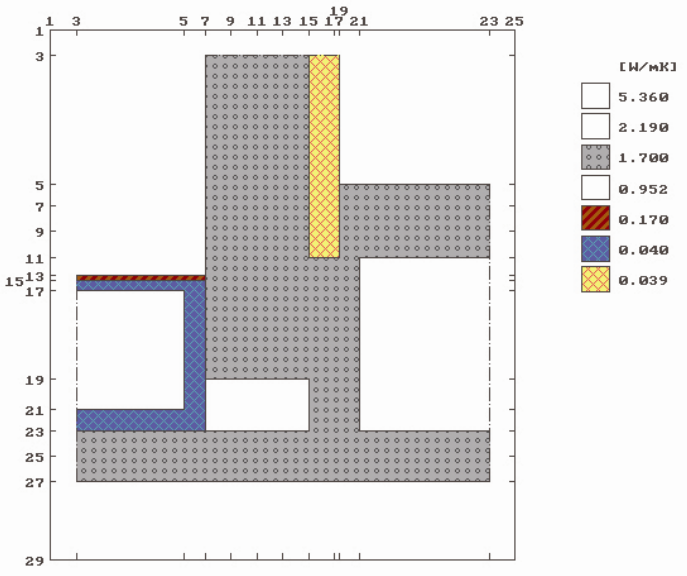
Heat losses by the cold bridge =
= calculation result minus heat losses of the node apart from the cold bridge
= 35,23 W/m – (U1 * 0,85 m * ΔT) – (U2 * 0,5 m * ΔT)
= 35,23 W/m – (0,282 * 0,85 * 25) – (0,264 * 0,5 * 20)
= 35,23 W/m – 5,993 W/m – 2,64 W/m
= 26,60 W/m

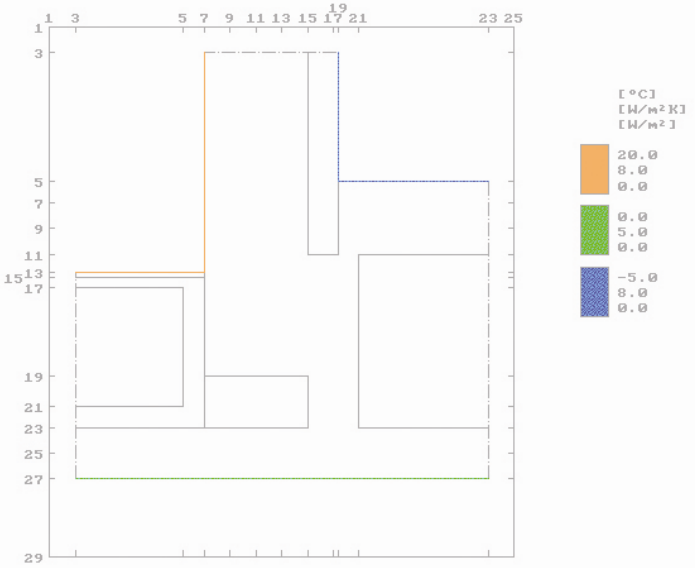
One notices that the heat losses due to the cold bridge are at the same order than the heat losses through the wall between the cafeteria and the visitors' parking.

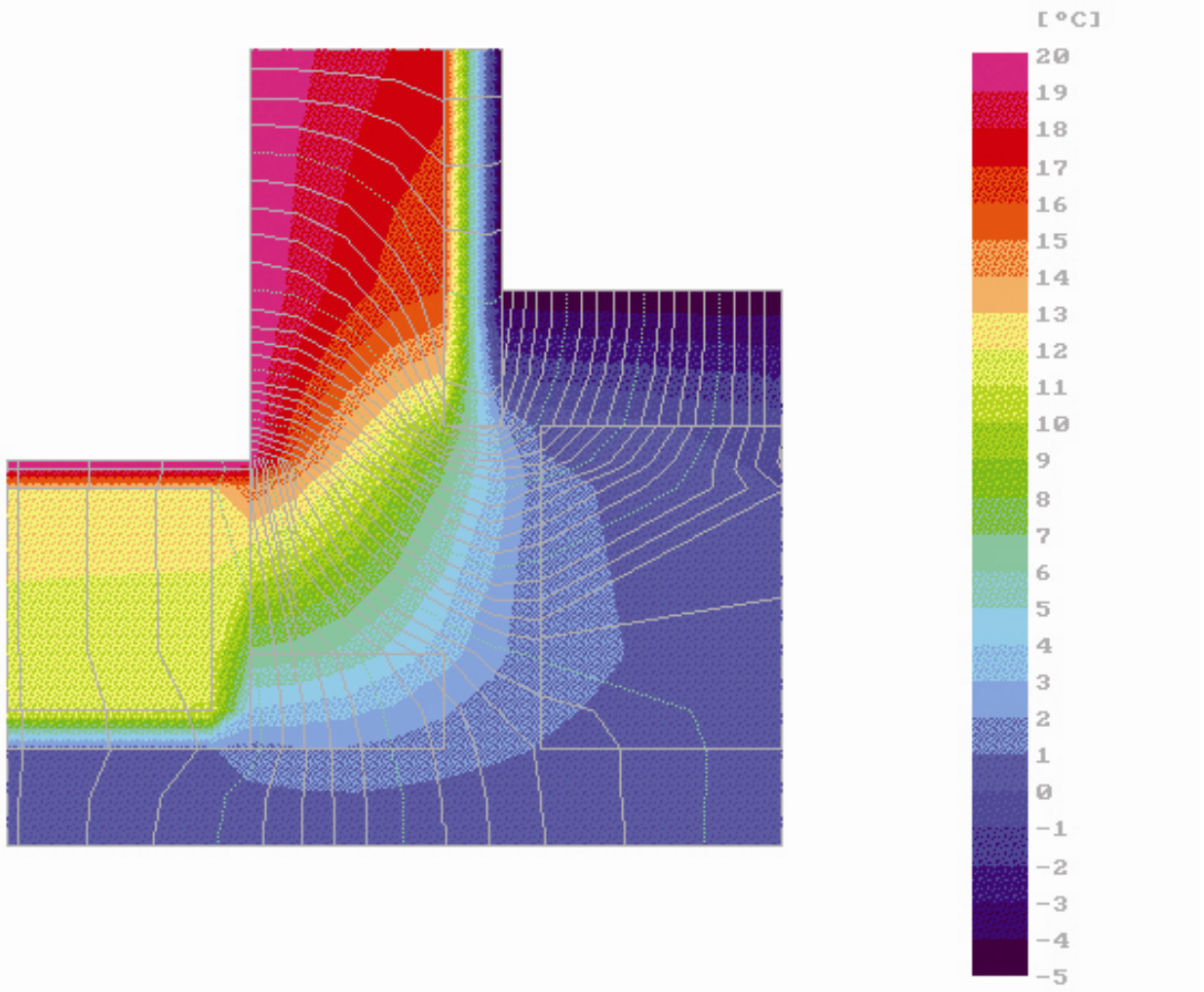
Nowhere on the wall or on the floor of the cafeteria, one could see any surface temperature lower than 14°C that could occasion surface condensation (for a relative humidity of 60 %).

2. NODE 1 – Foot of the wall between the cafeteria and the visitors' parking – Solution B

2.1 Graphical data and results :







NET DATA

Reference Unit [m] 1.0000
max. of lines 29
Width of lines 10.000 50.000 8.000 10.000 10.000 7.000
2.000 4.000 34.000 12.000 8.000 10.000
10.000 30.000
Total 205.000
Total edges deduced 165.000
max. of columns 25
Width of columns 10.000 42.000 8.000 10.000 10.000 10.000
10.000 10.000 2.000 8.000 50.000 10.000
Total 180.000
Total edges deduced 160.000

GEOMETRY OF MATERIALS

	Material name	pat. no.	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	3	7	19	9
2	reinforced concrete	37	1.700	3	9	19	11
3	reinforced concrete	37	1.700	3	11	19	13
4	reinforced concrete	37	1.700	3	13	19	15
5	reinforced concrete	37	1.700	11	15	23	17
6	reinforced concrete	37	1.700	11	17	23	21
7	reinforced concrete	37	1.700	5	19	7	23
8	reinforced concrete	37	1.700	7	19	9	23
9	reinforced concrete	37	1.700	9	19	11	23
10	mineral wool	67	0.039	3	15	11	19
11	extruded polystyrene	73	0.040	21	3	23	7
12	extruded polystyrene	73	0.040	17	5	21	7
13	timber	59	0.170	13	3	15	7
14	extruded polystyrene	73	0.040	15	3	17	7
15	reinforced concrete	37	1.700	23	3	25	23
16	reinforced concrete	37	1.700	25	3	27	23
17	air space	1	0.952	19	7	23	15
18	air space	1	2.190	17	3	21	5
19	air space	1	5.360	11	21	23	23

LIMIT SURFACES CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	cafeteria	13	3	3	7	20	8	0
2	BC_SIMPL	parking	3	19	5	23	-5	8	0
3	BC_SIMPL	cave	27	23	27	3	0	5	0

2.2 Numerical results :

KOBRU86 RESULTS NODE1B Node temperatures [°C]

	3	5	7	9	11	13	15	17	19	21	23
3			19.99	19.25	18.55	17.95	17.45	-1.25	-4.99		
5			19.97	18.64	17.45	16.52	15.92	-1.44	-4.98	-4.95	-4.97
7			19.97	18.22	16.69	15.50	14.78	-0.09	-3.05	-3.26	-3.67
9			19.95	17.51	15.45	13.79	12.69	1.51	-0.77	-1.22	-2.08
11			19.94	16.40	13.81	11.52	8.94	3.45	2.23	0.70	-0.55
13	19.99	20.01	19.74	15.07	12.47	10.12	7.46	3.76	3.09	1.06	-0.25
15	19.21	19.21	17.88	14.51	12.07	9.74	7.12	3.79	3.19	1.15	-0.17
17	12.58	12.63	14.70	13.26	11.25	9.03	6.55	3.79	3.27	1.30	-0.03
19	11.51	11.31	6.75	6.36	5.62	4.62	3.41	2.31	2.10	1.28	0.48
21	11.20	10.92	3.76	3.57	3.23	2.73	2.10	1.61	1.51	1.10	0.49
23	0.68	0.94	1.49	1.82	1.77	1.58	1.37	1.16	1.11	0.97	0.45
25	0.35	0.52	0.71	0.85	0.86	0.79	0.69	0.59	0.57	0.50	0.24
27	0.01	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.00

KOBRU86 RESULTATS NODE1B Node temperature (corners) [°C]

	3	7	19	23
3		19.99	-4.99	
5			-4.98	-4.97

13 19.99 19.74
27 0.01 0.00

KOBRU86 RESULTS NODE1B Temperatures (limit surfaces conditions) [°C]

	Name of limit conditions.	at min (X, Y)	at max (X, Y)
1	cafeteria	19.74 (13, 7)	20.01 (13, 5)
2	parking	-4.99 (3, 19)	-4.95 (5, 21)
3	cave	0.00 (27, 23)	0.03 (27, 9)

KOBRU86 RESULTS NODE1B Node not dimensional temperatures

	3	5	7	9	11	13	15	17	19	21	23
3			1.000	0.970	0.942	0.918	0.898	0.150	0.000		
5			0.999	0.946	0.898	0.861	0.837	0.142	0.001	0.002	0.001
7			0.999	0.929	0.868	0.820	0.791	0.197	0.078	0.069	0.053
9			0.998	0.900	0.818	0.752	0.707	0.260	0.169	0.151	0.117
11			0.998	0.856	0.752	0.661	0.558	0.338	0.289	0.228	0.178
13	0.999	1.000	0.990	0.803	0.699	0.605	0.498	0.350	0.323	0.243	0.190
15	0.968	0.968	0.915	0.780	0.683	0.590	0.485	0.352	0.327	0.246	0.193
17	0.703	0.705	0.788	0.730	0.650	0.561	0.462	0.352	0.331	0.252	0.199
19	0.661	0.652	0.470	0.455	0.425	0.385	0.337	0.293	0.284	0.251	0.219
21	0.648	0.637	0.350	0.343	0.329	0.309	0.284	0.264	0.260	0.244	0.219
23	0.227	0.238	0.260	0.273	0.271	0.263	0.255	0.246	0.245	0.239	0.218
25	0.214	0.221	0.228	0.234	0.234	0.232	0.228	0.224	0.223	0.220	0.210
27	0.200	0.201	0.201	0.201	0.201	0.201	0.201	0.201	0.201	0.201	0.200

KOBRU86 RESULTS NODE1B Node not dimensional temperatures (corners)

	3	7	19	23
3		1.000	0.000	
5			0.001	0.001
13	0.999	0.990		
27	0.200		0.200	

KOBRU86 RESULTS NODE1B Node not dimensional temperatures (limit surface conditions.)

	nom condit. lim.	émin (X, Y)	émax (X, Y)
1	cafeteria	0.990 (13, 7)	1.000 (13, 5)
2	parking	0.000 (3, 19)	0.002 (5, 21)
3	cave	0.200 (27, 23)	0.201 (27, 9)

KOBRU86 RESULTS NODE1B Heat losses [W/m]

Entering heat losses 36.84
Exiting heat losses 36.84

KOBRU86 RESULTS NOEUD1B Heat losses at limit conditions [W/m]

	Name of limit conditions	entering	exiting
1	cafeteria	36.84	
2	parking		22.76
3	cave		14.07

KOBRU86 RESULTS NODE1B Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
5	19	5	23		18.06
13	3	13	7	9.18	
27	3	27	23		14.07
3	7	13	7	27.66	
3	19	5	19		4.70

KOBRU86 RESULTS NODE1B Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses 1.473
Exiting heat losses 1.473

KOBRU86 RESULTS NODE1B Heat losses at limit conditions for temperature difference of 1°C [W/mK]

	Name of limit conditions	entering	exiting
1	cafeteria	1.473	
2	parking		0.911
3	cave		0.563

KOBRU86 RESULTS NODE1B Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	19	5	23		0.723
13	3	13	7	0.367	
27	3	27	23		0.563
3	7	13	7	1.106	
3	19	5	19		0.188

KOBRU86 RESULTS NODE1B U-Values and R-Values (complete Analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
4	7	4	19	0.003	331.222	50.000
13	4	27	4	0.003	344.534	42.000
13	6	27	6	0.001	1473.529	8.000
5	20	27	20	0.015	67.647	8.000
5	22	27	22	0.024	40.735	50.000

KOBRU86 RESULTS NODE1B U-Values and R-Values (adiabatic edges)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
3	7	3	19	0.003	331.222	50.000
13	3	27	3	0.003	344.534	42.000
5	23	27	23	0.024	40.735	50.000

2.3 Conclusions :

Heat losses through the wall, excluding the cold bridge (by current meter)
= U-Value of the wall (=U1) * Room height * ΔT between cafeteria and parking
= 0,282 * 3,8 * 25
= 26,79 W/m

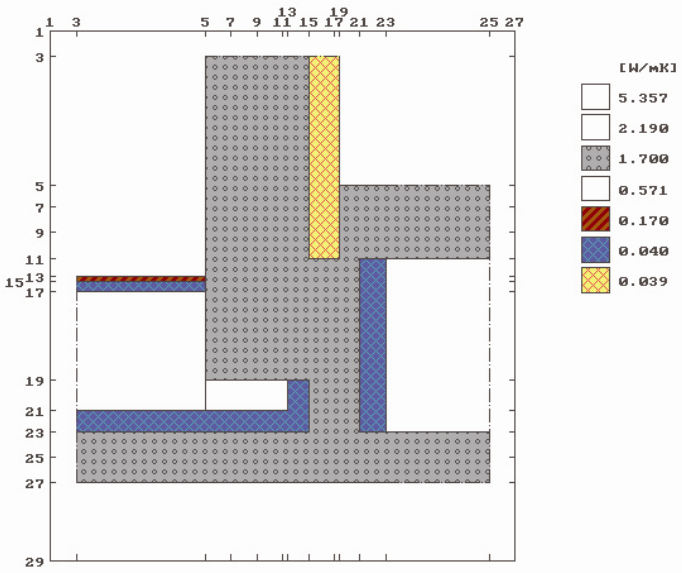
Heat losses by the cold bridge
= 36,84 W/m – (U1 * 0,85 m * ΔT) – (U2 * 0,5 m * ΔT)
= 36,84 W/m – (0,282 * 0,85 * 25) – (0,264 * 0,5 * 20)
= 36,84 W/m – 5,993 W/m – 2,64 W/m
= 28,207 W/m

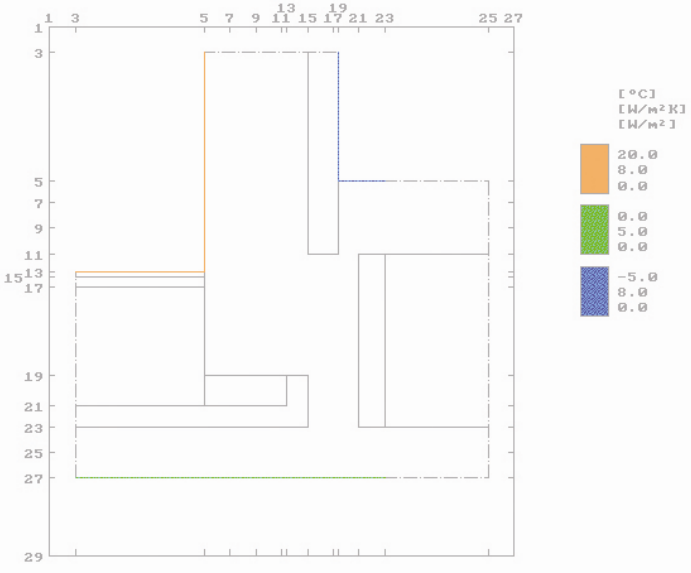
We can see that heat losses from the cold bridge are higher than those from the wall between the cafeteria and the parking. The A solution is thermally best than the B one.

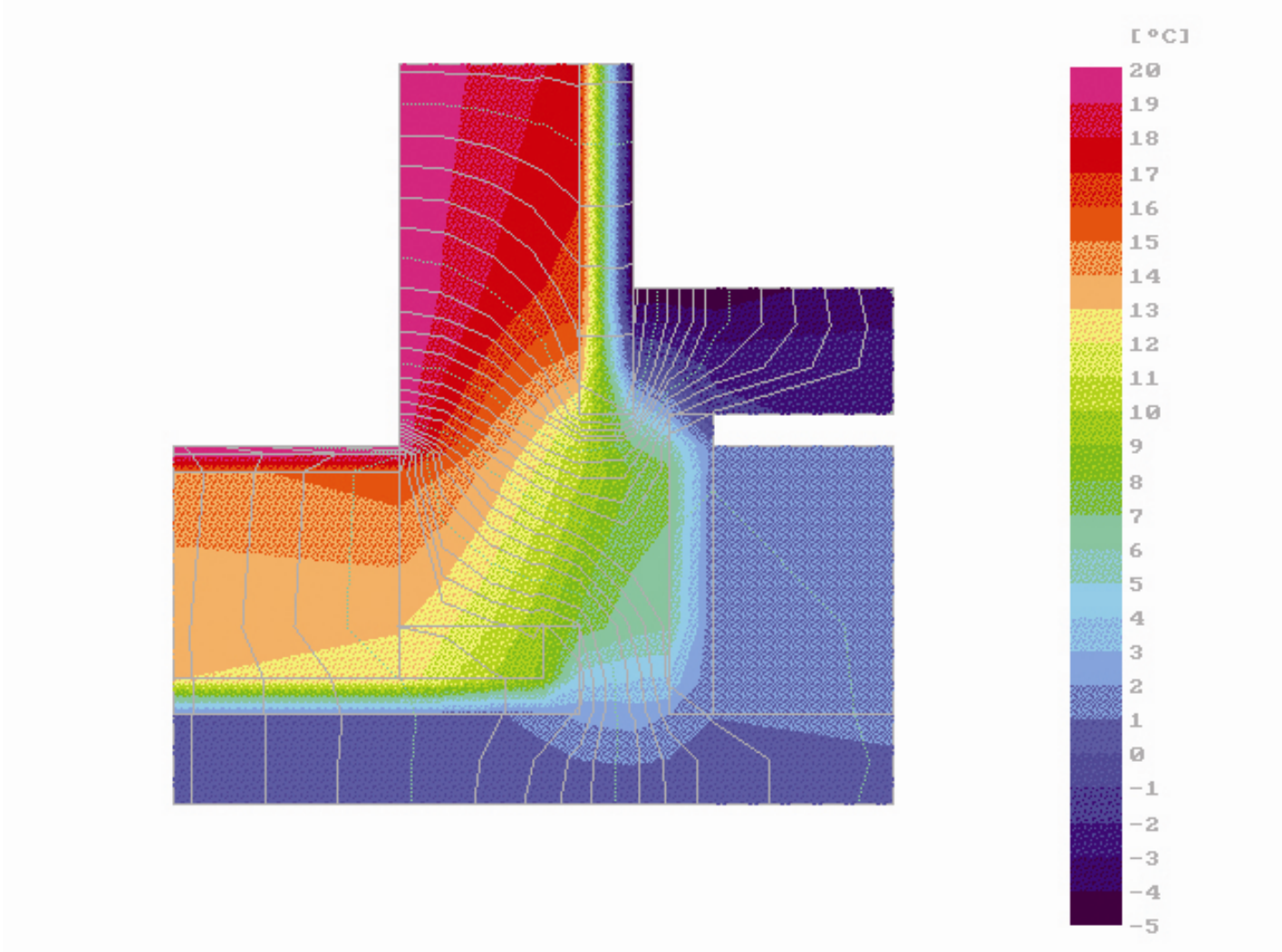
On the wall or on the floor of the cafeteria, one could see that any surface temperature lower than 14 °C -that could occasion surface condensation (for a relative humidity of 60 %) – appears nowhere.

3. NODE 1 – Foot of the wall between the cafeteria and the visitors' parking – Solution B

3.1 Graphical data and results:







NET DATA

Reference Unit [m] 1.0000
max. of lines 29
Width of lines 10.000 50.000 8.000 10.000 10.000 7.000
2.000 4.000 34.000 12.000 8.000 10.000
10.000 30.000
Total 205.000
Total edges deduced 165.000
max. of columns . 27
Width of columns 10.000 50.000 10.000 10.000 10.000 2.000
8.000 10.000 2.000 8.000 10.000 40.000
10.000
Total 180.000
Total edges deduced 120.000

GEOMETRY OF MATERIALS

	Material name	pat. no.	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	3	5	19	7
2	reinforced concrete	37	1.700	3	7	19	9
3	reinforced concrete	37	1.700	3	9	19	11
4	reinforced concrete	37	1.700	3	11	19	15
5	reinforced concrete	37	1.700	11	15	23	17
6	reinforced concrete	37	1.700	11	17	23	21
7	reinforced concrete	37	1.700	5	19	7	25
8	reinforced concrete	37	1.700	7	19	9	25
9	reinforced concrete	37	1.700	9	19	11	25
10	mineral wool	67	0.039	3	15	11	19
11	extruded polystyrene	73	0.040	21	3	23	15
12	extruded polystyrene	73	0.040	19	13	21	15
13	timber	59	0.170	13	3	15	5
14	polyst.extrudé	73	0.040	15	3	17	5
15	reinforced concrete	37	1.700	23	3	25	25
16	reinforced concrete	37	1.700	25	3	27	25
17	air space H^>=2cm	1	0.571	19	5	21	13
18	air space H^>=2cm	1	2.190	17	3	21	5
19	air space H^>=2cm	1	5.357	11	21	23	25
20	extruded polystyrene	73	0.040	11	21	23	23

LIMIT SURFACE CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [øC]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	cafeteria	13	3	3	5	20	8	0
2	BC_SIMPL	parking	3	19	5	23	-5	8	0
3	BC_SIMPL	cave	27	23	27	3	0	5	0

3.2 Numerical results :

KOBRU86 RESULTS NODE1C Node temperatures [°C]

	3	5	7	9	11	13	15	17	19	21	23	25
3		19.99	19.34	18.71	18.16	18.05	17.68	-1.22	-4.99			
5		19.97	18.91	17.94	17.15	17.02	16.60	-1.31	-4.98	-4.97	-4.79	-3.08
7		19.97	18.61	17.40	16.43	16.27	15.81	0.33	-2.79	-3.12	-3.58	-3.01
9		19.96	18.11	16.53	15.21	15.00	14.33	2.59	0.07	-0.74	-2.29	-2.86
11		19.94	17.32	15.38	13.62	13.23	11.47	6.28	4.70	2.25	-1.55	-2.79
13	20.01	19.93	16.38	14.47	12.68	12.29	10.56	7.48	6.93	5.70	1.26	1.19
15	19.44	18.59	15.96	14.20	12.44	12.06	10.39	7.78	7.36	6.37	1.26	1.19
17	14.58	15.57	15.01	13.66	11.99	11.63	10.12	8.26	8.00	7.38	1.26	1.19
19	13.36	13.06	12.18	11.01	9.58	9.26	7.68	6.56	6.41	6.10	1.16	1.12
21	13.01	12.60	11.23	10.06	8.91	8.71	4.29	4.08	4.03	3.84	1.09	1.09
23	0.73	0.73	0.76	0.88	1.20	1.34	2.18	2.46	2.43	1.99	1.03	1.06
25	0.37	0.38	0.41	0.50	0.68	0.73	0.99	1.11	1.10	0.95	0.65	0.97
27	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.02	0.12	0.92

KOBRU86 RESULTATS NODE1C Node temperatures (corners) [°C]

	3	5	19	23	25
3		19.99	-4.99		
5		-4.98	-3.08		

11		-1.55	-2.79	
13	20.01	19.93	1.26	1.19
27	0.01		0.92	

KOBRU86 RESULTS NODE1C Temperatures (limit surface conditions) [°C]

Name of limit condition	at min	(X, Y)	at max	(X, Y)
1 cafeteria	19.93	(13, 5)	20.01	(13, 3)
2 parking	-4.99	(3, 19)	-4.79	(5, 23)
3 cave	0.01	(27, 3)	0.12	(27, 23)

KOBRU86 RESULTS NODE1C Node not dimensional temperatures

	3	5	7	9	11	13	15	17	19	21	23	25
3	1.000	0.973	0.949	0.926	0.922	0.907	0.151	0.000				
5	0.999	0.956	0.918	0.886	0.881	0.864	0.148	0.001	0.001	0.008	0.077	
7	0.999	0.944	0.896	0.857	0.851	0.832	0.213	0.088	0.075	0.057	0.079	
9	0.998	0.924	0.861	0.809	0.800	0.773	0.303	0.203	0.171	0.109	0.085	
11	0.998	0.893	0.815	0.745	0.729	0.659	0.451	0.388	0.290	0.138	0.089	
13	1.001	0.997	0.855	0.779	0.707	0.692	0.622	0.499	0.477	0.428	0.250	0.248
15	0.978	0.944	0.838	0.768	0.698	0.682	0.616	0.511	0.494	0.455	0.250	0.248
17	0.783	0.823	0.800	0.746	0.680	0.665	0.605	0.531	0.520	0.495	0.250	0.248
19	0.735	0.722	0.687	0.641	0.583	0.570	0.507	0.462	0.456	0.444	0.246	0.245
21	0.720	0.704	0.649	0.603	0.557	0.548	0.372	0.363	0.361	0.354	0.244	0.243
23	0.229	0.229	0.231	0.235	0.248	0.253	0.287	0.298	0.297	0.280	0.241	0.242
25	0.215	0.215	0.216	0.220	0.227	0.229	0.240	0.244	0.244	0.238	0.226	0.239
27	0.200	0.200	0.201	0.201	0.201	0.201	0.201	0.201	0.202	0.201	0.205	0.237

KOBRU86 RESULTS NODE1C Node not dimensional temperatures (corners)

	3	5	19	23	25
3	1.000	0.000			
5		0.001		0.077	
11			0.138	0.089	
13	1.001	0.997		0.250	0.248
27	0.200			0.237	

KOBRU86 RESULTS NODE1C Not dimensional temperatures (limit surface conditions)

Name of limit condition	at min	(X, Y)	at max	(X, Y)
1 cafeteria	0.997	(13, 5)	1.001	(13, 3)
2 parking	0.000	(3, 19)	0.008	(5, 23)
3 cave	0.200	(27, 3)	0.205	(27, 23)

KOBRU86 RESULTS NODE1C Heat losses [W/m]

Entering heat losses	29.54
Exiting heat losses	29.54

KOBRU86 RESULTS NODE1C Heat losses at limit conditions [W/m]

Name of limit condition	entering	exiting
1 cafeteria	29.54	
2 parking		16.06
3 cave		13.47

KOBRU86 RESULTS NODE1C Heat losses at edge [W/m]

X1	Y1	X2	Y2	entering	exiting
5	19	5	23		10.95
13	3	13	5	10.64	
27	3	27	23		13.47

3	5	13	5	18.89	
3	19	5	19		5.11

KOBRU86 RESULTS NODE1C Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses	1.181
Exiting heat losses	1.181

KOBRU86 RESULTS NODE1C Heat losses at limit conditions

Name of limit conditions		entering	exiting
1	cafetaria	1.181	
2	parking		0.642
3	cave		0.539

KOBRU86 RESULTS NODE1C Heat losses at edge for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	19	5	23		0.438
13	3	13	5	0.426	
27	3	27	23		0.539
3	5	13	5	0.756	
3	19	5	19		0.204

KOBRU86 RESULTS NODE1C U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
4	5	4	19	0.003	331.222	50.000
13	4	27	4	0.003	344.534	50.000
5	20	27	20	0.015	67.647	8.000
5	22	27	22	0.001	1703.235	10.000

KOBRU86 RESULTS NODE1C U-Values and R-Values (adiabatic edges)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
3	5	3	19	0.003	331.222	50.000
13	3	27	3	0.003	344.534	50.000

3.3 Conclusions

Heat losses through the wall, excluding the cold bridge (by current meter)
= U wall (=U1) * Room height * ΔT
= 0,282 * 3,8 * 25
= 26,79 W/m

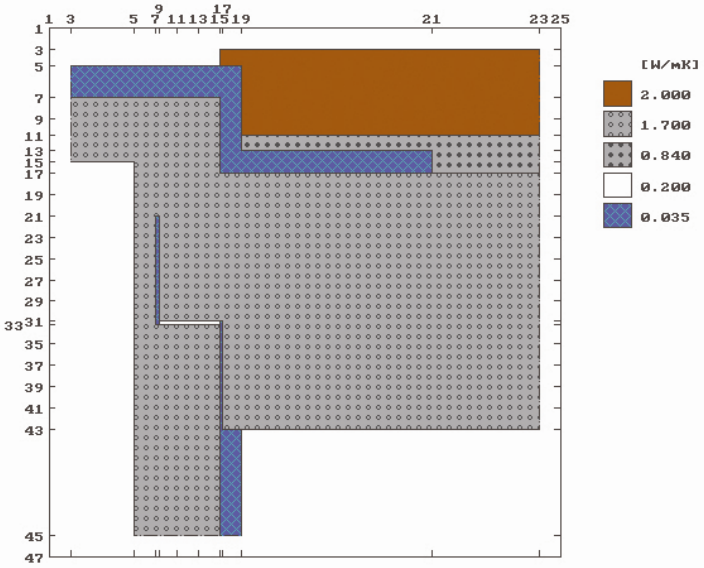
Heat losses by the cold bridge
= 29,54 W/m – (U1 * 0,85 m * ΔT) – (U2 * 0,5 m * ΔT)
= 29,54 W/m – (0,282 * 0,85 * 25) – (0,264 * 0,5 * 20)
= 29,54 W/m – 5,993 W/m – 2,64 W/m
= 20,907 W/m

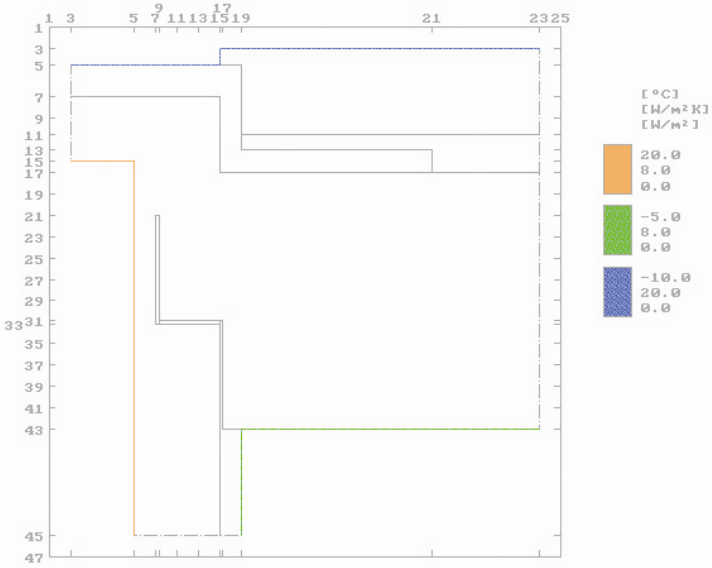
We notice a real improvement in comparison with the two first solutions.

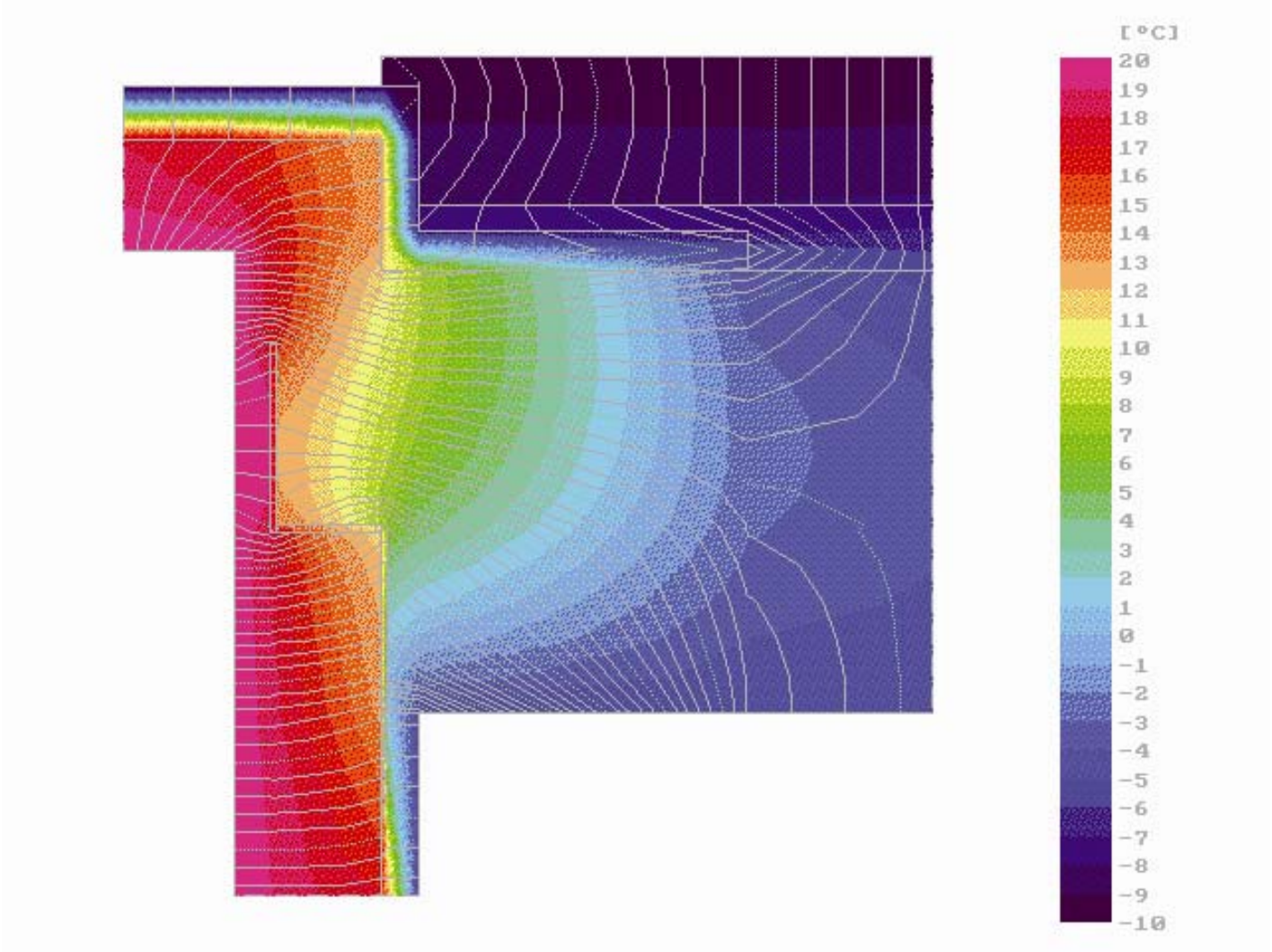
On the wall or on the floor of the cafeteria, one could see that any surface temperature lower than 14 °C -that could occasion surface condensation (for a relative humidity of 60 %) – appears nowhere.

4. NODE 2 – Concrete beam supporting the roof of the visitors' parking, resting on the wall close to the cafeteria: vertical section

4.1 Graphical data and results:







NET DATA

Reference Unit [m] 1.0000
max. of lines 47
Width of lines 10.000 8.000 15.000 10.000 7.500 7.000
5.500 5.500 10.000 10.000 10.000 10.000
10.000 10.000 9.000 2.000 9.000 10.000
10.000 10.000 10.000 50.000 10.000
Total 248.500
Total edges deduced 228.500
max. of columns 25
Width of columns 10.000 30.000 10.000 1.500 8.500 10.000
10.000 1.500 8.500 90.000 50.000 10.000
Total 240.000
Total edges deduced 220.000

GEOMETRY OF MATERIALS

	Material name	pat. n°	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	33	5	45	7
2	reinforced concrete	37	1.700	33	7	45	11
3	reinforced concrete	37	1.700	33	9	45	13
4	reinforced concrete	37	1.700	33	11	45	15
5	reinforced concrete	37	1.700	21	5	33	7
6	reinforced concrete	37	1.700	17	5	19	23
7	reinforced concrete	37	1.700	19	5	21	23
8	reinforced concrete	37	1.700	21	9	23	23
9	reinforced concrete	37	1.700	23	9	25	23
10	reinforced concrete	37	1.700	25	9	27	23
11	reinforced concrete	37	1.700	27	9	29	23
12	reinforced concrete	37	1.700	29	9	31	23
13	reinforced concrete	37	1.700	31	17	35	23
14	reinforced concrete	37	1.700	35	17	37	23
15	reinforced concrete	37	1.700	37	17	39	23
16	reinforced concrete	37	1.700	39	17	41	23
17	reinforced concrete	37	1.700	41	17	43	23
18	reinforced concrete	37	1.700	7	3	9	15
19	reinforced concrete	37	1.700	9	3	11	15
20	reinforced concrete	37	1.700	11	3	15	15
21	extruded polystyrene	73	0.035	43	15	45	19
22	extruded polystyrene	73	0.035	13	19	17	21
23	extruded polystyrene	73	0.035	7	15	17	19
24	extruded polystyrene	73	0.035	5	3	7	19
25	extruded polystyrene	73	0.035	31	15	43	17
26	extruded polystyrene	73	0.035	21	7	33	9
27	rubber juncture	1	0.200	31	9	33	15
28	cement screed	41	0.840	11	19	13	23
29	cement screed	41	0.840	13	21	17	23
30	sand gravel	7	2.000	9	19	11	23
31	sand gravel	7	2.000	7	19	9	23
32	sand gravel	7	2.000	3	19	7	23
33	sand gravel	7	2.000	3	15	5	19
34	extruded polystyrene	37	1.700	15	5	17	15

LIMIT SURFACE CONDITIONS

	type	name	net coordinate X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	cafeteria	45	5	15	3	20	8	0
2	BC_SIMPL	extérieur	5	3	3	23	-10	20	0
3	BC_SIMPL	parking	43	23	45	19	-5	8	0

4.2 Results :

KOBRU86 RESULTS NODE2-C Node temperatures [°C]

	3	5	7	9	11	13	15	17	19	21	23
3						-10.00	-10.00	-10.00	-10.00	-9.99	
5	-10.00	-10.00	-10.00	-10.00	-10.00	-10.00	-9.99	-9.92	-9.61	-9.60	-9.57
7	17.93	16.94	15.99	15.83	14.93	13.88	12.84	9.01	-8.76	-8.85	-8.77
9	18.42	17.46	16.40	16.24	15.26	14.21	13.44	10.11	-8.29	-8.35	-8.23
11	18.94	18.11	16.78	16.58	15.43	14.26	13.49	10.24	-8.00	-7.98	-7.82
13	19.51	18.97	17.16	16.90	15.50	14.11	13.20	10.20	-7.45	-7.17	-6.89

15	20.00	19.93	17.41	17.09	15.46	13.83	12.62	10.74	0.63	-5.51	-6.15
17		19.95	17.48	17.14	15.33	13.43	11.47	10.87	8.02	-3.83	-5.43
19		19.95	17.36	16.97	14.90	12.73	10.55	10.19	8.09	-3.32	-4.86
21		19.94	17.35	16.38	14.17	12.04	9.98	9.67	7.92	-2.95	-4.42
23		19.98	18.76	14.03	12.96	11.27	9.43	9.15	7.57	-2.71	-4.09
25		19.98	19.04	13.12	12.19	10.67	8.89	8.62	7.08	-2.59	-3.88
27		19.98	19.05	12.84	11.91	10.33	8.40	8.10	6.43	-2.58	-3.77
29		19.98	18.91	13.13	12.14	10.35	7.95	7.58	5.59	-2.69	-3.75
31		19.96	18.31	14.13	12.92	10.90	7.71	6.83	4.59	-2.87	-3.81
33		19.96	17.94	17.29	14.91	12.85	11.13	6.06	4.33	-2.92	-3.83
35		19.95	17.86	17.52	15.63	13.73	12.25	4.18	3.02	-3.19	-3.96
37		19.96	18.01	17.72	16.09	14.32	12.79	2.65	1.44	-3.57	-4.16
39		19.96	18.16	17.90	16.39	14.68	13.04	1.20	-0.31	-4.00	-4.41
41		19.97	18.29	18.04	16.62	14.96	13.26	0.13	-2.35	-4.49	-4.69
43		19.96	18.41	18.18	16.85	15.28	13.67	1.69	-4.93	-5.00	-4.99
45		19.99	19.07	18.93	18.20	17.44	16.86	13.52	-5.01		

KOBRU86 RESULTS NOEUD2-C Node temperature (corners) [°C]

	3	5	15	19	23
3			-10.00		-9.99
5	-10.00		-9.99		
15	20.00	19.93			
43				-4.93	-4.99
45		19.99		-5.01	

KOBRU86 RESULTS NODE2-C Temperatures (limit surface conditions) [°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 cafeteria	19.93	(15, 5)	20.00	(15, 3)
2 extérieur	-10.00	(3, 15)	-9.99	(3, 23)
3 parking	-5.01	(45, 19)	-4.93	(43, 19)

KOBRU86 RESULTS NODE2-C Node non dimensional temperatures

	3	5	7	9	11	13	15	17	19	21	23
3							-0.000	-0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.013	0.013	0.014
7	0.931	0.898	0.866	0.861	0.831	0.796	0.761	0.634	0.041	0.038	0.041
9	0.947	0.915	0.880	0.875	0.842	0.807	0.781	0.670	0.057	0.055	0.059
11	0.965	0.937	0.893	0.886	0.848	0.809	0.783	0.675	0.067	0.067	0.073
13	0.984	0.966	0.905	0.897	0.850	0.804	0.773	0.673	0.085	0.094	0.104
15	1.000	0.998	0.914	0.903	0.849	0.794	0.754	0.691	0.354	0.150	0.128
17		0.998	0.916	0.905	0.844	0.781	0.716	0.696	0.601	0.206	0.152
19		0.998	0.912	0.899	0.830	0.758	0.685	0.673	0.603	0.223	0.171
21		0.998	0.912	0.879	0.806	0.735	0.666	0.656	0.597	0.235	0.186
23		0.999	0.959	0.801	0.765	0.709	0.648	0.638	0.586	0.243	0.197
25		0.999	0.968	0.771	0.740	0.689	0.630	0.621	0.569	0.247	0.204
27		0.999	0.968	0.761	0.730	0.678	0.613	0.603	0.548	0.247	0.208
29		0.999	0.964	0.771	0.738	0.678	0.598	0.586	0.520	0.244	0.208
31		0.999	0.944	0.804	0.764	0.697	0.590	0.561	0.486	0.238	0.206
33		0.999	0.931	0.910	0.830	0.762	0.704	0.535	0.478	0.236	0.206
35		0.998	0.929	0.917	0.854	0.791	0.742	0.473	0.434	0.227	0.201
37		0.999	0.934	0.924	0.870	0.811	0.760	0.422	0.381	0.214	0.195
39		0.999	0.939	0.930	0.880	0.823	0.768	0.373	0.323	0.200	0.186
41		0.999	0.943	0.935	0.887	0.832	0.775	0.338	0.255	0.184	0.177
43		0.999	0.947	0.939	0.895	0.843	0.789	0.390	0.169	0.167	0.167
45		1.000	0.969	0.964	0.940	0.915	0.895	0.784	0.166		

KOBRU86 RESULTS NODE2-C Node non dimensional temperatures (corners)

	3	5	15	19	23
3			-0.000		0.000
5	0.000		0.000		
15	1.000	0.998			
43				0.169	0.167
45		1.000		0.166	

KOBRU86 RESULTS NODE2-C Not dimensional temperature (limit surface conditions)

Name of limit condition	at min (X, Y)	at max (X, Y)
1 cafeteria	0.998 (15, 5)	1.000 (15, 3)
2 exterior	-0.000 (3, 15)	0.000 (3, 23)
3 parking	0.166 (45, 19)	0.169 (43, 19)

KOBRU86 RESULTS NODE2-C Heat losses [W/m]

Entering heat losses 57.45
Exiting heat losses 57.45

KOBRU86 RESULTS NODE2-C Heat losses at limit conditions [W/m]

Name of limit condition	entering	exiting
1 cafeteria	57.43	
2 exterior	0.02	19.27
3 parking		38.18

KOBRU86 RESULTS NODE2-C Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
3	15	3	23		14.52
5	3	5	15		4.42
15	3	15	5	9.00	
43	19	43	23		26.25
15	5	45	5	48.43	
3	15	5	15		0.31
43	19	45	19		11.94

KOBRU86 RESULTS NODE2-C Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses 1.915
Exiting heat losses 1.915

KOBRU86 RESULTS NODE2-C Heat losses at limit condition for temperature difference of 1°C [W/mK]

Name of limit condition	entering	exiting
1 cafeteria	1.914	
2 exterior	0.001	0.642
3 parking		1.273

KOBRU86 RESULTS NODE2-C Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
3	15	3	23		0.484
5	3	5	15		0.147
15	3	15	5	0.300	
43	19	43	23		0.875
15	5	45	5	1.614	
3	15	5	15		0.010
43	19	45	19		0.398

KOBRU86 RESULTS NODE2-C U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
44	5	44	19	0.003	309.244	50.000
5	4	15	4	0.002	446.219	30.000
3	20	43	20	0.002	413.457	90.000
3	22	43	22	0.009	112.267	50.000

KOBRU86 RESULTS NODE2-C U-Values and R-Values (adiabatic edges)

X1	Y1	X2	Y2	U-Values [W/m2K]	R-Values [m2K/W]	Length [m]
45	5	45	19	0.003	309.244	50.000
5	3	15	3	0.002	446.219	30.000
3	23	43	23	0.009	112.267	50.000

4.3 Conclusions:

Hypotheses of room temperatures: 20°C in the cafeteria; -5°C in the visitors' parking
The calculation of U3-Value (=U-Value of the floor of the cafeteria) and the U4-Value (=U-Value of the wall between cafeteria and visitors' parking) have been calculated separately.

For a span from centre to centre (beam + wall), the surface of the wall is = (2 * 3,8) + (0,5 * 2,6) = 8,9 m²

Heat losses through the wall, for a span length :
= U wall (= U4) * Surface of the wall * ΔT
= 0,3 * 8,9 * 25
= 66,75 W

Heat losses by the cold bridge (vertical section)
= 57,43 W/m – (U4*0,5m*ΔT) – (U3*0,3m*ΔT)
= 57,43 W/m – (0,3*0,5*25) – (0,213*0,3*30)
= 57,43 W/m – 3,75 W/m – 1,917 W/m
= 51,763 W/m

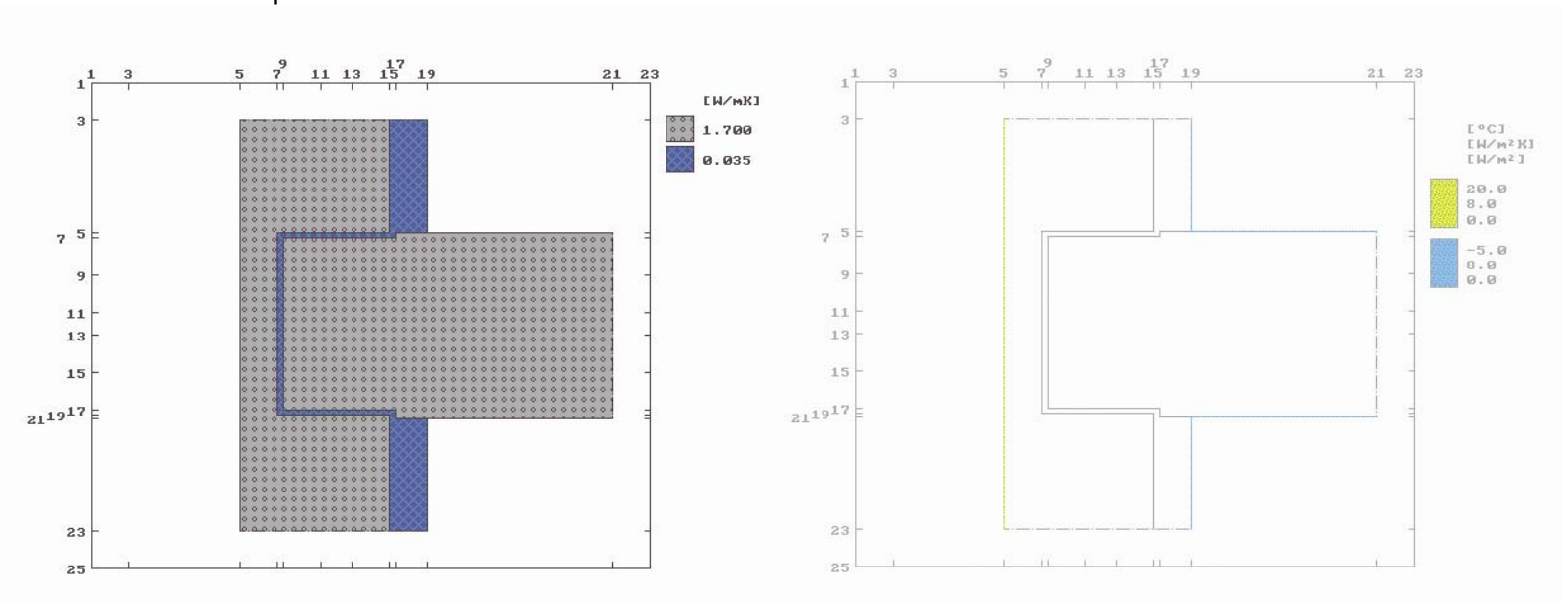
By beam, the losses are equal to : 51,988 * 0,5 m = 25,994 W

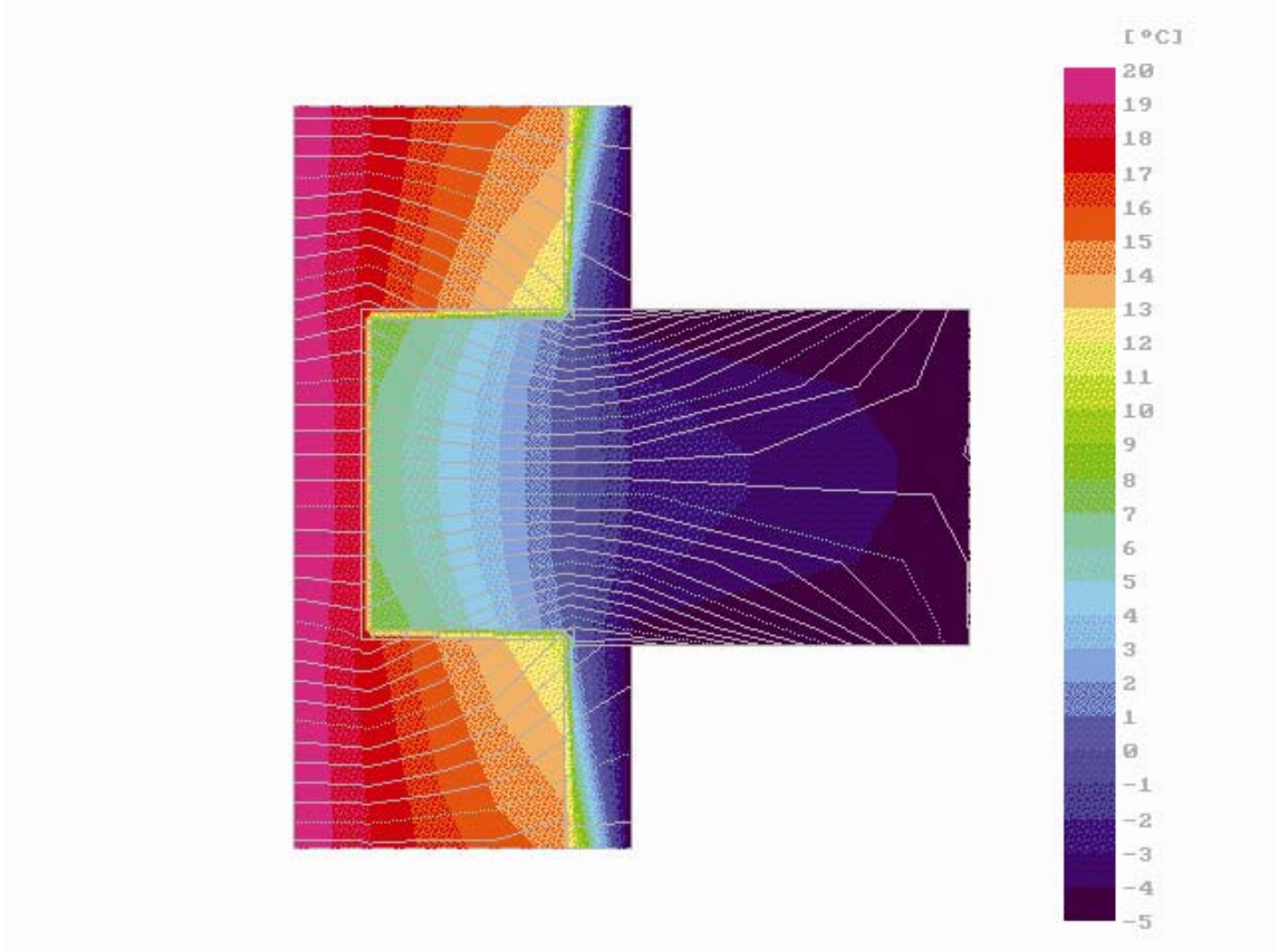
By span (wall + beam), we notice that the losses due to the beam are 2,5 times lower than those due to the part of the wall concerned.

On the wall or on the floor of the cafeteria, one could see that any surface temperature lower than 14 °C -that could occasion surface condensation (for a relative humidity of 60 %) – appears nowhere.

5. NODE 2 – Concrete beam supporting the roof of the visitors' parking, resting on the wall close to the cafeteria: layout

5.1 Graphical data and results:





NET DATA

Reference Unit [m] 1.0000
max. of lines 25
Width of lines 10.000 30.000 1.500 10.000 10.000 6.000
10.000 10.000 1.500 1.000 30.000 10.000
Total 130.000
Total edged deduced 110.000
max. of columns 23
Width of columns 10.000 30.000 10.000 1.500 10.000 8.500
10.000 1.500 8.500 50.000 10.000
Total 150.000
Total edged deduced 100.000

GEOMETRY OF MATERIALS

	Material Name	pat. n°	lambda [W/mK]	net coordinate X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	3	5	5	9
2	reinforced concrete	37	1.700	3	9	5	11
3	reinforced concrete	37	1.700	3	11	5	13
4	reinforced concrete	37	1.700	3	13	5	15
5	reinforced concrete	37	1.700	5	5	9	7
6	reinforced concrete	37	1.700	9	5	11	7
7	reinforced concrete	37	1.700	11	5	13	7
8	reinforced concrete	37	1.700	13	5	15	7
9	reinforced concrete	37	1.700	15	5	19	7
10	reinforced concrete	37	1.700	19	5	23	7
11	reinforced concrete	37	1.700	19	7	23	11
12	reinforced concrete	37	1.700	19	11	23	13
13	reinforced concrete	37	1.700	19	13	23	15
14	reinforced concrete	37	1.700	7	9	9	17
15	reinforced concrete	37	1.700	9	9	11	17
16	reinforced concrete	37	1.700	11	9	13	17
17	reinforced concrete	37	1.700	13	9	15	17
18	reinforced concrete	37	1.700	15	9	17	17
19	reinforced concrete	37	1.700	5	17	9	21
20	reinforced concrete	37	1.700	9	17	11	21
21	reinforced concrete	37	1.700	11	17	13	21
22	reinforced concrete	37	1.700	13	17	15	21
23	reinforced concrete	37	1.700	15	17	21	21
24	extruded polystyrene	73	0.035	3	15	5	19
25	extruded polystyrene	73	0.035	21	15	23	19
26	extruded polystyrene	73	0.035	19	15	21	17
27	extruded polystyrene	73	0.035	17	7	19	17
28	extruded polystyrene	73	0.035	7	7	17	9
29	extruded polystyrene	73	0.035	5	7	7	17

LIMIT SURFACE CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	parking1	3	19	5	21	-5	8	0
2	BC_SIMPL	parking2	21	21	23	19	-5	8	0
3	BC_SIMPL	cafeteria	23	5	3	5	20	8	0

5.2 Results:

KOBRU86 RESULTS NODE2-P Node temperatures [°C]

	3	5	7	9	11	13	15	17	19	21
3		19.97	18.26	18.01	16.46	15.41	14.63	11.54	-5.01	
5		19.95	17.72	17.30	14.89	13.19	11.49	1.03	-4.93	-5.01
7		19.95	17.90	8.20	6.26	4.21	1.09	0.48	-4.51	-4.96
9		19.97	18.28	7.18	5.34	3.35	0.50	0.03	-2.84	-4.66
11		19.97	18.34	6.79	4.96	3.04	0.44	0.04	-2.21	-4.51
13		19.97	18.35	6.79	4.96	3.04	0.44	0.04	-2.18	-4.50
15		19.97	18.30	7.17	5.32	3.33	0.48	0.02	-2.74	-4.64
17		19.96	17.97	8.18	6.23	4.15	0.96	0.31	-4.27	-4.93
19		19.95	17.81	17.20	14.83	13.13	11.38	0.69	-4.65	-4.98
21		19.95	17.71	17.31	14.94	13.25	11.56	1.09	-4.93	-5.01
23		19.97	18.27	18.02	16.48	15.44	14.67	11.57	-5.01	

KOBRU86 RESULTS NODE2-P Node temperature (corners) [°C]

	5	19	21
3	19.97	-5.01	
5		-4.93	-5.01
21		-4.93	-5.01
23	19.97	-5.01	

KOBRU86 RESULTS NODE2-P Temperatures (limit surface conditions) [°C]

Name of limit condition.	at min	(X, Y)	at max	(X, Y)
1 parking1	-5.01	(5, 21)	-4.93	(5, 19)
2 parking2	-5.01	(21, 21)	-4.93	(21, 19)
3 cafeteria	19.95	(21, 5)	19.97	(23, 5)

KOBRU86 RESULTS NODE2-P Node not dimensional temperatures

	3	5	7	9	11	13	15	17	19	21
3		0.999	0.930	0.920	0.858	0.816	0.785	0.661	-0.000	
5		0.998	0.909	0.892	0.796	0.727	0.659	0.241	0.003	-0.001
7		0.998	0.916	0.528	0.451	0.368	0.244	0.219	0.020	0.001
9		0.999	0.931	0.487	0.414	0.334	0.220	0.201	0.086	0.013
11		0.999	0.934	0.472	0.399	0.322	0.218	0.202	0.112	0.020
13		0.999	0.934	0.471	0.398	0.322	0.218	0.202	0.113	0.020
15		0.999	0.932	0.487	0.413	0.333	0.219	0.201	0.091	0.014
17		0.998	0.919	0.527	0.449	0.366	0.238	0.212	0.029	0.003
19		0.998	0.913	0.888	0.793	0.725	0.655	0.228	0.014	0.001
21		0.998	0.908	0.892	0.798	0.730	0.662	0.244	0.003	-0.001
23		0.999	0.931	0.921	0.859	0.818	0.787	0.663	-0.000	

KOBRU86 RESULTS NOEUD2-P Node not dimensional temperatures (corners)

	5	19	21
3	0.999	-0.000	
5		0.003	-0.001
21		0.003	-0.001
23	0.999	-0.000	

KOBRU86 RESULTS NOEUD2-P Node not dimensional temperatures (limit surfaces conditions.)

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 parking1	-0.001	(5, 21)	0.003	(5, 19)
2 parking2	-0.001	(21, 21)	0.003	(21, 19)
3 cafeteria	0.998	(21, 5)	0.999	(23, 5)

KOBRU86 RESULTS NODE2-P Heat losses [W/m]

Entering heat losses	35.05
Exiting heat losses	35.05

KOBRU86 RESULTS NODE2-P Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 parking1		17.60
2 parking2		17.45
3 cafeteria	35.05	

KOBRU86 RESULTS NODE2-P Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
5	19	5	21		10.83
21	19	21	21		10.74

3	5	23	5	35.05	
3	19	5	19		6.76
21	19	23	19		6.70

KOBRU86 RESULTS NODE2-P Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses 1.402
Exiting heat losses 1.402

KOBRU86 RESULTS NODE2-P Heat losses at limit conditions for temperature difference of 1°C [W/mK]

	Name of limit conditions	entering	exiting
1	parking1		0.704
2	parking2		0.698
3	cafeteria	1.402	

KOBRU86 RESULTS NODE2-P Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	19	5	21		0.433
21	19	21	21		0.430
3	5	23	5	1.402	
3	19	5	19		0.271
21	19	23	19		0.268

KOBRU86 RESULTS NODE2-P U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
4	5	4	19	0.003	309.244	30.000
22	5	22	19	0.003	309.244	30.000
5	20	21	20	0.034	29.412	50.000

KOBRU86 RESULTS NODE2-P U-Values and R-Values (adiabatic edges)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
3	5	3	19	0.003	309.244	30.000
23	5	23	19	0.003	309.244	30.000
5	21	21	21	0.034	29.412	50.000

5.3 Conclusions:

Heat losses through the wall, for a span length:

= U mur (=U4) * Surface du mur * ΔT
= 0,3 * 8,9*25 = 66,75 W

Heat losses by the cold bridge (layout)

= 35,05 W/m – (U4*0,6m*ΔT)
= 35,05 W/m – (0,3*0,6*25)
= 35,05 W/m – 4,5 W/m
= 30,55 W/m

By beam, the losses (layout) are equal to : 30,55 W/m * 1,2 m = 36,66 W

By span, we notice that the losses (layout) due to the beam are just more than half of losses due to the wall concerned.

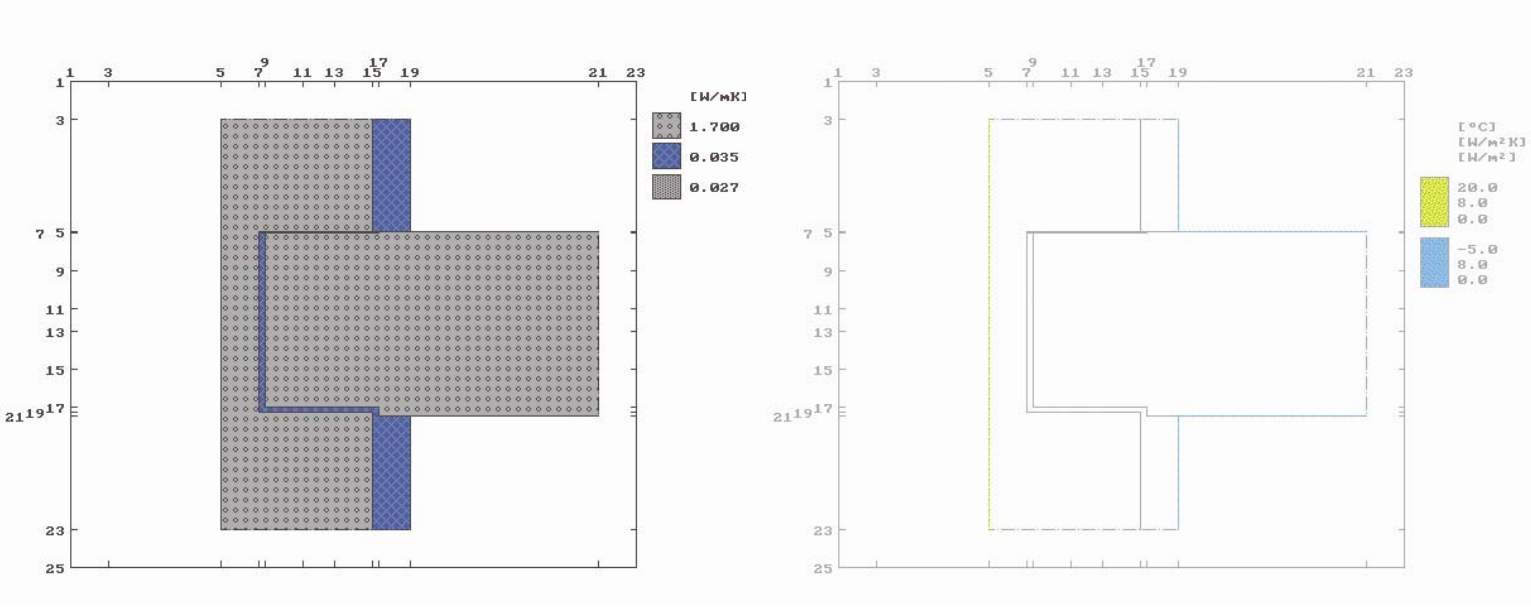
By beam, we can reasonably consider that the thermal bridge is assimilated to the maximum of the vertical thermal bridge and the horizontal one, i.e. the maximum among (25,99 ; 36,66).

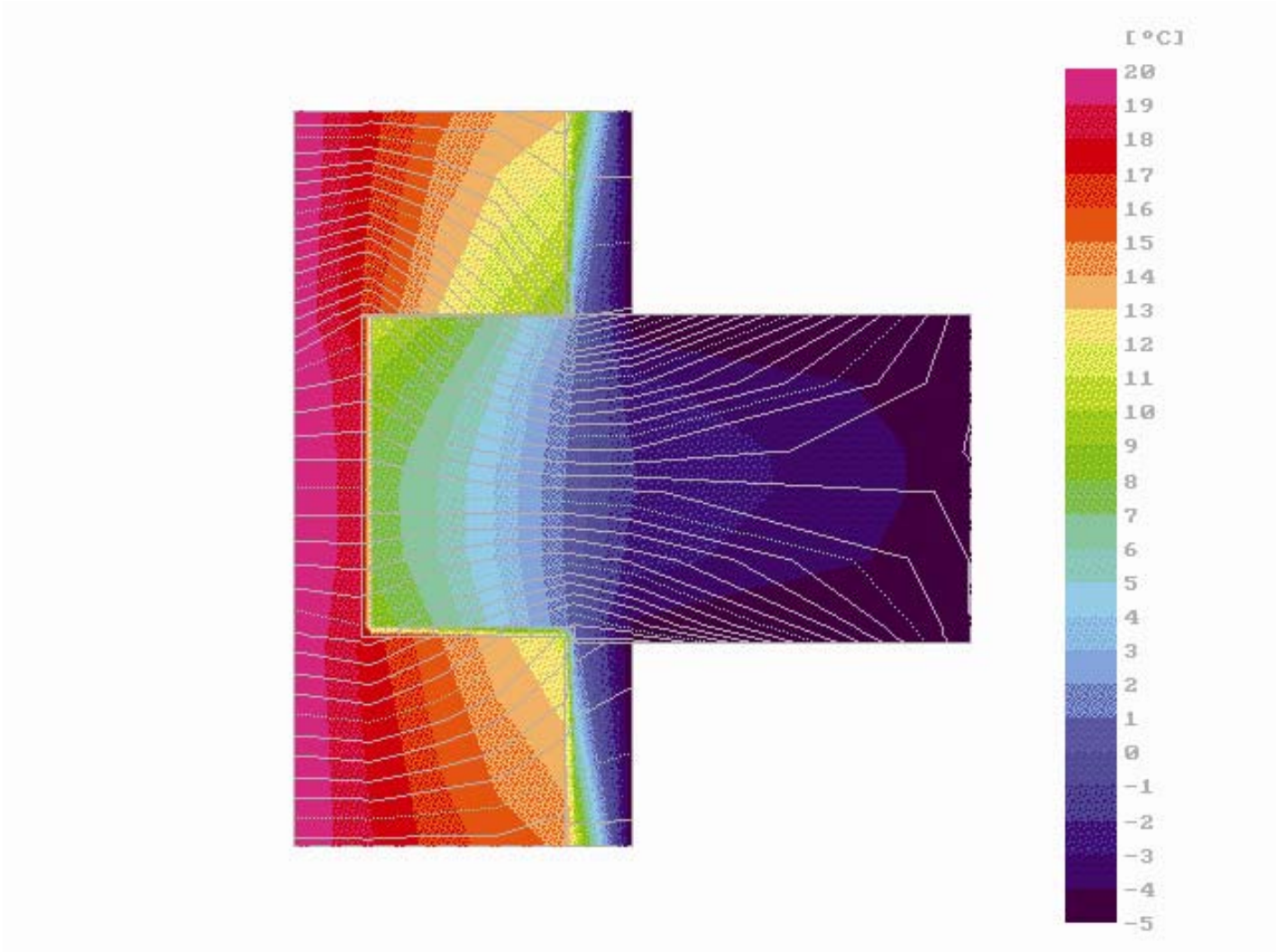
In that case, we therefore consider that the punctual losses due to the thermal bridge at each beam are 36,66 W, to be compared with the 66,75 W representing the losses by the rest of the wall for a span.

On the wall or on the floor of the cafeteria, one could see that any surface temperature lower than 14 °C -that could occasion surface condensation (for a relative humidity of 60 %) – appears nowhere.

6. NODE 2 – Concrete beam supporting the roof of the visitors' parking, resting on the wall close to the cafeteria: layout as built

6.1 Graphical data and results:





NET DATA

Reference Unit [m] 1.0000
max. of lines 25
Width of lines 10.000 30.000 0.300 10.000 10.000 6.000
10.000 10.000 1.500 1.000 30.000 10.000
Total 128.800
Total edges deduced 108.800
max. of columns 23
Width of columns 10.000 30.000 10.000 1.500 10.000 8.500
10.000 1.500 8.500 50.000 10.000
Total 150.000
Total edges deduced 100.000

GEOMETRY OF MATERIALS

	Material Name	pat. no.	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	3	5	5	9
2	reinforced concrete	37	1.700	3	9	5	11
3	reinforced concrete	37	1.700	3	11	5	13
4	reinforced concrete	37	1.700	3	13	5	15
5	reinforced concrete	37	1.700	5	5	9	7
6	reinforced concrete	37	1.700	9	5	11	7
7	reinforced concrete	37	1.700	11	5	13	7
8	reinforced concrete	37	1.700	13	5	15	7
9	reinforced concrete	37	1.700	15	5	19	7
10	reinforced concrete	37	1.700	19	5	23	7
11	reinforced concrete	37	1.700	19	7	23	11
12	reinforced concrete	37	1.700	19	11	23	13
13	reinforced concrete	37	1.700	19	13	23	15
14	reinforced concrete	37	1.700	7	9	9	17
15	reinforced concrete	37	1.700	9	9	11	17
16	reinforced concrete	37	1.700	11	9	13	17
17	reinforced concrete	37	1.700	13	9	15	17
18	reinforced concrete	37	1.700	15	9	17	17
19	reinforced concrete	37	1.700	5	17	9	21
20	reinforced concrete	37	1.700	9	17	11	21
21	reinforced concrete	37	1.700	11	17	13	21
22	reinforced concrete	37	1.700	13	17	15	21
23	reinforced concrete	37	1.700	15	17	21	21
24	extruded polystyrene	73	0.035	3	15	5	19
25	extruded polystyrene	73	0.035	21	15	23	19
26	extruded polystyrene	73	0.035	19	15	21	17
27	extruded polystyrene	73	0.035	17	7	19	17
28	extruded polystyrene	73	0.035	7	7	17	9
29	air space V 2cm	32	0.027	5	7	7	17

LIMIT SURFACE CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [øC]	h [W/mýK]	flux [W/mý]
1	BC_SIMPL	parking1	3	19	5	21	-5	8	0
2	BC_SIMPL	parking2	21	21	23	19	-5	8	0
3	BC_SIMPL	cafetaria	23	5	3	5	20	8	0

6.2 Results:

KOBRU86 RESULTS NODE2-R Node temperatures [°C]

	3	5	7	9	11	13	15	17	19	21
3		19.96	17.68	17.36	15.32	14.02	13.16	10.31	-5.02	
5		19.93	16.89	16.24	12.89	10.74	8.94	1.74	-4.92	-5.02
7		19.93	16.99	10.90	8.83	6.48	2.61	1.66	-4.82	-5.01
9		19.97	18.19	8.87	7.04	4.83	1.42	0.84	-2.75	-4.67
11		19.97	18.41	7.91	6.11	4.05	1.09	0.63	-1.99	-4.49
13		19.97	18.43	7.68	5.88	3.85	0.98	0.54	-1.95	-4.48
15		19.97	18.38	7.82	6.00	3.92	0.88	0.39	-2.56	-4.62
17		19.96	18.04	8.72	6.79	4.64	1.25	0.56	-4.22	-4.93
19		19.95	17.88	17.28	14.96	13.28	11.54	0.92	-4.63	-4.98
21		19.95	17.78	17.39	15.07	13.40	11.72	1.31	-4.93	-5.01
23		19.97	18.30	18.06	16.55	15.53	14.76	11.65	-5.01	

KOBRU86 RESULTS NODE2-R Node temperatures (corners) [°C]

	5	19	21
3	19.96	-5.02	
5		-4.92	-5.02
21		-4.93	-5.01
23	19.97	-5.01	

KOBRU86 RESULTS NODE2-R Temperatures (limit surface conditions) [°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 parking1	-5.02	(5, 21)	-4.92	(5, 19)
2 parking2	-5.01	(21, 21)	-4.93	(21, 19)
3 cafeteria	19.93	(5, 5)	19.97	(23, 5)

KOBRU86 RESULTS NODE2-R Node not dimensional temperatures

	3	5	7	9	11	13	15	17	19	21
3		0.998	0.907	0.894	0.813	0.761	0.726	0.612	-0.001	
5		0.997	0.876	0.850	0.716	0.630	0.557	0.270	0.003	-0.001
7		0.997	0.880	0.636	0.553	0.459	0.305	0.266	0.007	-0.000
9		0.999	0.928	0.555	0.482	0.393	0.257	0.233	0.090	0.013
11		0.999	0.936	0.516	0.444	0.362	0.244	0.225	0.121	0.020
13		0.999	0.937	0.507	0.435	0.354	0.239	0.222	0.122	0.021
15		0.999	0.935	0.513	0.440	0.357	0.235	0.215	0.097	0.015
17		0.998	0.922	0.549	0.472	0.386	0.250	0.223	0.031	0.003
19		0.998	0.915	0.891	0.798	0.731	0.661	0.237	0.015	0.001
21		0.998	0.911	0.895	0.803	0.736	0.669	0.252	0.003	-0.001
23		0.999	0.932	0.923	0.862	0.821	0.791	0.666	-0.000	

KOBRU86 RESULTS NODE2-R Node not dimensional temperatures (corners)

	5	19	21
3	0.998	-0.001	
5		0.003	-0.001
21		0.003	-0.001
23	0.999	-0.000	

KOBRU86 RESULTS NODE2-R Node not dimensional temperatures (limit surface conditions)

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 parking1	-0.001	(5, 21)	0.003	(5, 19)
2 parking2	-0.001	(21, 21)	0.003	(21, 19)
3 cafeteria	0.997	(5, 5)	0.999	(23, 5)

KOBRU86 RESULTS NODE2-R Heat losses [W/m]

Entering heat losses	38.41
Exiting heat losses	38.41

KOBRU86 RESULTS NODE2-R Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 parking1		19.95
2 parking2		18.46
3 cafeteria	38.41	

KOBRU86 RESULTS NODE2-R Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
5	19	5	21		12.41
21	19	21	21		11.41

3	5	23	5	38.41	
3	19	5	19		7.54
21	19	23	19		7.05

KOBRU86 RESULTS NODE2-R Heat losses for difference temperature of 1°C [W/mK]

Entering heat losses 1.536
Exiting heat losses 1.536

KOBRU86 RESULTS NODE2-R Heat losses at limit conditions for difference temperature of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 parking1		0.798
2 parking2		0.738
3 cafeteria	1.536	

KOBRU86 RESULTS NODE2-R Heat losses at edges for difference temperature of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	19	5	21		0.496
21	19	21	21		0.456
3	5	23	5	1.536	
3	19	5	19		0.302
21	19	23	19		0.282

KOBRU86 RESULTS NODE2-R U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
4	5	4	19	0.003	309.244	30.000
22	5	22	19	0.003	309.244	30.000
5	20	21	20	0.035	28.706	50.000

KOBRU86 RESULTS NODE2-R U-Values and R-Values (adiabatic edges)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
3	5	3	19	0.003	309.244	30.000
23	5	23	19	0.003	309.244	30.000
5	21	21	21	0.035	28.706	50.000

6.3 Conclusions:

For a span, surface of wall = (2*3,8) + (0,5*2,6) = 8,9 m²
Losses by the wall = U wall (=U4) * Wall's surface *ΔT
0,3 * 8,9*25 = 66,75 W

Heat losses by the cold bridge = 38,41 W/m - (U4*0,6m*ΔT)
38,41 W/m – (0,3*0,6*25)
38,41 W/m – 4,5 W/m
33,91 W/m

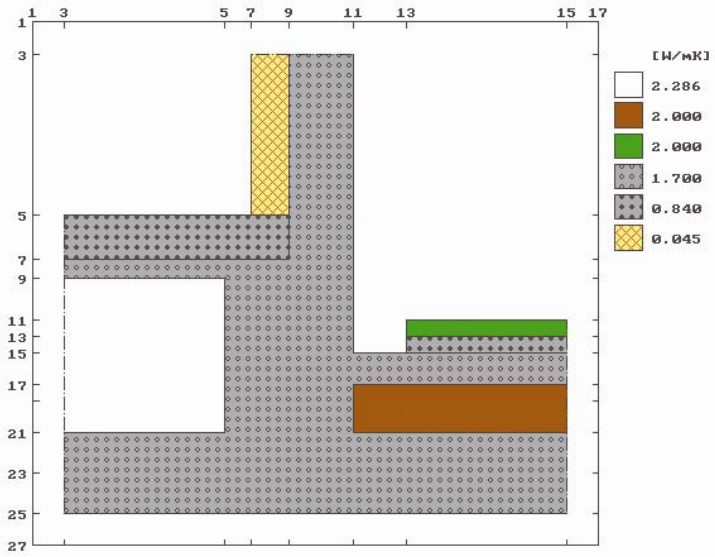
By beam, losses are equal to : 33,91 * 1,2 = 40,692 W
For one span, we notice that the losses due to the beam are just higher than half of those due to the wall concerned.

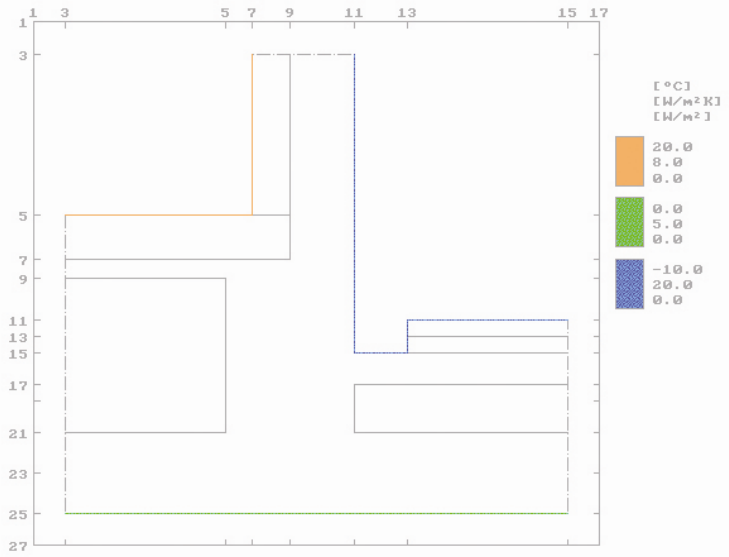
By beam, we can reasonably consider that the thermal bridge is assimilated to the maximum of the vertical thermal bridge and the horizontal one, i.e. the maximum between (25,99 ; 40,69). We consider than that the cold bridge is equal to 40,692 W.

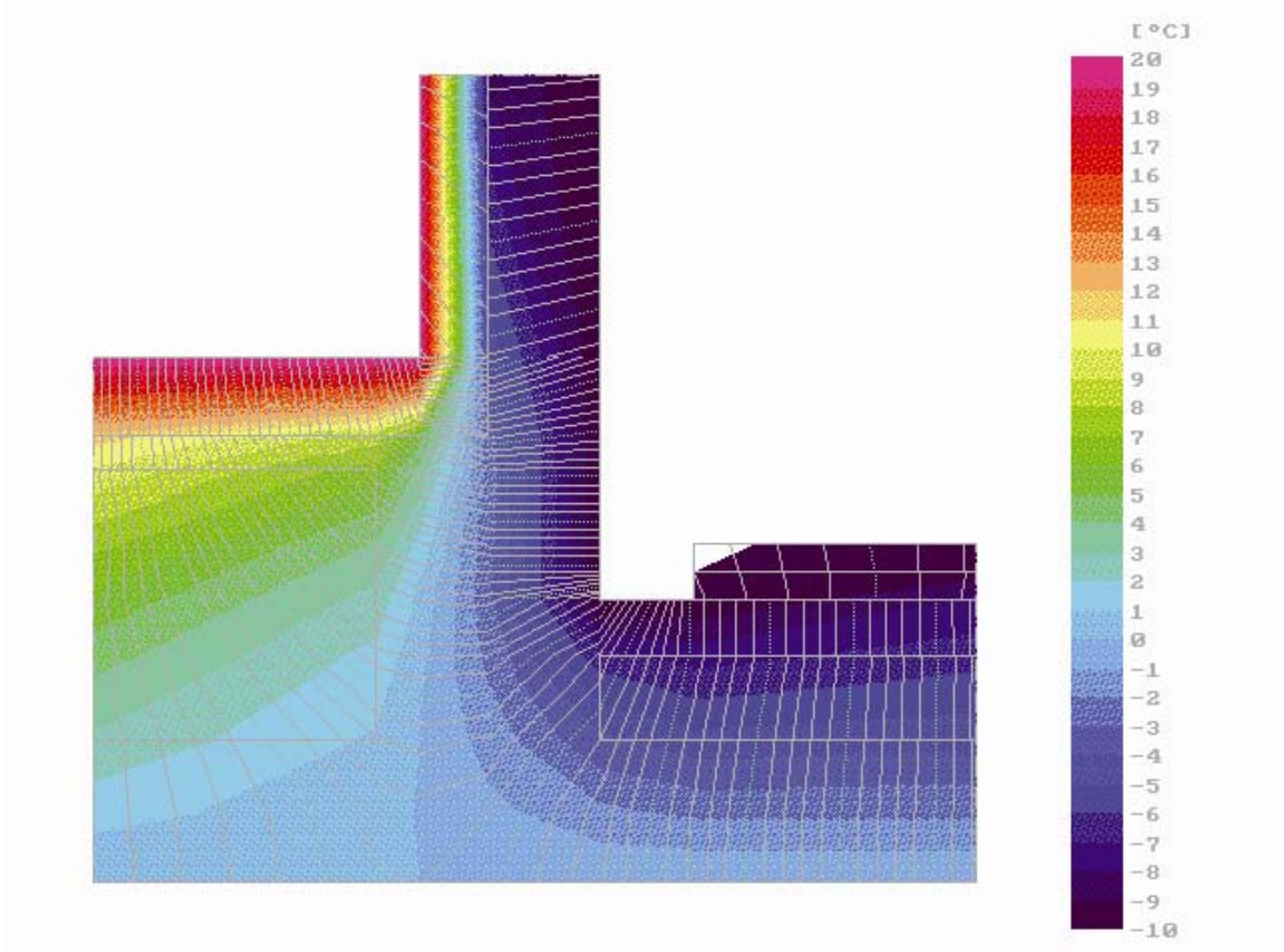
On the wall or on the floor of the cafeteria, one could see that any surface temperature lower than 14 °C -that could occasion surface condensation (for a relative humidity of 60 %) – appears nowhere.

7. NODE 3 – Foot of the wall between the technical room and exterior

7.1 Graphical data and results:







NET DATA

Reference Unit [m] 1.0000
max. of lines 27
Width of lines 10.000 50.000 14.000 6.000 13.000 5.000 5.000 10.000 5.000 10.000 12.500 12.500 10.000
Total 163.000
Total edges deduced 143.000
max. of columns 17
Width of columns 10.000 50.000 8.000 12.000 20.000 16.500 50.000 10.000
Total 176.500
Total edges deduced 156.500

GEOMETRY OF MATERIALS

	Material Name	pat. n°	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	3	9	21	11
2	reinforced concrete	37	1.700	9	5	21	9
3	mineral wool	67	0.045	3	7	5	9
4	cement screed	41	0.840	5	3	7	9
5	reinforced concrete	37	1.700	7	3	9	9
6	reinforced concrete	37	1.700	21	3	23	15
7	reinforced concrete	37	1.700	23	3	25	15
8	honeycomb lawn	3	2.000	11	13	13	15
9	cement screed	41	0.840	13	13	15	15
10	reinforced concrete	37	1.700	15	11	17	15
11	sand gravel	7	2.000	17	11	21	15
12	air space	1	2.286	9	3	21	5

LIMIT SURFACE CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	protected space	5	3	3	7	20	8	0
2	BC_SIMPL	exterior	3	11	11	15	-10	20	0
3	BC_SIMPL	basement	25	15	25	3	0	5	0

7.2 Numerical results:

KOBRU86 RESULTS NODE3 Node temperature [°C]

	3	5	7	9	11	13	15
3			20.03	-8.13	-10.00		
5	19.95	19.91	19.87	-4.31	-9.97		
7	11.45	8.45	5.50	-2.65	-9.97		
9	9.75	6.44	3.67	-2.34	-9.97		
11	7.30	3.94	1.61	-2.61	-9.97	-10.01	-9.98
13	6.48	3.22	1.10	-2.67	-9.97	-10.01	-9.38
15	5.73	2.61	0.71	-2.66	-9.93	-9.93	-7.93
17	4.41	1.71	0.26	-2.23	-6.74	-7.47	-6.39
19	3.83	1.37	0.12	-1.97	-5.61	-6.48	-5.71
21	2.82	0.86	-0.01	-1.42	-3.79	-4.68	-4.30
23	1.37	0.35	-0.05	-0.71	-1.81	-2.30	-2.19
25	0.05	-0.00	0.00	-0.01	-0.05	-0.06	-0.06

KOBRU86 RESULTS NODE3 Node temperatures (corners) [°C]

	3	7	11	13	15
3		20.03	-10.00		
5	19.95	19.87			
11			-10.01	-9.98	
15		-9.93	-9.93		
25	0.05		-0.06		

KOBRU86 RESULTS NODE3 Temperatures (limit surface conditions) [°C]

	Name of limit conditions	at min (X, Y)	at max (X, Y)
1	protected space	19.87 (5, 7)	20.03 (3, 7)

2	exterior	-10.01	(13, 13)	-9.93 (15, 13)
3	basement	-0.06	(25, 13)	0.05 (25, 3)

KOBRU86 RESULTS NODE3 Node not dimensional temperatures

	3	5	7	9	11	13	15
3			1.001	0.062	0.000		
5	0.998	0.997	0.996	0.190	0.001		
7	0.715	0.615	0.517	0.245	0.001		
9	0.658	0.548	0.456	0.255	0.001		
11	0.577	0.465	0.387	0.246	0.001	-0.000	0.001
13	0.549	0.441	0.370	0.244	0.001	-0.000	0.021
15	0.524	0.420	0.357	0.245	0.002	0.002	0.069
17	0.480	0.390	0.342	0.259	0.109	0.084	0.120
19	0.461	0.379	0.337	0.268	0.146	0.117	0.143
21	0.427	0.362	0.333	0.286	0.207	0.177	0.190
23	0.379	0.345	0.332	0.310	0.273	0.257	0.260
25	0.335	0.333	0.333	0.333	0.332	0.331	0.331

KOBRU86 RESULTS NODE3 Node not dimensional temperatures (corners)

	3	7	11	13	15
3		1.001	0.000		
5	0.998	0.996			
11			-0.000	0.001	
15		0.002	0.002		
25	0.335		0.331		

KOBRU86 RESULTS NODE3 Node not dimensional temperatures (limit surface conditions)

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 protected space	0.996	(5, 7)	1.001	(3, 7)
2 exterior	-0.000	(13, 13)	0.002	(15, 13)
3 basement	0.331	(25, 13)	0.335	(25, 3)

KOBRU86 RESULTS NODE3 Heat losses [W/m]

Entering heat losses	81.88
Exiting heat losses	81.88

KOBRU86 RESULTS NODE3 Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 protected space	58.04	
2 exterior	0.53	75.98
3 basement	23.31	5.89

KOBRU86 RESULTS NODE3 heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
5	3	5	7	36.66	
11	13	11	15		6.27
15	11	15	13		22.94
25	3	25	15	17.42	
3	7	5	7	21.38	
3	11	15	11		43.55
11	13	15	13		2.69

KOBRU86 RESULTS NODE3 Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses	2.729
Exiting heat losses	2.729

KOBRU86 RESULTS NODE3 Heat losses at limit conditions for temperature difference of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 protected space	1.935	
2 exterior	0.018	2.533
3 basement	0.777	0.196

KOBRU86 RESULTS NODE3 Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	3	5	7	1.222	
11	13	11	15		0.209
15	11	15	13		0.765
25	3	25	15	0.581	
3	7	5	7	0.713	
3	11	15	11		1.452
11	13	15	13		0.090

KOBRU86 RESULTS NODE3 U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
4	7	4	11	0.004	278.431	50.000
5	4	25	4	0.018	55.899	50.000
5	6	25	6	0.016	63.137	8.000
15	12	25	12	0.035	28.088	16.500
11	14	25	14	0.027	36.541	50.000

KOBRU86 RESULTS NODE3 U-Values and R-Values (adiabatic edges)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
3	7	3	11	0.004	278.431	50.000
5	3	25	3	0.018	55.899	50.000
11	15	25	15	0.027	36.541	50.000

7.3 Conclusions:

Hypotheses of room temperatures: 20°C in the cafeteria; -5°C in the visitors' parking; -10°C at the exterior
The calculation of U5-Value (=U-Value of the wall of technical room) and the U6-Value (=U-Value of the floor of technical room) have been calculated separately.

Losses by the wall

= U wall (=U5) * Room height * ΔT
= 0,34 * 3,3 * 30
= 33,66 W/m

Losses by the thermal bridge

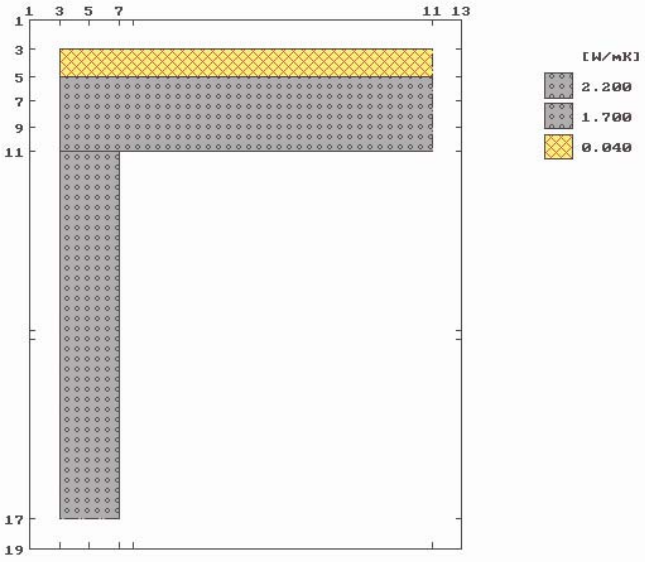
= 58,04 W/m – (U5 * 0,5 m * ΔT) – (U6 * 0,58 m * ΔT)
= 58,04 W/m – (0,34 * 0,5 * 30) – (1,112 * 0,58 * 20)
= 58,04 W/m – 5,1 W/m – 12,899 W/m
= 40,041 W/m

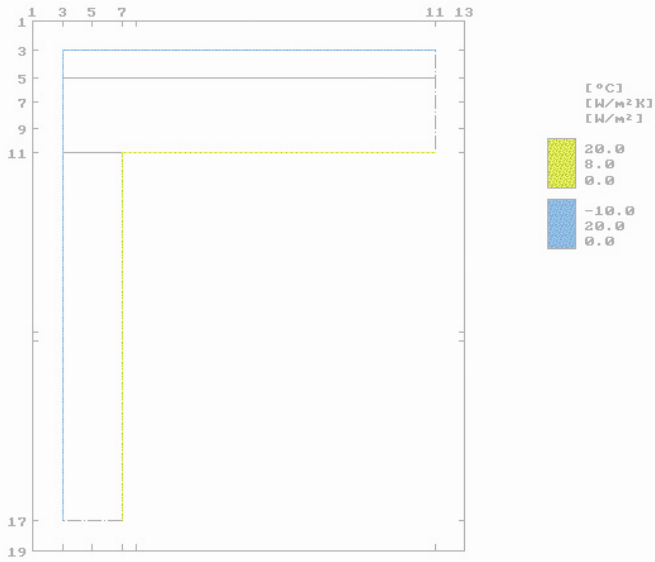
We notice that the losses due to the thermal bridge are just higher than those attributed to the wall itself.

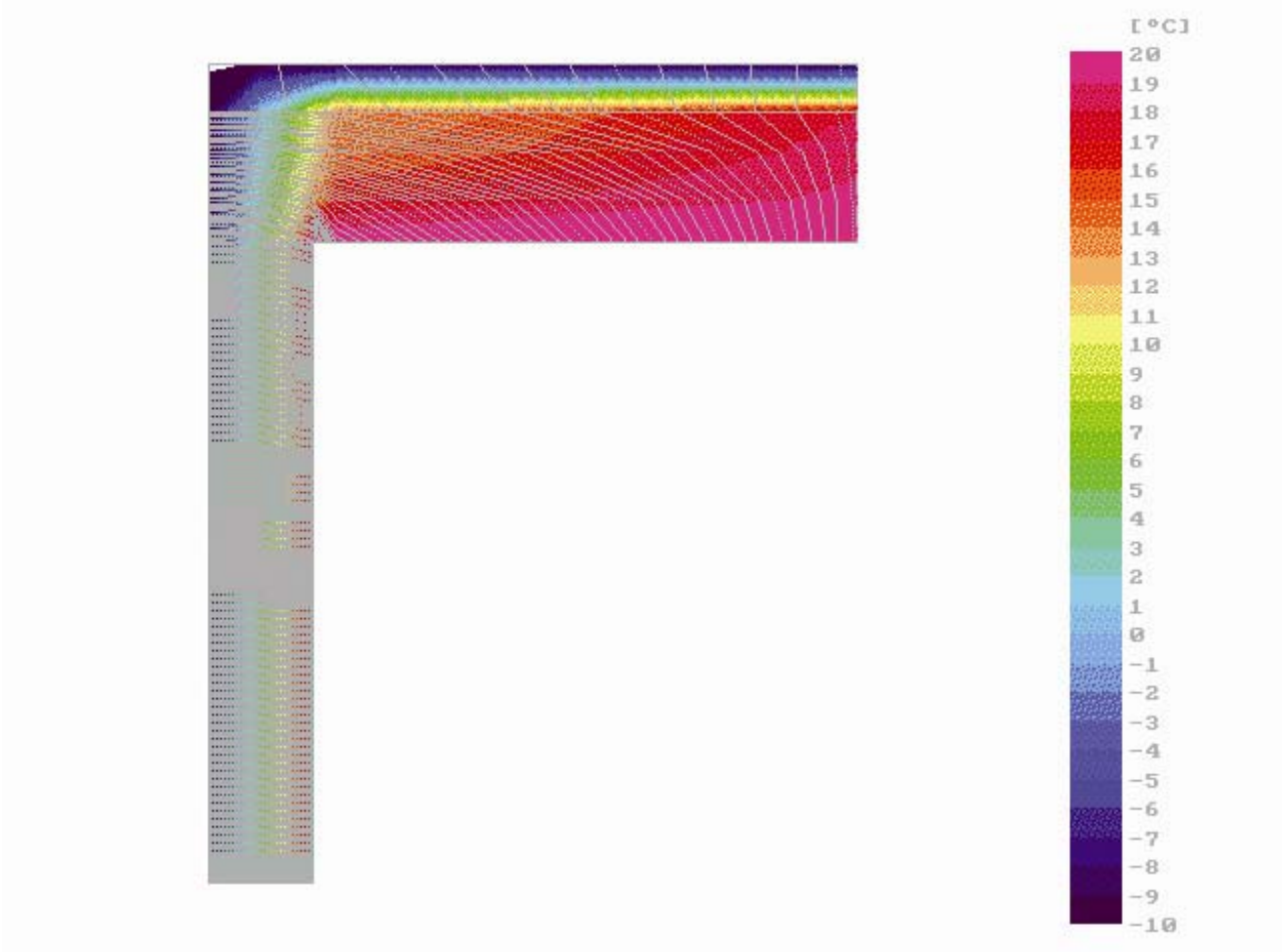
On the wall or on the floor of the cafeteria, one could see that any surface temperature lower than 14 °C -that could occasion surface condensation (for a relative humidity of 60 %) – appears nowhere.

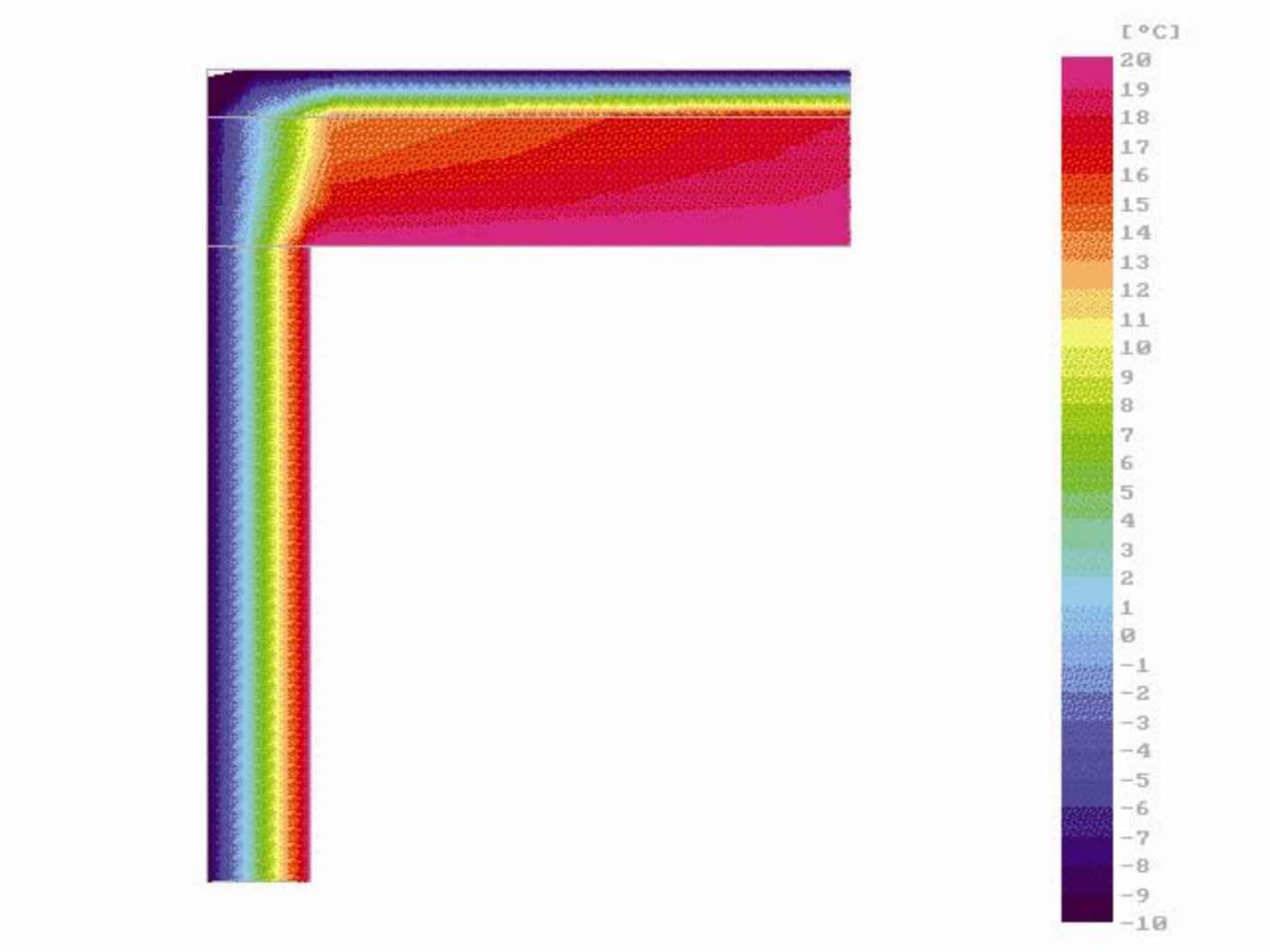
8. NODE4H – Initial situation (vertical section – wall's top)

8.1 Graphical data and results:









NET DATA

Reference Unit [m] 1.0000
max. of lines 19
Width of lines 10.000 9.000 8.000 9.000 8.000 60.000 3.000 60.000 10.000
Total 177.000
Total edges deduced 157.000
max. of columns 13
Width of columns 10.000 10.000 10.000 4.500 100.000 10.000
Total 144.500
Total edges deduced 124.500

GEOMETRY OF MATERIALS

	Material Name	pat. no.	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	5	3	7	11
2	reinforced concrete	37	2.200	11	3	17	5
3	mineral wool	67	0.040	3	3	5	11
4	reinforced concrete	37	1.700	7	3	9	11
5	reinforced concrete	37	1.700	9	3	11	11
6	reinforced concrete	37	2.200	11	5	17	7

LIMIT SURFACE CONDITIONS

	type	name	net data X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	exterior	17	3	3	11	-10	20	0
2	BC_SIMPL	interior	11	11	17	7	20	8	0

8.2 Numerical results :

KOBRU86 RESULTS NODE4-H Node temperatures [°C]

	3	5	7	9	11
3	-10.01	-10.00	-10.00	-10.00	-9.99
5	-9.96	0.49	9.95	13.68	17.95
7	-9.90	1.03	10.91	14.66	18.56
9	-9.90	2.46	13.61	16.94	19.31
11	-9.85	4.54	19.51	19.90	20.01
13	-9.84	4.88	19.62		
15	-9.84	4.88	19.60		
17	-9.84	4.88	19.60		

KOBRU86 RESULTS NODE4-H Node temperatures (corners) [°C]

	3	7	11
3	-10.01		-9.99
11		19.51	20.01
17	-9.84	19.60	

KOBRU86 RESULTS NODE4-H Temperature (limit surface conditions) [°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-10.01	(3, 3)	-9.84	(13, 3)
2 interior	19.51	(11, 7)	20.01	(11, 11)

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures

	3	5	7	9	11
3	-0.000	0.000	0.000	0.000	0.000
5	0.001	0.350	0.665	0.789	0.932
7	0.003	0.368	0.697	0.822	0.952
9	0.003	0.415	0.787	0.898	0.977
11	0.005	0.485	0.984	0.997	1.000
13	0.005	0.496	0.987		
15	0.005	0.496	0.987		
17	0.005	0.496	0.987		

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures (corners)

	3	7	11
3	-0.000		0.000
11		0.984	1.000
17	0.005	0.987	

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures (limit surface conditions)

Name of limit condition	at min	(X, Y)	at max	(X, Y)
1 exterior	-0.000	(3, 3)	0.005	(13, 3)
2 interior	0.984	(11, 7)	1.000	(11, 11)

KOBRU86 RESULTS NODE4-H Heat losses [W/m]

Entering heat losses	459.99
Exiting heat losses	459.99

KOBRU86 RESULTS NODE4-H Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 exterior	0.39	459.99
2 interior	459.60	

KOBRU86 RESULTS NODE4-H Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
3	3	3	11		12.34
11	7	11	11	47.86	
3	3	17	3		447.26
11	7	17	7	411.74	

KOBRU86 RESULTS NODE4-H Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses	15.333
Exiting heat losses	15.333

KOBRU86 RESULTS NODE4-H Heat losses at limit conditions for temperature difference of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 exterior	0.013	15.333
2 interior	15.320	

KOBRU86 RESULTS NODE4-H Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
3	3	3	11		0.411
11	7	11	11	1.595	
3	3	17	3		14.909
11	7	17	7	13.725	

KOBRU86 RESULTS NODE4-H U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
12	3	12	7	0.108	9.091	123.000
3	8	11	8	0.004	239.706	104.500

KOBRU86 RESULTS NODE4-H U-Values and R-Values (adiabatic edges)

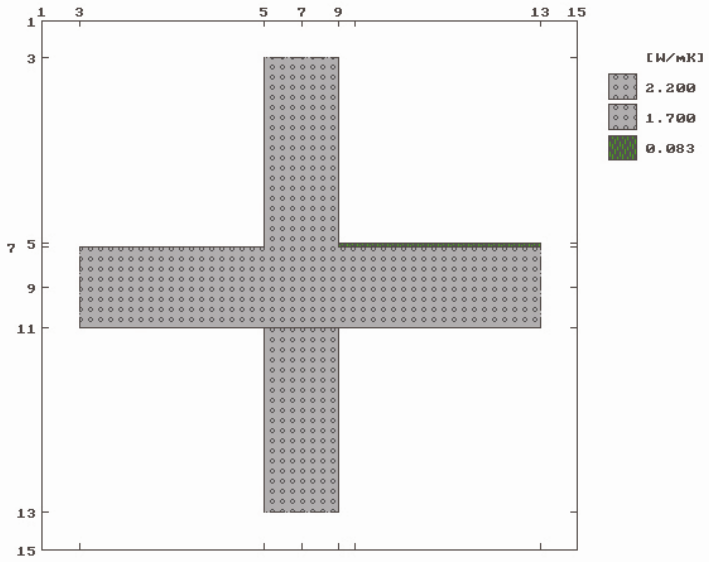
X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m2K/W]	Length [m]
17	3	17	7	0.108	9.091	123.000
3	11	11	11	0.004	239.706	104.500

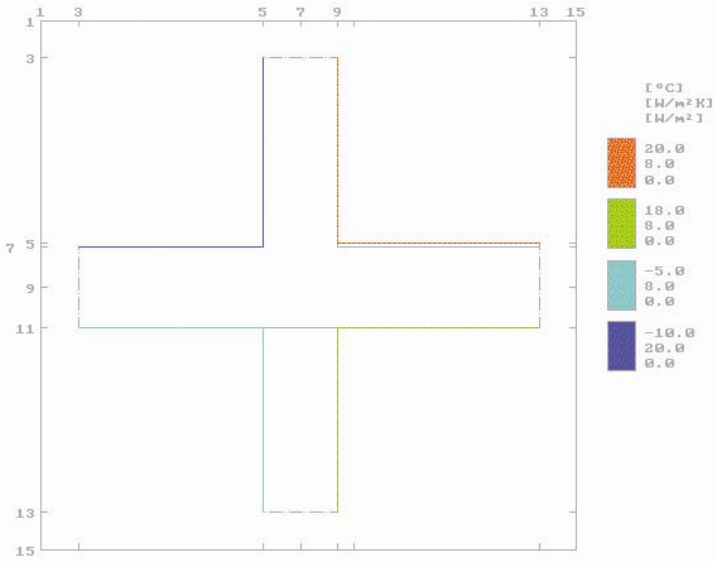
8.3 Conclusions

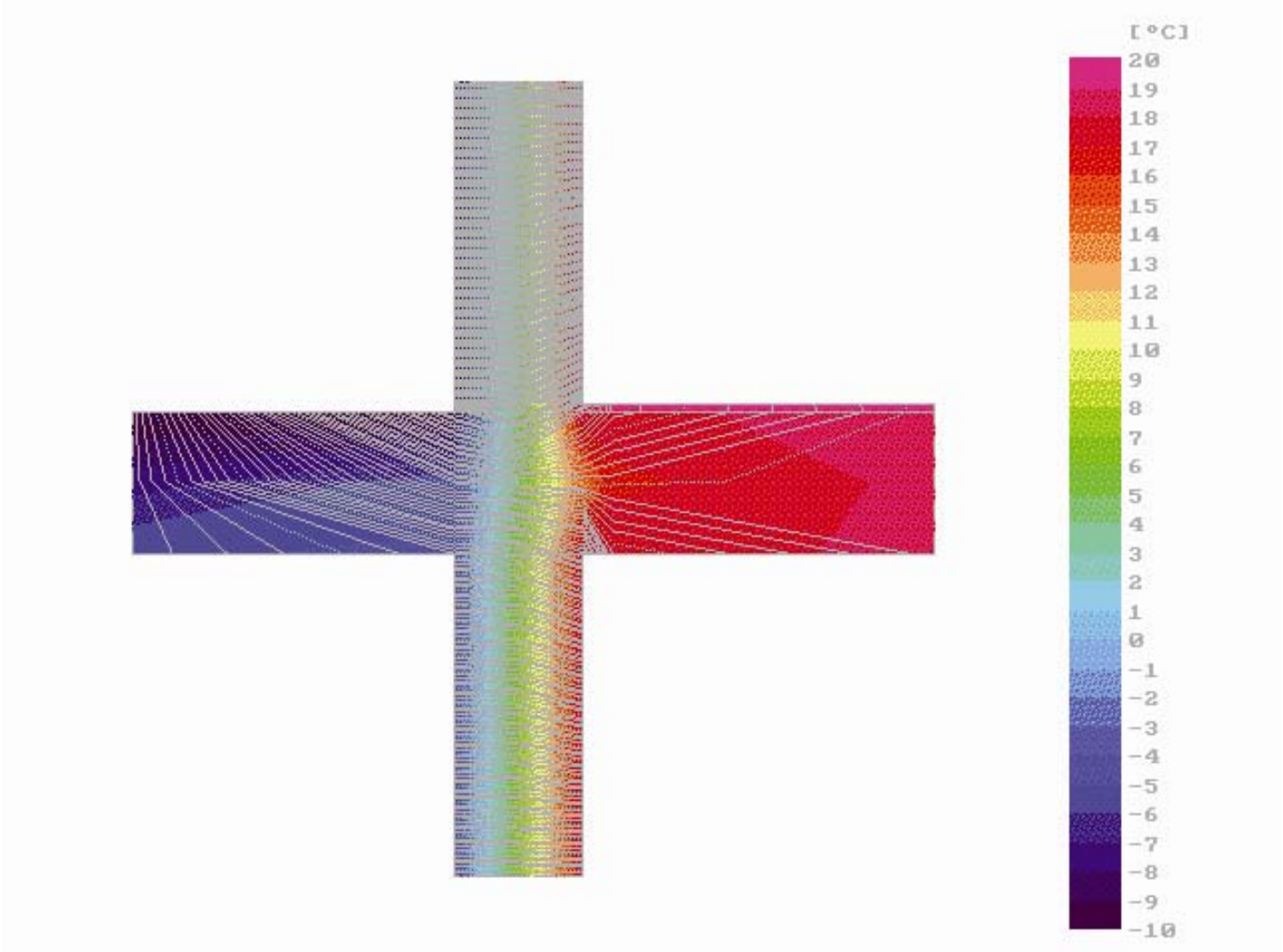
The lowest indoor temperature encountered in the section is 19,51 °C.

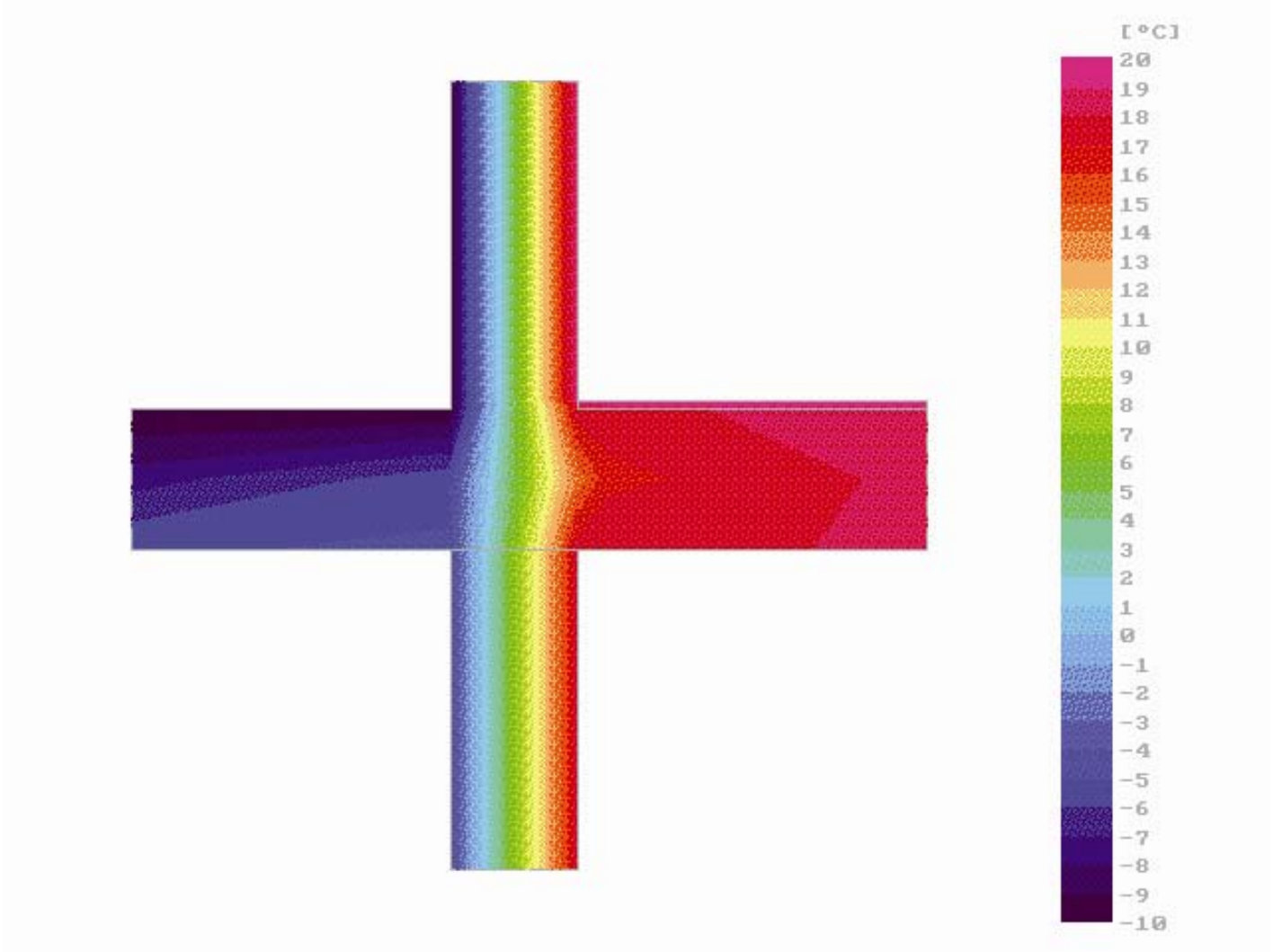
9. NOEUD4E – Initial situation (vertical section – wall's bottom)

9.1 Graphical data and results:









NET DATA

Reference Unit [m] 1.0000
max. of lines 15
Width of lines 10.000 50.000 1.000 11.000 11.000 50.000
10.000
Total 143.000
Total edges deduced 123.000
max. of columns 15
Width of columns 10.000 50.000 10.000 10.000 4.500 50.000
10.000
Total 144.500
Total edges deduced 124.500

GEOMETRY OF MATERIALS

Material	Name	pat. no.	lambda [W/mK]	X1	Y1	X2	Y2
1	reinforced concrete	37	2.200	3	5	7	7
2	reinforced concrete	37	2.200	3	7	7	9
3	reinforced concrete	37	2.200	7	3	9	13
4	reinforced concrete	37	2.200	9	3	11	13
5	reinforced concrete	37	1.700	11	5	13	7
6	reinforced concrete	37	1.700	11	7	13	9
7	carpet	20	0.083	5	9	7	13

LIMIT SURFACE CONDITIONS

	type	name	net data X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	exterior	7	3	3	5	-10	20	0
2	BC_SIMPL	parking	13	5	11	3	-5	8	0
3	BC_SIMPL	interior	3	9	5	13	20	8	0
4	BC_SIMPL	corridor	11	13	13	9	18	8	0

9.2 Numerical results:

KOBRU86 RESULTS NODE4-E Node temperatures [°C]

	3	5	7	9	11	13
3		-9.84	4.89	19.63		
5		-9.84	4.69	19.47	19.99	19.99
7	-10.01	-9.88	4.62	17.55	17.65	18.77
9	-7.47	-5.37	4.88	14.26	16.68	18.32
11	-5.13	-4.83	6.18	17.66	17.95	18.02
13		-4.74	6.52	17.80		

KOBRU86 RESULTS NODE4-E Node temperatures (corners) [°C]

	3	5	9	13
3		-9.84	19.63	
5		19.47	19.99	
7	-10.01	-9.88		
11	-5.13	-4.83	17.66	18.02
13		-4.74	17.80	

KOBRU86 RESULTS NODE4-E Temperatures (limit surfaces conditions) [°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-10.01	(7, 3)	-9.84	(3, 5)
2 parking	-5.13	(11, 3)	-4.74	(13, 5)
3 interior	19.47	(5, 9)	19.99	(5, 13)
4 corridor	17.66	(11, 9)	18.02	(11, 13)

KOBRU86 RESULTS NODE4-E Node not dimensional temperatures

	3	5	7	9	11	13
3		0.005	0.496	0.988		
5		0.005	0.490	0.982	1.000	1.000
7	-0.000	0.004	0.487	0.918	0.922	0.959
9	0.084	0.154	0.496	0.809	0.889	0.944
11	0.162	0.172	0.539	0.922	0.932	0.934
13		0.175	0.551	0.927		

KOBRU86 RESULTS NODE4-E Node not dimensional temperatures (corners)

	3	5	9	13
3		0.005	0.988	
5		0.982	1.000	
7	-0.000	0.004		
11	0.162	0.172	0.922	0.934
13		0.175	0.927	

KOBRU86 RESULTS NODE4-E Node not dimensional temperatures (limit surfaces conditions)

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-0.000	(7, 3)	0.005	(3, 5)
2 parking	0.162	(11, 3)	0.175	(13, 5)
3 interior	0.982	(5, 9)	1.000	(5, 13)
4 corridor	0.922	(11, 9)	0.934	(11, 13)

KOBRU86 RESULTS NODE4-E Heat losses [W/m]

Entering heat losses 314.40
Exiting heat losses 314.40

KOBRU86 RESULTS NODE4-E Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 exterior		221.36
2 parking		93.05
3 interior	193.42	
4 corridor	120.99	

KOBRU86 RESULTS NODE4-E Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
5	9	5	13	15.00	
7	3	7	5		57.92
11	3	11	5		6.92
11	9	11	13	11.14	
3	5	7	5		163.44
11	5	13	5		86.13
3	9	5	9	178.42	
11	9	13	9	109.85	

KOBRU86 RESULTS NODE4-E Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses 10.480
Exiting heat losses 10.480

KOBRU86 RESULTS NODE4-E Heat losses at limit conditions for temperature difference of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 exterior		7.379
2 parking		3.102
3 interior	6.447	
4 corridor	4.033	

KOBRU86 RESULTS NODE4-E Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	9	5	13	0.500	
7	3	7	5		1.931
11	3	11	5		0.231
11	9	11	13	0.371	
3	5	7	5		5.448
11	5	13	5		2.871
3	9	5	9	5.947	
11	9	13	9	3.662	

KOBRU86 RESULTS NODE4-E U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m²K/W]	Length [m]
4	5	4	9	0.108	9.091	50.000
12	5	12	9	0.083	11.765	50.000
7	4	11	4	0.098	10.000	50.000
5	10	11	10	0.045	22.048	54.500

KOBRU86 RESULTS NODE4-E U-Values and R-Values (adiabatic edges)

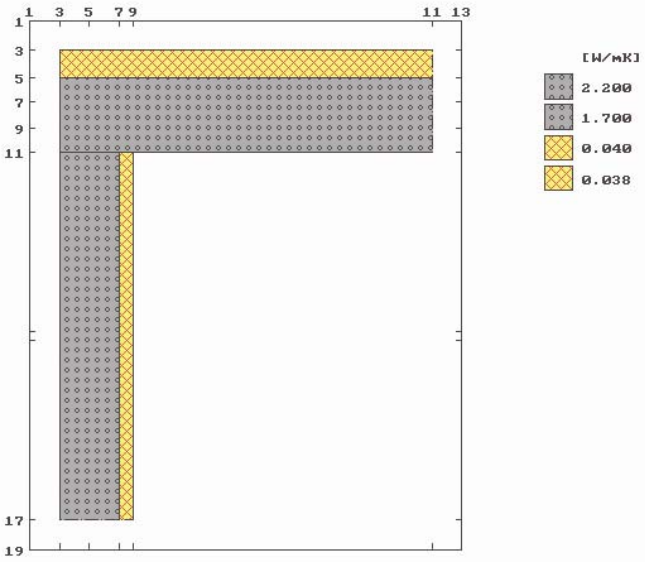
X1	Y1	X2	Y2	U-Value [W/m2K]	R-Value [m²K/W]	Length [m]
3	5	3	9	0.108	9.091	50.000
13	5	13	9	0.083	11.765	50.000
7	3	11	3	0.098	10.000	50.000
5	13	11	13	0.045	22.048	54.500

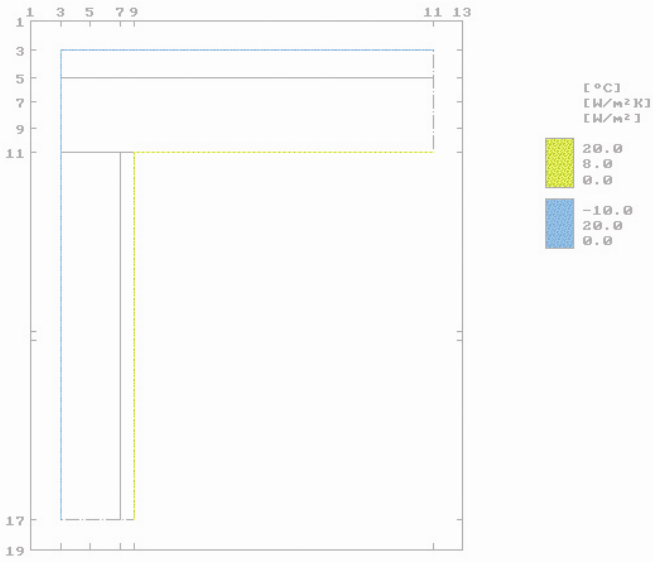
9.3 Conclusions

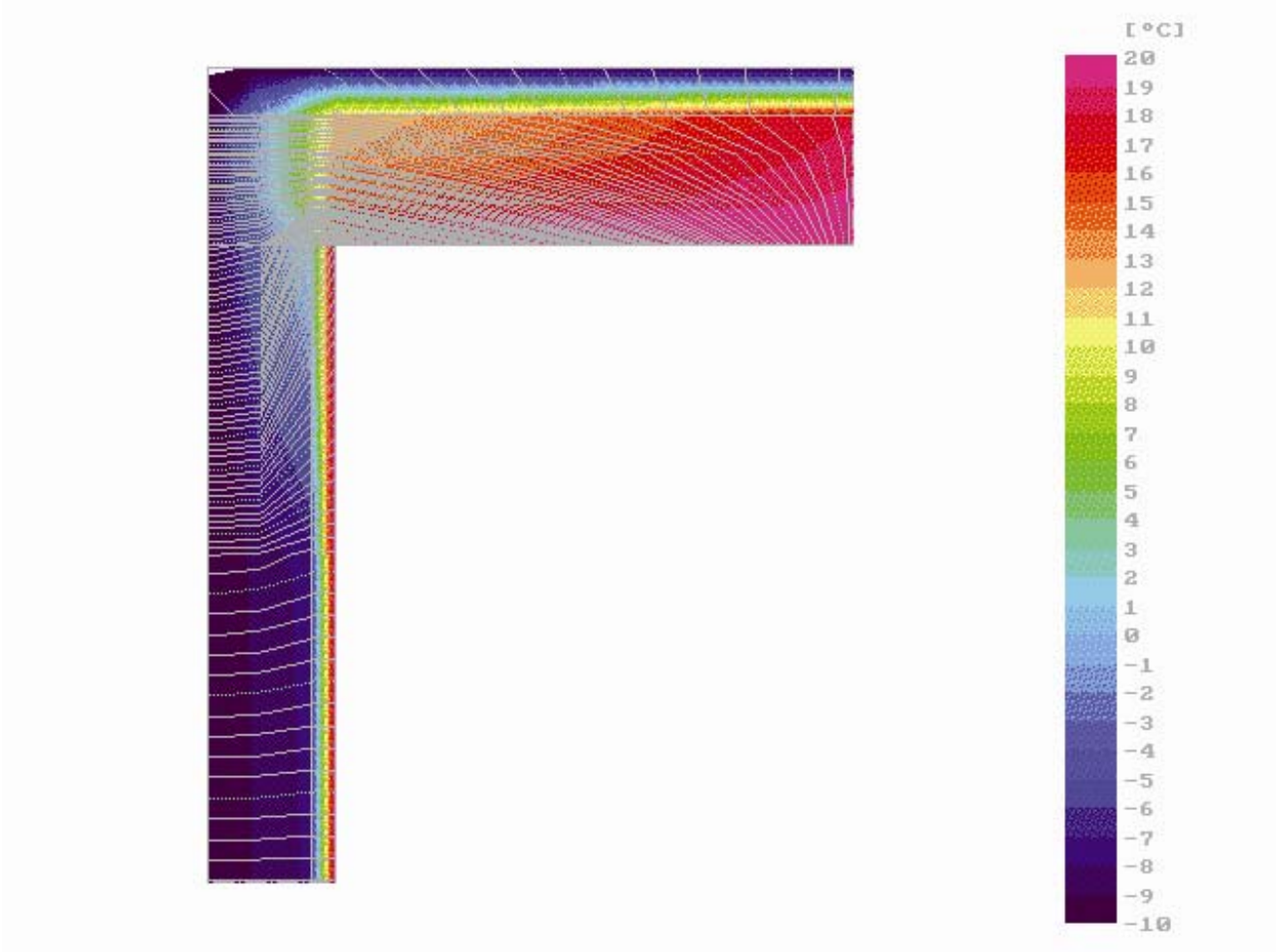
The lowest indoor temperature encountered in the section is 19,47 °C.

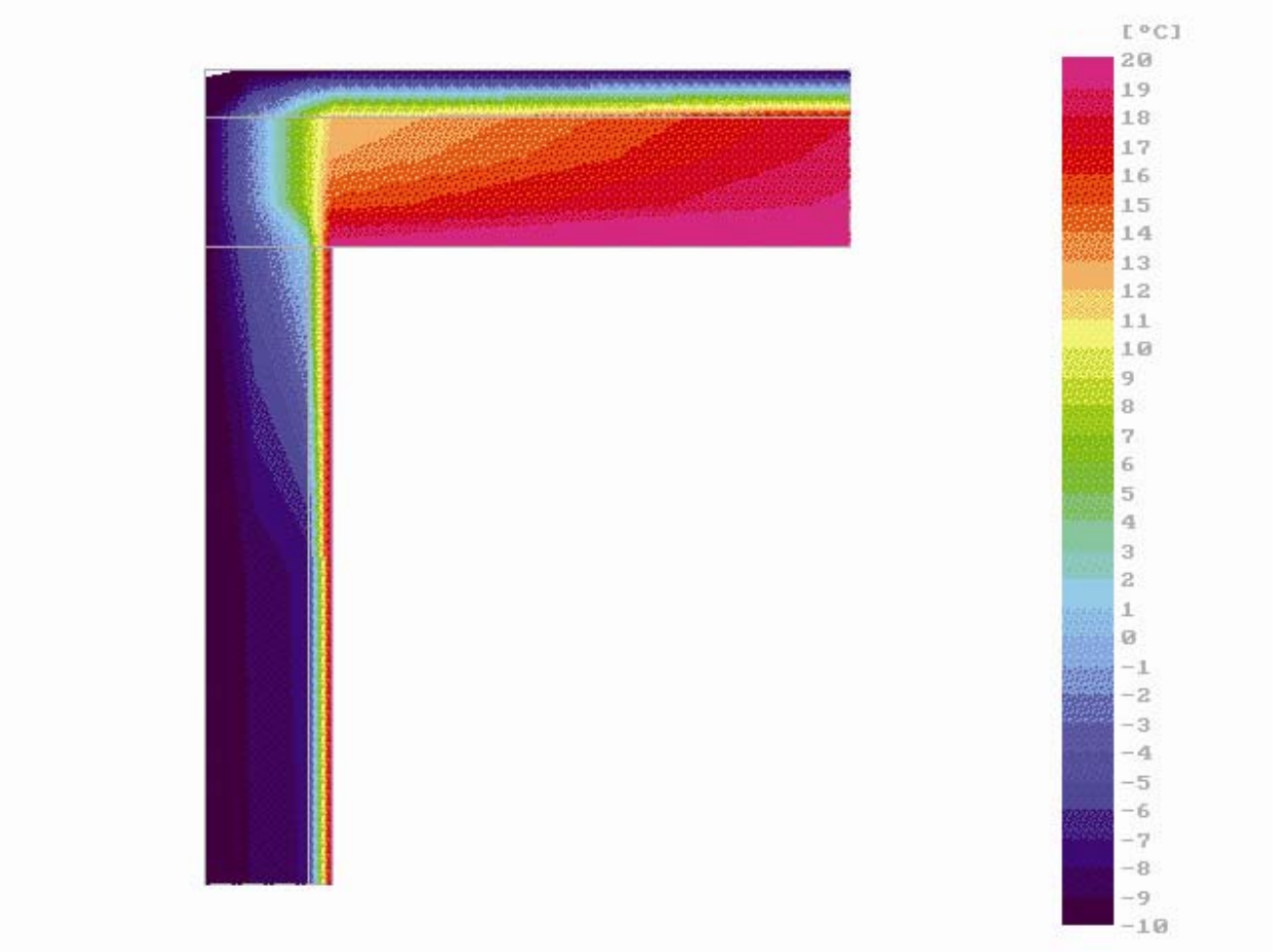
10. NODE4H – Wall's top - solution A

10.1 Graphical data and results:









NET DATA

Reference Unit [m] 1.0000
max. of lines 19
Width of lines 10.000 9.000 8.000 9.000 8.000 60.000
3.000 60.000 10.000
Total 177.000
Total edges deduced 157.000
max. of columns 13
Width of columns 10.000 10.000 10.000 4.500 100.000 10.000
Total 144.500
Total edges deduced 124.500

GEOMETRY OF MATERIALS

	Material name	pat. no.	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	1.700	5	3	7	11
2	reinforced concrete	37	2.200	11	3	17	5
3	mineral wool	67	0.040	3	3	5	11
4	URSA 34	67	0.038	11	7	17	9
5	reinforced concrete	37	1.700	7	3	9	11
6	reinforced concrete	37	1.700	9	3	11	11
7	reinforced concrete	37	2.200	11	5	17	7

LIMIT SURFACE CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	exterior	17	3	3	11	-10	20	0
2	BC_SIMPL	interior	11	11	17	9	20	8	0

10.2 Numerical results :

KOBRU86 RESULTS NODE4-H Node temperatures [°C]

	3	5	7	9	11
3	-10.01	-10.00	-10.00	-10.00	-9.99
5	-9.96	-1.31	7.86	11.93	17.88
7	-9.92	-1.29	8.28	12.92	18.50
9	-9.94	-1.99	8.00	15.46	19.28
11	-9.92	-4.00	1.56	19.82	20.03
13	-10.01	-8.66	-7.45	20.02	
15	-9.99	-8.75	-7.61	19.97	
17	-9.99	-8.91	-7.83	19.97	

KOBRU86 RESULTS NODE4-H Node temperatures (corners) [°C]

	3	9	11
3	-10.01	-9.99	
11		19.82	20.03
17	-9.99	19.97	

KOBRU86 RESULTS NODE4-H Temperatures (limit surface conditions)[°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-10.01	(13, 3)	-9.92	(11, 3)
2 interior	19.82	(11, 9)	20.03	(11, 11)

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures

	3	5	7	9	11
3	-0.000	0.000	0.000	0.000	0.000
5	0.001	0.290	0.595	0.731	0.929
7	0.003	0.290	0.609	0.764	0.950
9	0.002	0.267	0.600	0.849	0.976
11	0.003	0.200	0.385	0.994	1.001
13	-0.000	0.045	0.085	1.001	
15	0.000	0.042	0.080	0.999	
17	0.000	0.036	0.072	0.999	

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures (corners)

	3	9	11
3	-0.000	0.000	
11		0.994	1.001
17	0.000	0.999	

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures (limit surface conditions)

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-0.000	(13, 3)	0.003	(11, 3)
2 interior	0.994	(11, 9)	1.001	(11, 11)

KOBRU86 RESULTS NODE4-H Heat losses [W/m]

Entering heat losses	110.68
Exiting heat losses	110.68

KOBRU86 RESULTS NODE4-H Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 exterior	0.33	110.68
2 interior	110.35	

KOBRU86 RESULTS NODE4-H Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
3	3	3	11		11.85
11	9	11	11	57.87	
3	3	17	3		98.50
11	9	17	9	52.48	

KOBRU86 RESULTS NODE4-H Heat losses for temperature difference of 1°C [W/mK]

Entering heat losses	3.689
Exiting heat losses	3.689

KOBRU86 RESULTS NODE4-H Heat losses at limit conditions for temperature difference of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 exterior	0.011	3.689
2 interior	3.678	

KOBRU86 RESULTS NODE4-H Heat losses at edges for temperature difference of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
3	3	3	11		0.395
11	9	11	11	1.929	
3	3	17	3		3.283
11	9	17	9	1.749	

KOBRU86 RESULTS NODE4-H U-Value and R-Value (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m²K]	R-Value [m²K/W]	Length [m]
12	3	12	9	0.008	127.512	123.000
3	10	11	10	0.004	239.706	100.000

KOBRU86 RESULTS NODE4-H U-Value and R-Value (adiabatic edges)

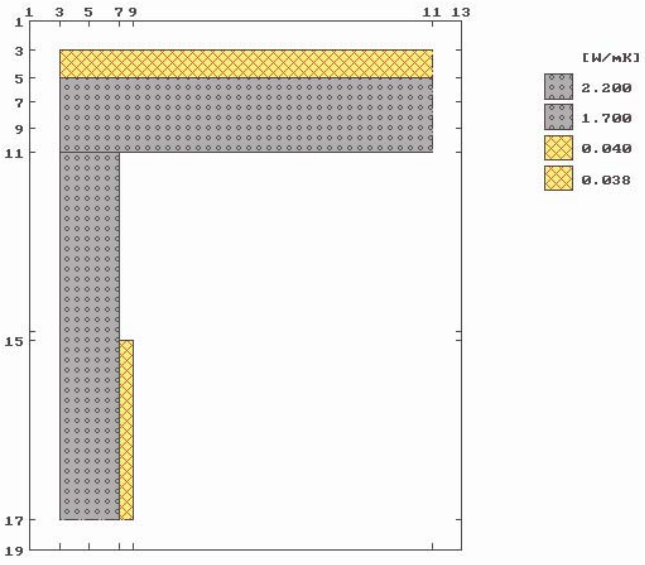
X1	Y1	X2	Y2	U-Value [W/m²K]	R-Value [m²K/W]	Length [m]
17	3	17	9	0.008	127.512	123.000
3	11	11	11	0.004	239.706	100.000

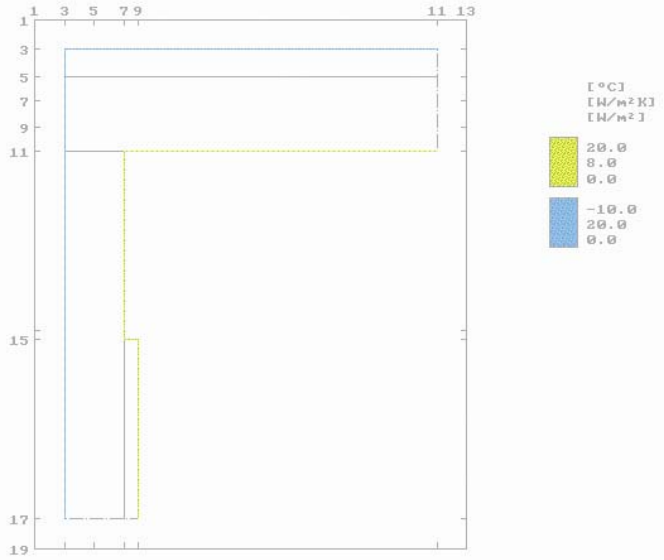
10.3 Conclusions

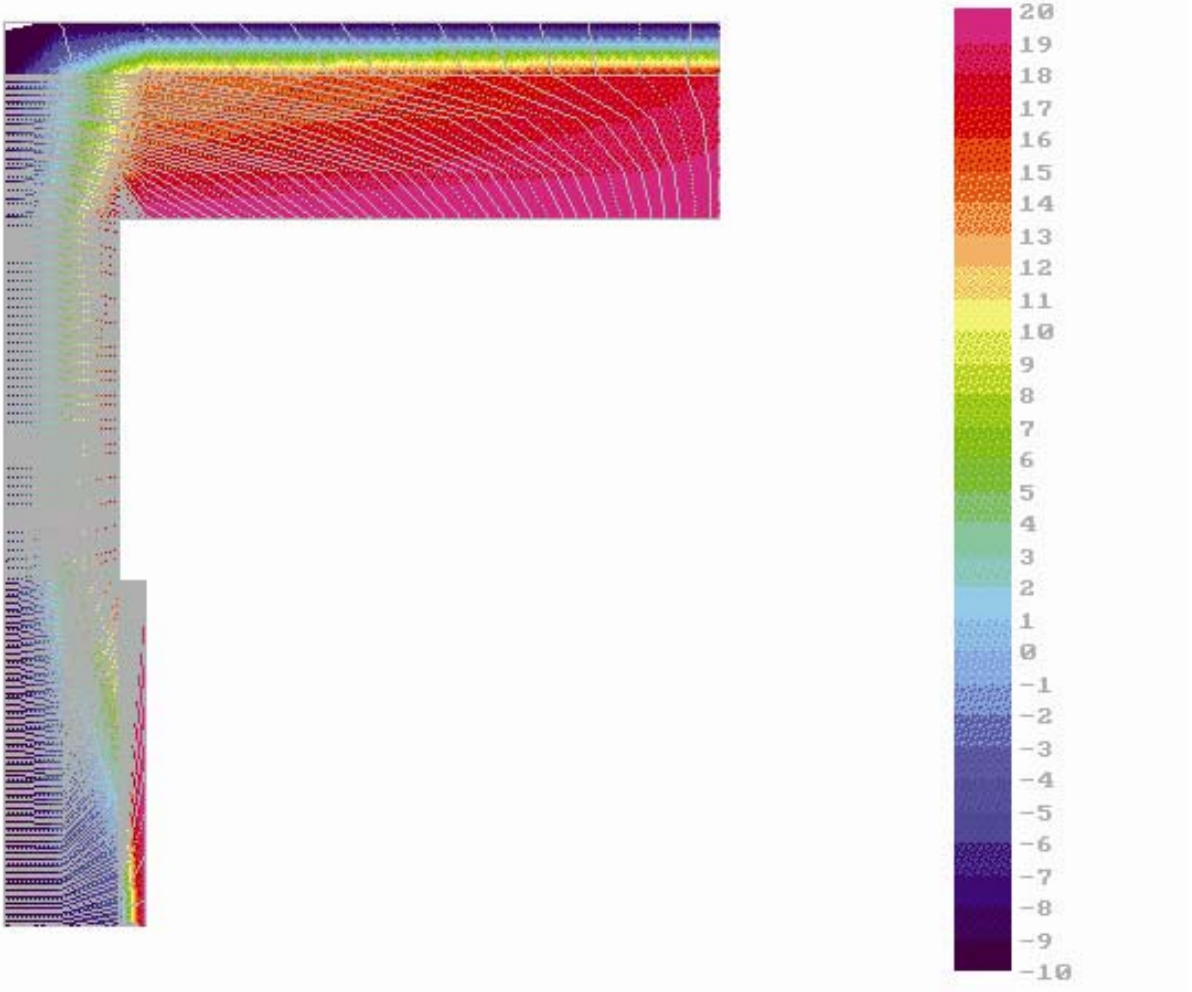
The lowest indoor temperature becomes 19,82 °C, i.e. nearly the same as the initial situation.

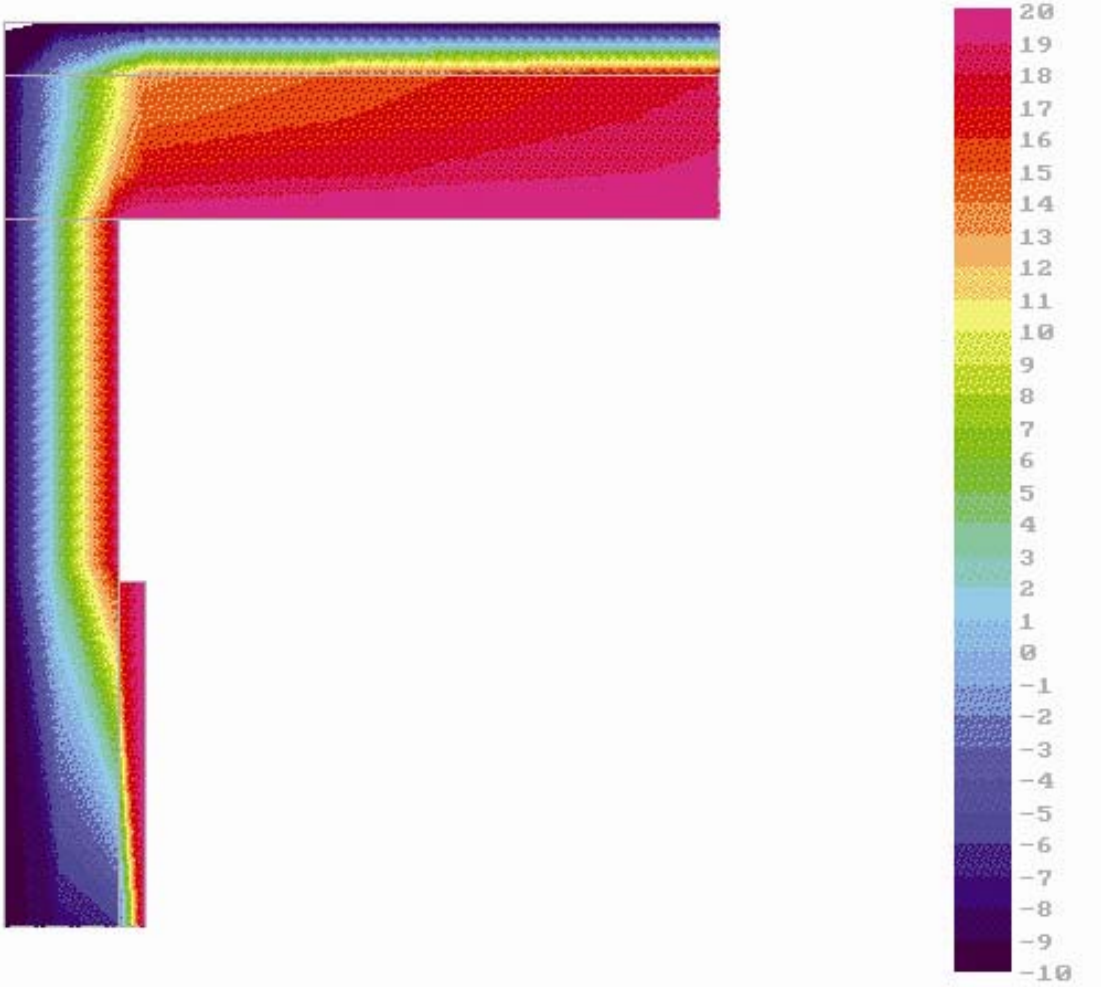
11. NOEUD4H – Wall's top – solution B (with lower ceiling)

11.1 Graphical data and results :









NET DATA

Reference Unit [m] 1.0000
max. of lines 19
Width of lines 10.000 9.000 8.000 9.000 8.000 60.000
3.000 60.000 10.000
Total 177.000
Total edges deduced 157.000
max. of columns 13
Width of columns 10.000 10.000 10.000 4.500 100.000 10.000
Total 144.500
Total edges deduced 124.500

GEOMETRY OF MATERIALS

Material Name	pat. no.	lambda [W/mK]	net coordinate X1	Y1	X2	Y2
1 reinforced concrete	37	1.700	5	3	7	11
2 reinforced concrete	37	2.200	11	3	17	5
3 mineral wool	67	0.040	3	3	5	11
4 URSA 34	67	0.038	15	7	17	9
5 reinforced concrete	37	1.700	7	3	9	11
6 reinforced concrete	37	1.700	9	3	11	11
7 reinforced concrete	37	2.200	11	5	17	7

LIMIT SURFACE CONDITIONS

type	name	net coordinate X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1 BC_SIMPL	exterior	17	3	3	11	-10	20	0
2 BC_SIMPL	interior	11	11	17	9	20	8	0

11.2 Numerical results:

KOBRU86 RESULTS NODE4-H Node temperatures [°C]

	3	5	7	9	11
3	-10.01	-10.00	-10.00	-10.00	-9.99

```
 5 -9.96  0.49  9.95 13.68 17.95
 7 -9.90  1.03 10.91 14.67 18.56
 9 -9.90  2.45 13.61 16.94 19.31
11 -9.84  4.53 19.52 19.90 20.01
13 -9.84  4.40 19.59
15 -9.80  3.49 16.42 20.10
17 -10.03 -7.78 -6.14 19.93
```

KOBRU86 RESULTS NODE4-H Node temperatures (corners) [°C]

```
    3     7     9    11
 3 -10.01             -9.99
11        19.52        20.01
15        16.42 20.10
17 -10.03        19.93
```

KOBRU86 RESULTS NODE4-H Temperatures (limit surface conditions) [°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-10.03	(17, 3)	-9.80	(15, 3)
2 interior	16.42	(15, 7)	20.10	(15, 9)

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures

```
    3     5     7     9    11
 3 -0.000 0.000 0.000 0.000 0.000
 5 0.001 0.350 0.665 0.789 0.932
 7 0.003 0.368 0.697 0.822 0.952
 9 0.003 0.415 0.787 0.898 0.977
11 0.005 0.484 0.984 0.997 1.000
13 0.005 0.480 0.986
15 0.007 0.450 0.881 1.003
17 -0.001 0.074 0.129 0.998
```

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures (corners)

```
    3     7     9    11
 3 -0.000             0.000
11        0.984        1.000
15        0.881 1.003
17 -0.001        0.998
```

KOBRU86 RESULTS NODE4-H Node not dimensional temperatures (limit surface conditions)

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-0.001	(17, 3)	0.007	(15, 3)
2 interior	0.881	(15, 7)	1.003	(15, 9)

KOBRU86 RESULTS NODE4-H Heat losses [W/m]

```
Entering heat losses      371.72
Exiting heat losses       371.73
```

KOBRU86 RESULTS NODE4-H Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 exterior	0.39	364.52
2 interior	371.34	7.20

KOBRU86 RESULTS NODE4-H Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
3	3	3	11		12.34
11	7	11	11	47.73	
15	7	15	9	62.56	
3	3	17	3		351.79
11	7	15	7	261.04	
15	9	17	9		7.20

KOBRU86 RESULTS NODE4-2 Heat losses for difference temperature of 1°C [W/mK]

Entering heat losses 12.391
Exiting heat losses 12.391

KOBRU86 RESULTS NODE4-H Heat losses at limit conditions for difference temperature of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 exterior	0.013	12.151
2 interior	12.378	0.240

KOBRU86 RESULTS NODE4-H losses at edges for difference temperature of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
3	3	3	11		0.411
11	7	11	11	1.591	
15	7	15	9	2.085	
3	3	17	3		11.726
11	7	15	7	8.701	
15	9	17	9		0.240

KOBRU86 RESULTS NODE4-H U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m²K]	R-Value [m²K/W]	Length [m]
12	3	12	7	0.108	9.091	63.000
16	3	16	9	0.008	127.512	60.000
3	8	11	8	0.004	239.706	104.500

KOBRU86 RESULTATS NOEUD4-2 U-Values and R-Values (adiabatic edges)

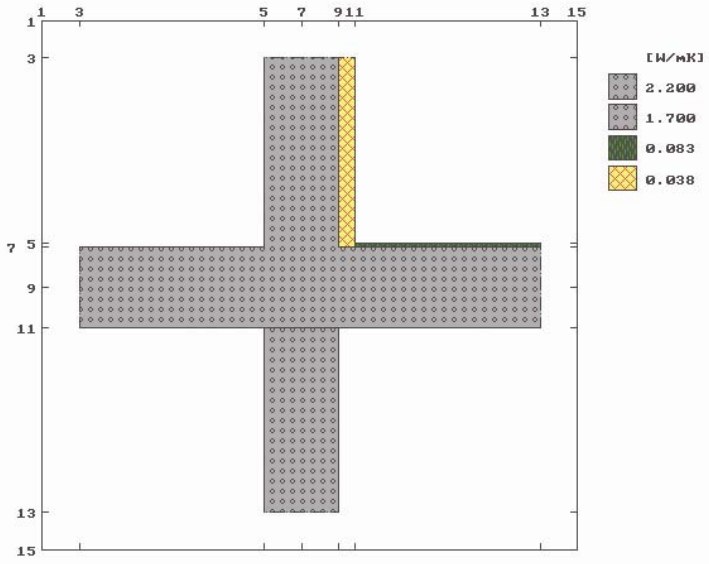
X1	Y1	X2	Y2	U-Value [W/m²K]	R-Value [m²K/W]	Length [m]
17	3	17	9	0.008	127.512	60.000
3	11	11	11	0.004	239.706	104.500

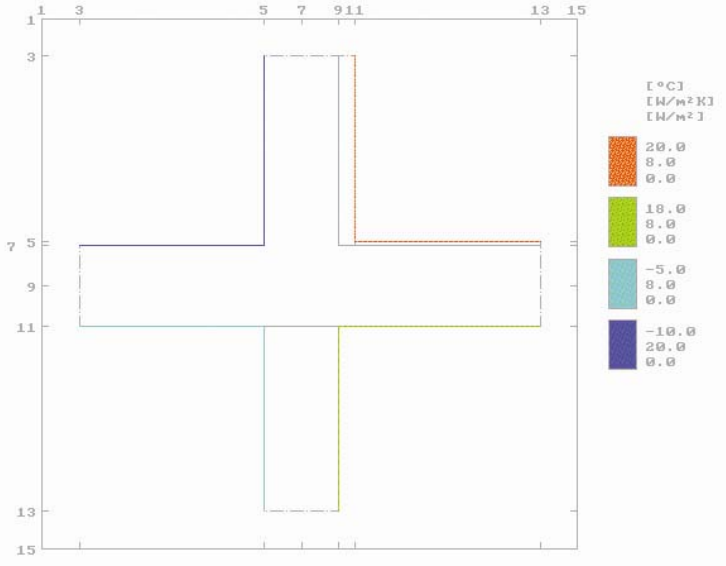
11.3 Conclusions:

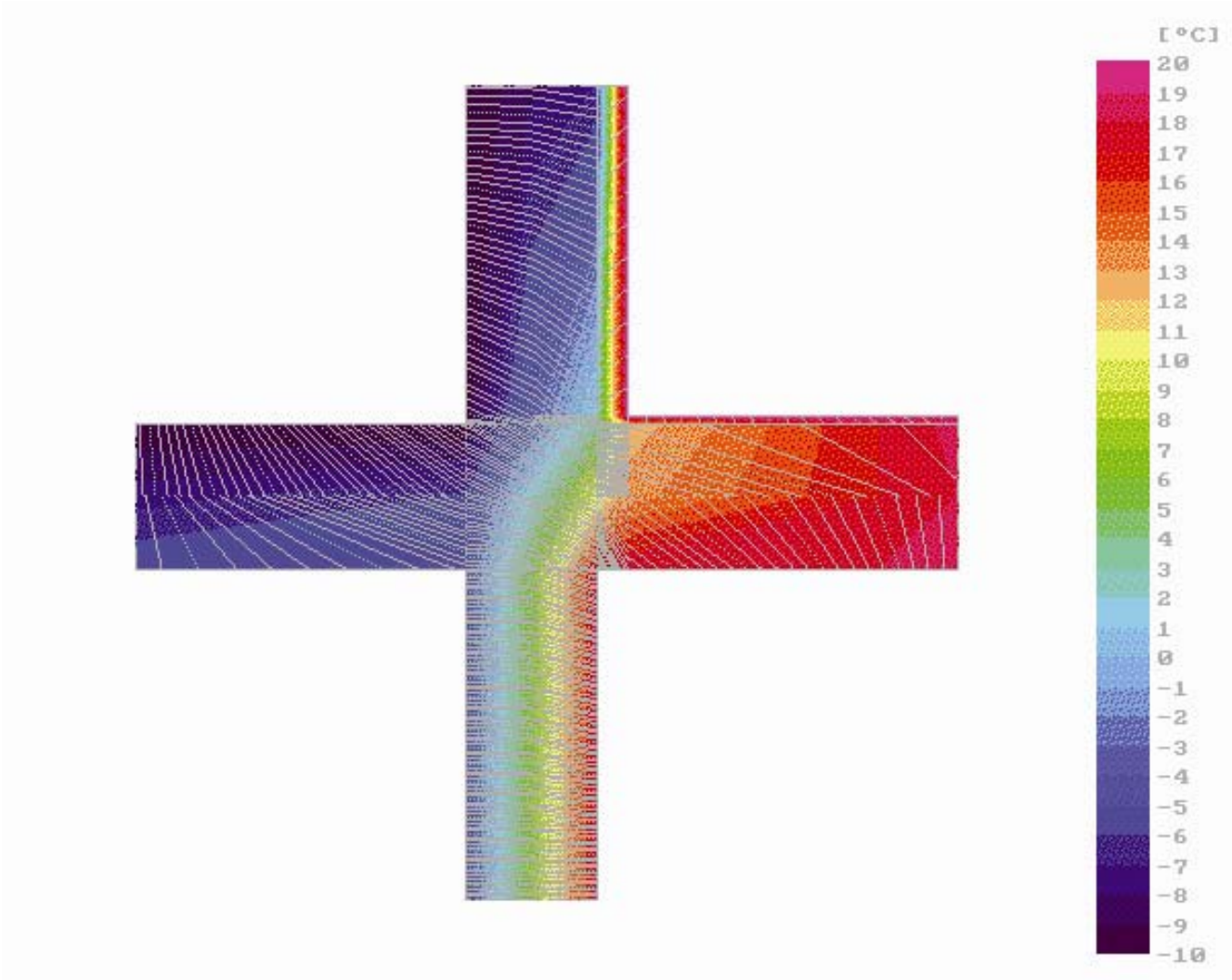
Just close to the end of the insulation panel, the lowest indoor temperature is 16,42 °C, much higher than 14°C necessary to avoid any risk of condensation.

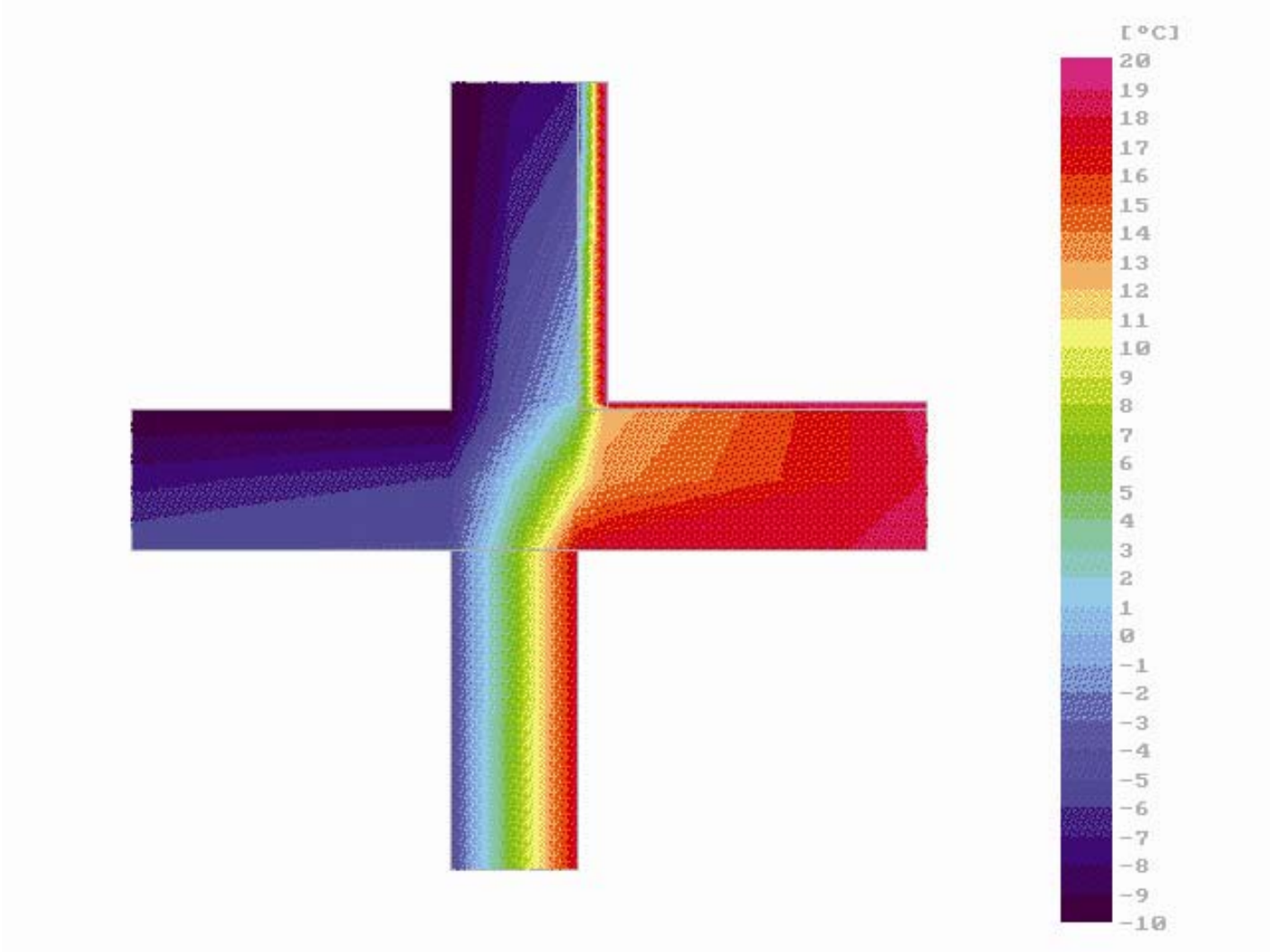
12. NOEUD4E – Wall's bottom –Solution (A or B)

12.1 Graphical data and results:









NET DATA

Reference Unit [m] 1.0000
max. of lines 15
Width of lines 10.000 50.000 1.000 11.000 11.000 50.000 10.000
Total 143.000
Total edges deduced 123.000
max. of columns . 15
Width of columns 10.000 50.000 10.000 10.000 4.500 50.000 10.000
Total 144.500
Total edges deduced 124.500

GEOMETRY OF MATERIALS

	Material Name	pat. no.	lambda [W/mK]	net coordinates X1	Y1	X2	Y2
1	reinforced concrete	37	2.200	3	5	7	7
2	reinforced concrete	37	2.200	3	7	7	9
3	reinforced concrete	37	2.200	7	3	9	13
4	reinforced concrete	37	2.200	9	3	11	13
5	reinforced concrete	37	1.700	11	5	13	7
6	reinforced concrete	37	1.700	11	7	13	9
7	URSA 34	67	0.038	3	9	7	11
8	carpet	20	0.083	5	11	7	13

LIMIT SURFACE CONDITIONS

	type	name	net coordinates X1	Y1	X2	Y2	temp [°C]	h [W/m²K]	flux [W/m²]
1	BC_SIMPL	exterior	7	3	3	5	-10	20	0
2	BC_SIMPL	parking	13	5	11	3	-5	8	0
3	BC_SIMPL	interior	3	11	5	13	20	8	0
4	BC_SIMPL	corridor	11	13	13	9	18	8	0

12.2 Numerical results:

KOBRU86 RESULTS NOEUD4-E Node temperatures [°C]

	3	5	7	9	11	13
3		-10.01	-8.28	-6.92	19.98	
5		-9.91	-3.67	1.18	19.94	20.00
7	-9.99	-9.92	-3.23	3.43	12.40	18.38
9	-7.48	-5.91	1.69	10.06	13.59	18.00
11	-5.13	-4.85	5.67	17.60	17.85	18.05
13		-4.73	6.51	17.81		

KOBRU86 RESULTS NODE4-E Node temperatures (corners) [°C]

	3	5	9	11	13
3		-10.01		19.98	
5			19.94	20.00	
7	-9.99	-9.92			
11	-5.13	-4.85	17.60		18.05
13		-4.73	17.81		

KOBRU86 RESULTS NODE4-E Temperatures (limit surface conditions) [°C]

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-10.01	(3, 5)	-9.91	(5, 5)
2 parking	-5.13	(11, 3)	-4.73	(13, 5)
3 interior	19.94	(5, 11)	20.00	(5, 13)
4 corridor	17.60	(11, 9)	18.05	(11, 13)

KOBRU86 RESULTS NODE4-E Node not dimensional temperatures

	3	5	7	9	11	13
3		-0.000	0.057	0.103	0.999	
5		0.003	0.211	0.373	0.998	1.000
7	0.000	0.003	0.226	0.448	0.747	0.946
9	0.084	0.136	0.390	0.669	0.786	0.933
11	0.162	0.172	0.522	0.920	0.928	0.935
13		0.176	0.550	0.927		

KOBRU86 RESULTS NODE4B-E Node not dimensional temperatures (corners)

	3	5	9	11	13
3		-0.000		0.999	
5			0.998	1.000	
7	0.000	0.003			
11	0.162	0.172	0.920		0.935
13		0.176	0.927		

KOBRU86 RESULTS NOEUD4-E Node not dimensional temperatures (limit surfaces conditions)

Name of limit conditions	at min	(X, Y)	at max	(X, Y)
1 exterior	-0.000	(3, 5)	0.003	(5, 5)
2 parking	0.162	(11, 3)	0.176	(13, 5)
3 interior	0.998	(5, 11)	1.000	(5, 13)
4 corridor	0.920	(11, 9)	0.935	(11, 13)

KOBRU86 RESULTS NODE4-E Heat losses [W/m]

Entering heat losses 176.94
Exiting heat losses 176.94

KOBRU86 RESULTS NODE4-E Heat losses at limit conditions [W/m]

Name of limit conditions	entering	exiting
1 exterior		89.87
2 parking		87.06
3 interior	29.34	
4 corridor	147.59	

KOBRU86 RESULTS NODE4-E Heat losses at edges [W/m]

X1	Y1	X2	Y2	entering	exiting
5	11	5	13	13.12	
7	3	7	5		44.63
11	3	11	5		3.89
11	9	11	13	30.22	
3	5	7	5		45.25
11	5	13	5		83.17
11	9	13	9	117.38	
3	11	5	11	16.22	

KOBRU86 RESULTS NODE4-E Heat losses for difference temperature of 1°C [W/mK]

Entering heat losses 5.898
Exiting heat losses 5.898

KOBRU86 RESULTS NOEUD4-E Heat losses at limit conditions for difference temperature of 1°C [W/mK]

Name of limit conditions	entering	exiting
1 exterior		2.996
2 parking		2.902
3 interior	0.978	
4 corridor	4.920	

KOBRU86 RESULTS NODE4-E Heat losses at edges for difference temperature of 1°C [W/mK]

X1	Y1	X2	Y2	entering	exiting
5	11	5	13	0.437	
7	3	7	5		1.488
11	3	11	5		0.130
11	9	11	13	1.007	
3	5	7	5		1.508
11	5	13	5		2.772
11	9	13	9	3.913	
3	11	5	11	0.541	

KOBRU86 RESULTS NODE4-E U-Values and R-Values (complete analysis)

X1	Y1	X2	Y2	U-Value [W/m²K]	R-Value [m²K/W]	Length [m]
4	5	4	11	0.008	127.512	50.000
12	5	12	9	0.083	11.765	50.000
7	4	11	4	0.098	10.000	50.000
5	12	11	12	0.045	22.048	50.000

KOBRU86 RESULTS NODE4-E U-Values and R-Values (adiabatic edges)

X1	Y1	X2	Y2	U-Value [W/m²K]	R-Value [m²K/W]	Length [m]
3	5	3	11	0.008	127.512	50.000
13	5	13	9	0.083	11.765	50.000
7	3	11	3	0.098	10.000	50.000
5	13	11	13	0.045	22.048	50.000

12.3 Conclusions

Attention : the insulation panel on the wall has the consequence that the indoor temperature at the interface with the floor is 12,4 °C, a little bit lower than 14°C as hoped to avoid any condensation risk.
At the same location, the simulated temperature was 17,55 °C (before the installation of the insulation panel).
Nevertheless, 12,4 °C is a superficial temperature without any risk of condensation as long as the indoor humidity is lower than 60 % for a room temperature of 20°C.