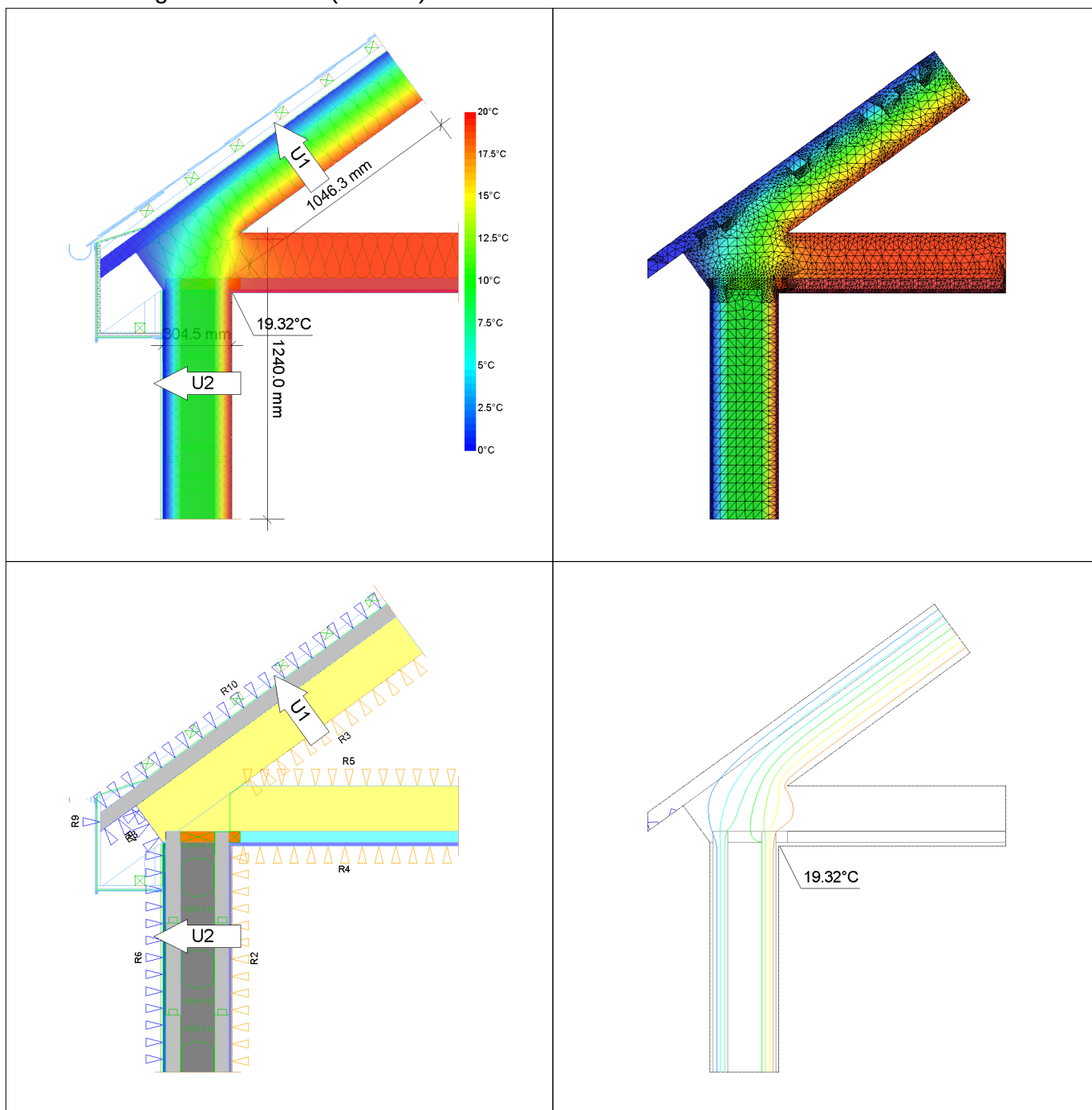


Date: 8.4.2017

Thermal bridges calculation (ψ -Value)

Nr.	Description	Length	U-value	Correction factor
U1	U2	1.046 m	0.12 W/(m²K)	F _e (1.00)
U2	U2	1.240 m	0.23 W/(m²K)	F _e (1.00)

Thermal bridges calculation

$$\psi = -0.019 \text{ W/(mK)}$$

Date: 8.4.2017

Materials list:

	Description	Lambda
	Air Ceiling Service Cavity	0.472 W/(mK)
	Amvic Concrete	2.000 W/(mK)
	EXTERNAL RENDER	1.000 W/(mK)
	insulation 0.031	0.031 W/(mK)
	insulation 0.034	0.034 W/(mK)
	PLASTERBOARD	0.250 W/(mK)
	Softwood	0.130 W/(mK)

Boundary conditions and Flow of heat:

Nr	Temp	Rsi/Rse	Length	Flow of heat
R 1	--	--	2.76 m	--
R 2	20.00 °C	0.13	1.00 m	4.582 W/m
R 3	20.00 °C	0.10	1.00 m	2.580 W/m
R 4	20.00 °C	0.10	1.00 m	0.397 W/m
R 5	20.00 °C	0.17	0.97 m	0.225 W/m
R 6	0.00 °C	0.04	1.02 m	-4.671 W/m
R 7	0.00 °C	0.13	0.20 m	-0.267 W/m
R 8	0.00 °C	0.13	0.20 m	-0.009 W/m
R 9	0.00 °C	0.13	0.08 m	0.000 W/m
R 10	0.00 °C	0.10	1.57 m	-2.837 W/m

Calculation of the thermal conductivity L2D temperature for 2 conditions

Conductance L2D	+0.38923 W/mK
Psi-value	-0.01858 W/mK

Date: 8.4.2017

Input data - material regions

		Description	Lambda	
	M1	insulation 0.031	0.031 W/(mK)	
Description	Nr	X	Y	
Contour	1	-0.43 m	-0.32 m	
	2	-0.49 m	-0.32 m	
	3	-0.49 m	-1.39 m	
	4	-0.43 m	-1.39 m	
Contour	1	-0.21 m	-0.32 m	
	2	-0.28 m	-0.32 m	
	3	-0.28 m	-1.39 m	
	4	-0.21 m	-1.39 m	
Contour	1	+0.49 m	+0.69 m	
	2	-0.78 m	-0.24 m	
	3	-0.78 m	-0.32 m	
	4	+0.53 m	+0.63 m	

		Description	Lambda	
	M2	Softwood	0.130 W/(mK)	
Description	Nr	X	Y	
Contour	1	-0.28 m	-0.32 m	
	2	-0.43 m	-0.32 m	
	3	-0.43 m	-0.37 m	
	4	-0.28 m	-0.37 m	
Contour	1	-0.16 m	-0.32 m	
	2	-0.21 m	-0.32 m	
	3	-0.21 m	-0.37 m	
	4	-0.16 m	-0.37 m	

		Description	Lambda	
	M3	Amvic Concrete	2.000 W/(mK)	
Description	Nr	X	Y	
Contour	1	-0.28 m	-0.37 m	
	2	-0.43 m	-0.37 m	
	3	-0.43 m	-1.39 m	
	4	-0.28 m	-1.39 m	

		Description	Lambda	
	M4	PLASTERBOARD	0.250 W/(mK)	
Description	Nr	X	Y	
Contour	1	-0.16 m	-0.37 m	
	2	-0.21 m	-0.37 m	
	3	-0.21 m	-1.39 m	
	4	-0.20 m	-1.39 m	
	5	-0.20 m	-0.39 m	
	6	+0.80 m	-0.39 m	
	7	+0.80 m	-0.37 m	
	8	-0.16 m	-0.37 m	

		Description	Lambda	
	M5	EXTERNAL RENDER	1.000 W/(mK)	

Date: 8.4.2017

Description	Nr	X	Y
Contour	1	-0.49 m	-0.37 m
	2	-0.51 m	-0.37 m
	3	-0.51 m	-1.39 m
	4	-0.49 m	-1.39 m

	Description	Lambda
M6	insulation 0.034	0.034 W/(mK)

Description	Nr	X	Y
Contour	1	+0.53 m	+0.63 m
	2	-0.62 m	-0.21 m
	3	-0.51 m	-0.37 m
	4	-0.49 m	-0.37 m
	5	-0.49 m	-0.32 m
	6	+0.80 m	-0.32 m
	7	+0.80 m	-0.12 m
	8	-0.16 m	-0.12 m
	9	+0.64 m	+0.47 m

	Description	Lambda
M7	Air Ceiling Service Cavity	0.472 W/(mK)

Description	Nr	X	Y
Contour	1	+0.80 m	-0.32 m
	2	-0.16 m	-0.32 m
	3	-0.16 m	-0.37 m
	4	+0.80 m	-0.37 m

Input data - border areas

	Description	Temperature	Rsi/Rse	Length
R2	External walls, internal party walls, heat flow to outside	+20.00 °C	0.13	1.00 m
		X	Y	
Starting point		-0.20 m	-1.39 m	
Endpoint		-0.20 m	-0.39 m	

	Description	Temperature	Rsi/Rse	Length
R3	Heat flux upward	+20.00 °C	0.10	1.00 m
		X	Y	
Starting point		-0.16 m	-0.12 m	
Endpoint		+0.64 m	+0.47 m	

	Description	Temperature	Rsi/Rse	Length
R4	Heat flux upward	+20.00 °C	0.10	1.00 m
		X	Y	
Starting point		-0.20 m	-0.39 m	
Endpoint		+0.80 m	-0.39 m	

	Description	Temperature	Rsi/Rse	Length
R5	Heat flux downwards to heated rooms	+20.00 °C	0.17	0.97 m
		X	Y	
Starting point		+0.80 m	-0.12 m	
Endpoint		-0.16 m	-0.12 m	

Date: 8.4.2017

Input data - border areas

	Description	Temperature	Rsi/Rse	Length
R6	External wall, Roof, Heatflow horizontal and vertical	+0.00 °C	0.04	1.02 m
		X	Y	
Starting point		-0.51 m	-0.37 m	
Endpoint		-0.51 m	-1.39 m	

	Description	Temperature	Rsi/Rse	Length
R7	Exterior rear-ventilated, Heatflow horizontal	+0.00 °C	0.13	0.20 m
		X	Y	
Starting point		-0.62 m	-0.21 m	
Endpoint		-0.51 m	-0.37 m	

	Description	Temperature	Rsi/Rse	Length
R8	Exterior rear-ventilated, Heatflow horizontal	+0.00 °C	0.13	0.20 m
		X	Y	
Starting point		-0.78 m	-0.32 m	
Endpoint		-0.62 m	-0.21 m	

	Description	Temperature	Rsi/Rse	Length
R9	Exterior rear-ventilated, Heatflow horizontal	+0.00 °C	0.13	0.08 m
		X	Y	
Starting point		-0.78 m	-0.24 m	
Endpoint		-0.78 m	-0.32 m	

	Description	Temperature	Rsi/Rse	Length
R10	Roof area, Insulated rafter Rse=0.10	+0.00 °C	0.10	1.57 m
		X	Y	
Starting point		+0.49 m	+0.69 m	
Endpoint		-0.78 m	-0.24 m	

Input data - U-values

	Description	U-values	Fx
U1	U2	1.05	1.00
X		Y	Alignment
+0.17 m		+0.12 m	126 °

	Description	U-values	Fx
U2	U2	1.24	1.00
X		Y	Alignment
-0.20 m		-0.78 m	180 °

Date: 8.4.2017

```

*****
PSI - VALUE CALCULATION
*****

N E T W O R K   G E N E R A T I O N
Combining the thermal bridge areas... ready
Generation of the element cells
  There were : 1125   Element cells produced.
Topology optimization... ready
E N D   :   N E T W O R K   G E N E R A T I O N
Assembling the finite element structure... ready
  Number of elements____:1405
  Number of nodes_____:824
S T A R T   :   F I N I T E   E L E M E N T   C A L C U L A T I O N
Initialize matrices...Number of nodes 824
Assembling the stiffness matrix and load vector... ready
Solve equations:
  Begin the iteration. According to the method of conjugate gradient:
... Finished, the system of equations was solved.
  Number of iterations 245
  The temperatures in the network nodes are calculated.
E N D   :   F I N I T E   E L E M E N T   C A L C U L A T I O N
*****
***   CONVERGENCE TEST               *****
***   To DIN10211:2008-04, A.2       *****
  Convergence - structure... ready
  Number of elements____:5620
  Number of nodes_____:3053
S T A R T   :   F I N I T E   E L E M E N T   C A L C U L A T I O N
Initialize matrices...Number of nodes 3053
Assembling the stiffness matrix and load vector... ready
Solve equations:
  Begin the iteration. According to the method of conjugate gradient:
... Finished, the system of equations was solved.
  Number of iterations 635
  The temperatures in the network nodes are calculated.
E N D   :   F I N I T E   E L E M E N T   C A L C U L A T I O N
Sum of absolute values   of all penetrating heat flows:
  from the baseline           [W/m]:7.802
  from the convergence calculation [W/m]:7.785
Convergence [%] 0.2 <= 1
=====
Calculation of heat flows
Boundary condition Type      Heat flow      Length      Temperature      Rs(i,e)
                             q [W/m]        [m]          [°C]             [m2K/W]
    1      Neumann          0.000        2.759         --              --
    4      Robin           0.397        1.004        20.000          0.100
    2      Robin           4.582        1.000        20.000          0.130
    6      Robin          -4.671        1.016         0.000          0.040
    7      Robin          -0.267        0.201         0.000          0.130
    5      Robin           0.225        0.967        20.000          0.170
    3      Robin           2.580        1.000        20.000          0.100
    9      Robin           0.000        0.084         0.000          0.130
    8      Robin          -0.009        0.195         0.000          0.130
   10      Robin          -2.837        1.569         0.000          0.100
      Total:          -0.00017
Total heat flow (positive)           Q+ =      7.78465 [W/m]
Total heat flow (from interior outwards) Q =      7.78465 [W/m]

```

Date: 8.4.2017

Psi-value calculation:

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Table of undisturbed U-values

Number factors	Description	Length [m]	U-value undisturbed [W/m2K]	Temperature correction Designation	Factor
1	U2	1.046	0.121	F_e	1.000
2	U2	1.240	0.227	F_e	1.000

Calculation of the L2D for 2 temperature conditions

Temperature difference (DeltaT) : 20.00000 [K]

L2D = Q / deltaT = 0.38923 [W/mK]

=====

L2D = 0.389 [W/mK]

- (0.121 * 1.046 * 1.000) = -0.126 [W/mK]

- (0.227 * 1.240 * 1.000) = -0.281 [W/mK]

=====

Psi-value = -0.01858 [W/mK]

*** END of CALCULATION ***
