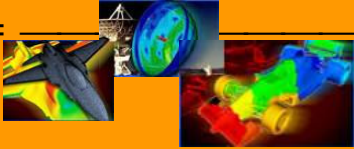
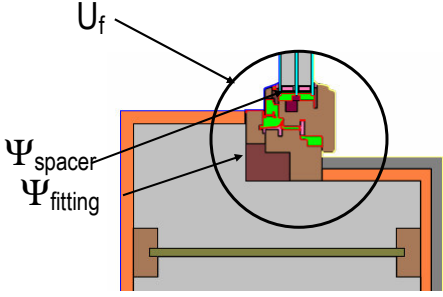
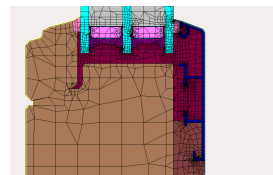


$$U_w = \frac{U_g \cdot A_{\text{glas}} + U_f \cdot A_{\text{frame}} + \Psi_{\text{spacer}} \cdot L_{\text{spacer}} + \Psi_{\text{fitting}} \cdot L_{\text{joint of fitting}}}{A_{\text{total}}}$$



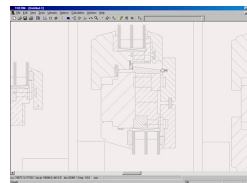
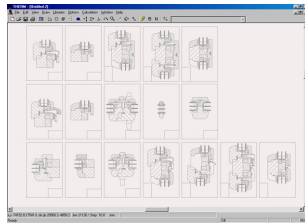
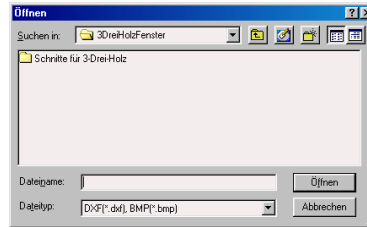
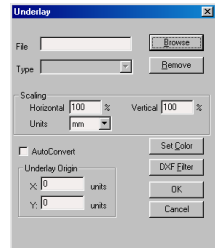
24.04.2006 **IZF** finite element calculation Seite 1

Finite Element Method

- We make a calculation model for a structural element consisting out of small elements and we know there thermal quality exact or nearly exact.
- If you lay a net over the structural element, calculate all junctions, you can conclude the thermal quality of the whole element out of the grill.



DXF File as underlay

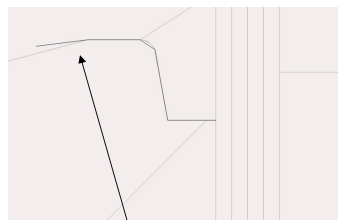


24.04.2006 **IZF**

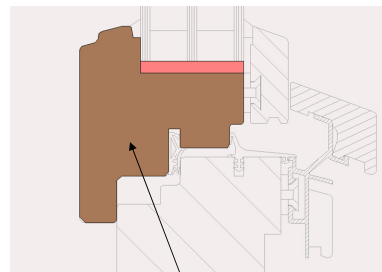
finite element calculation

Seite 3

Start with drawing a contour



Redraw the contour



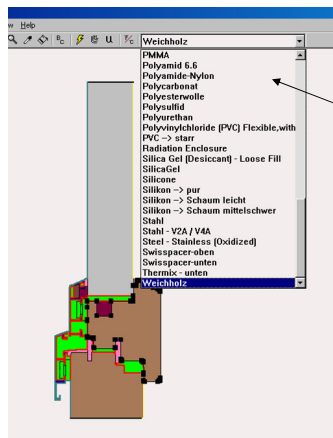
After the contour is finished,
define the thermal quality of the element

24.04.2006 **IZF**

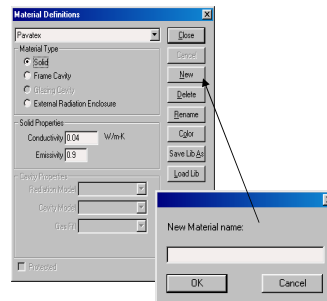
finite element calculation

Seite 4

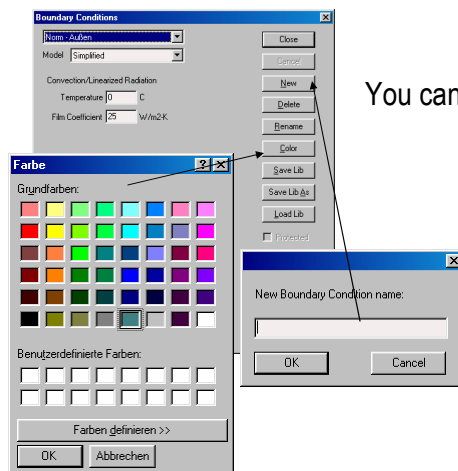
Finite element method



The thermal quality is defined in the material library

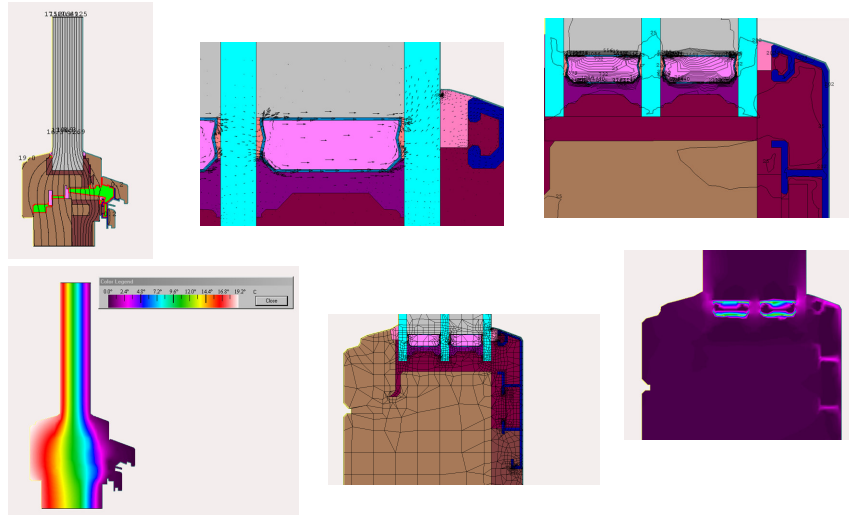


Define the boundary conditions



You can define all climate dates you need

Output of the results

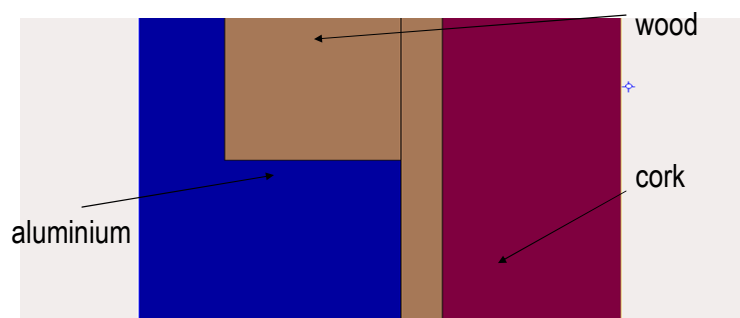


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finite element calculation

Seite 7

Example with different layers

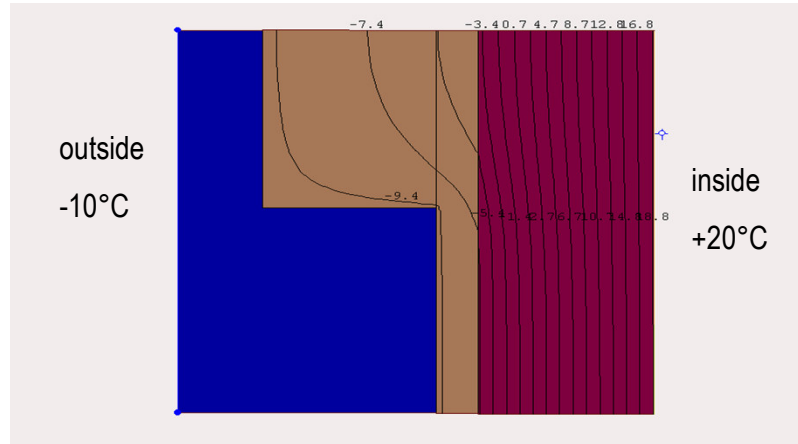


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finite element calculation

Seite 8

Example with different layers

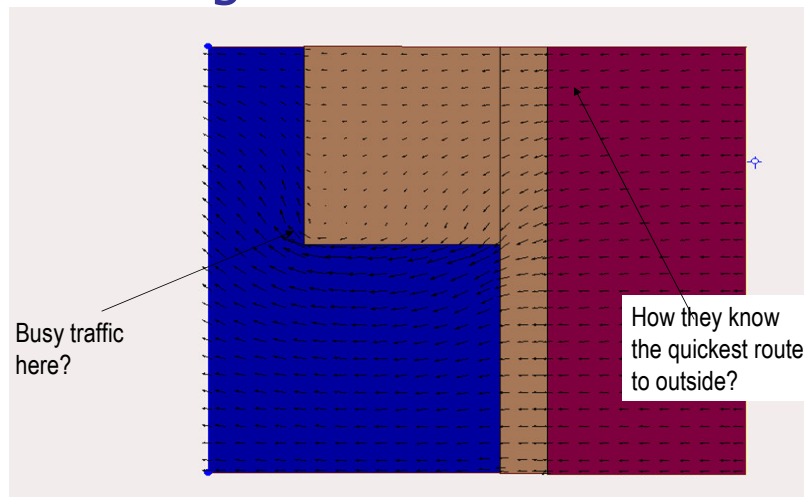


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finite element calculation

Seite 9

Is it possible that heat energy is intelligent?

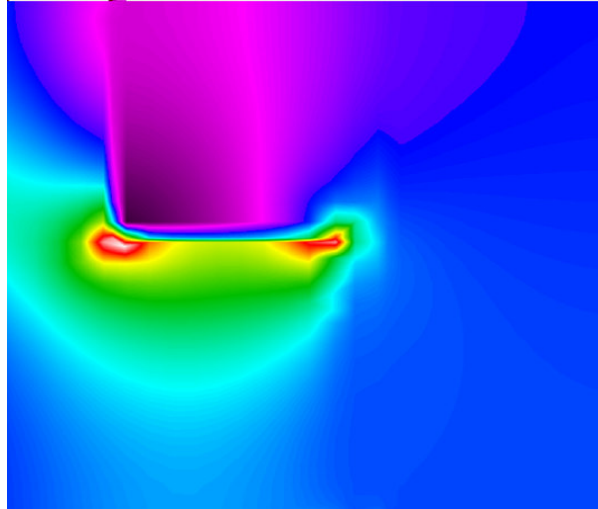


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finite element calculation

Seite 10

Find out the weakest places

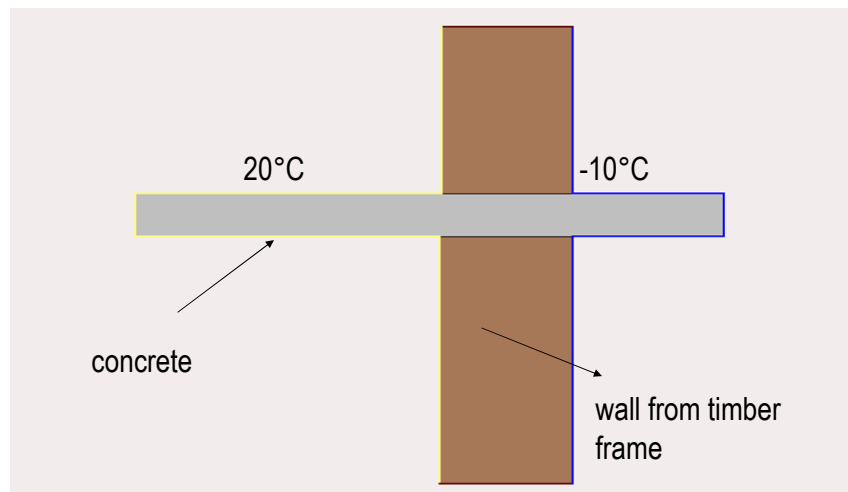


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finite element calculation

Seite 11

Example: thermal bridge- constructiv

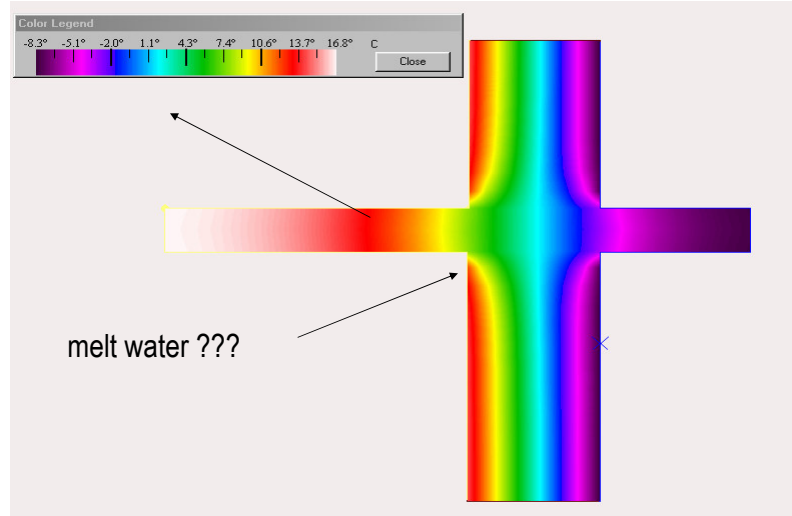


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finite element calculation

Seite 12

Example:thermal bridge- constructiv

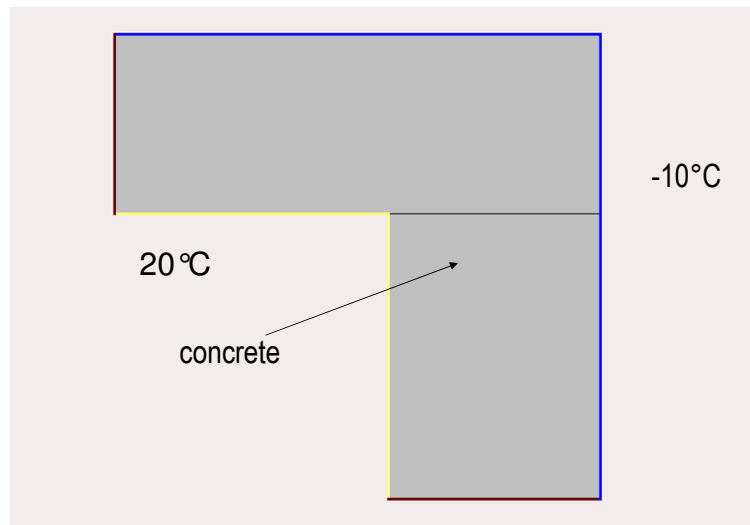


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finite element calculation

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Example:thermal bridge- geometric

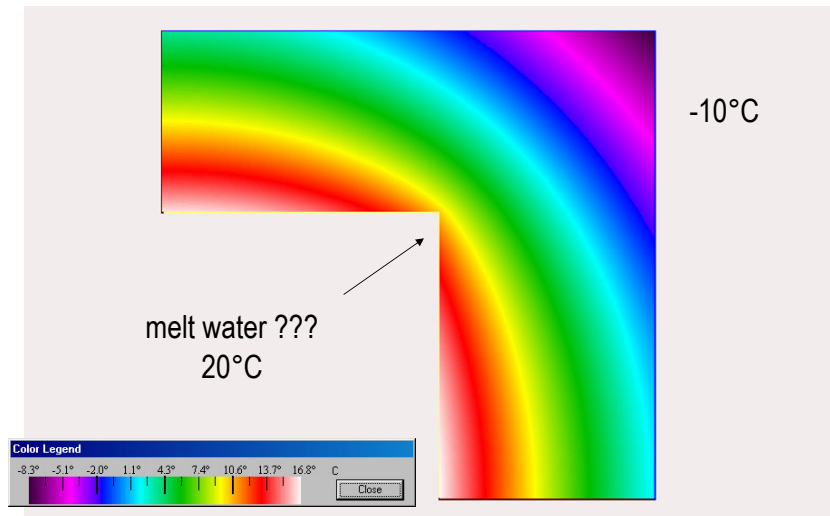


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finite element calculation

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Example:thermal bridge- geometric

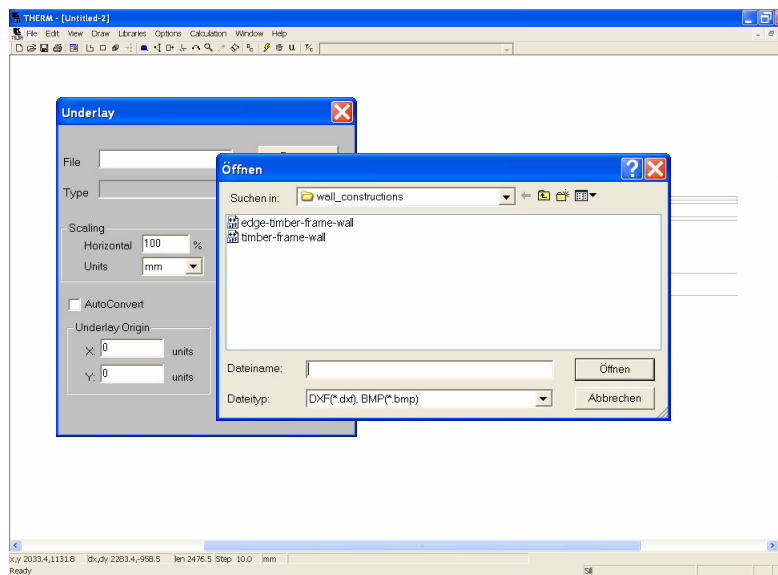


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finite element calculation

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Now its your turn. Let's calc a timber frame wall

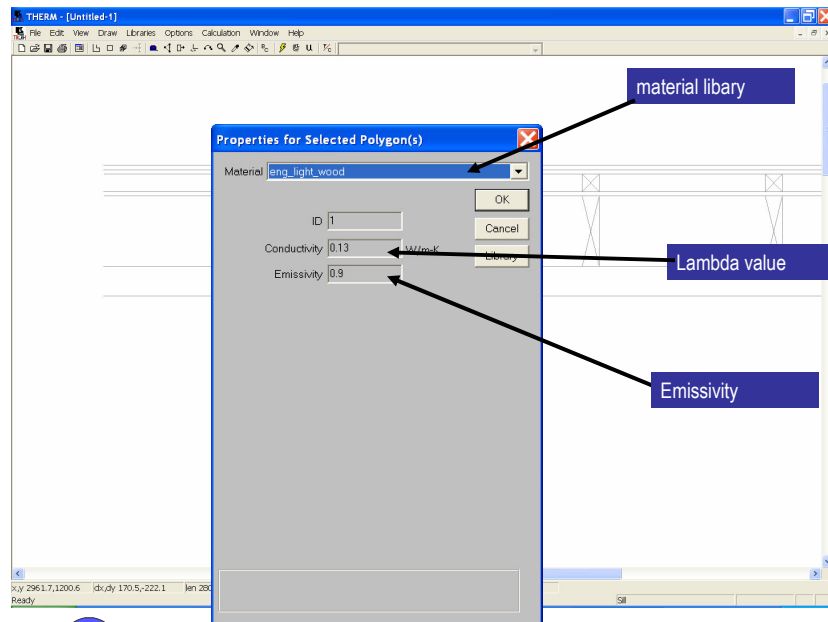


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finite element calculation

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Cover the construction with material



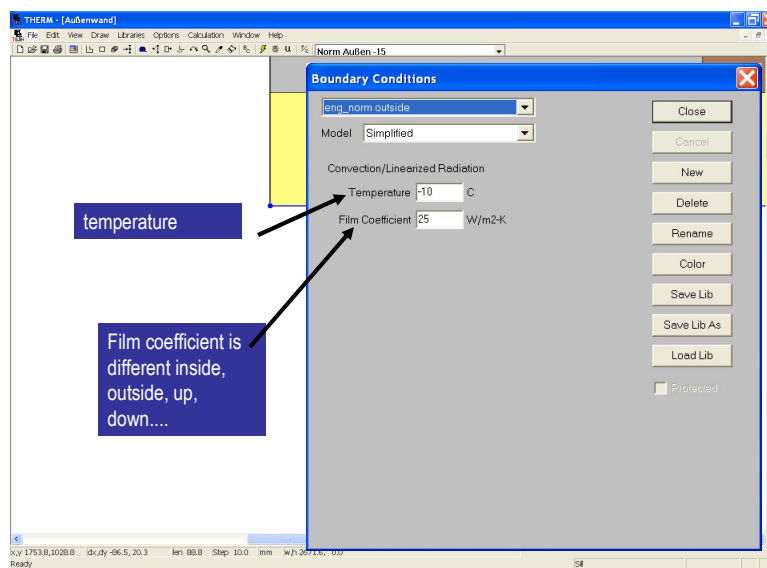
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finite element calculation

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define the boundary conditions



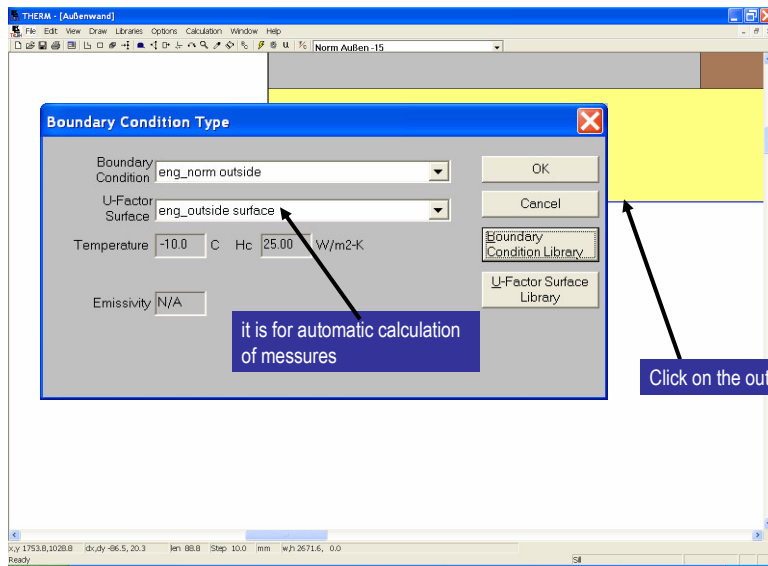
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finite element calculation

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now define the U-factor surface)

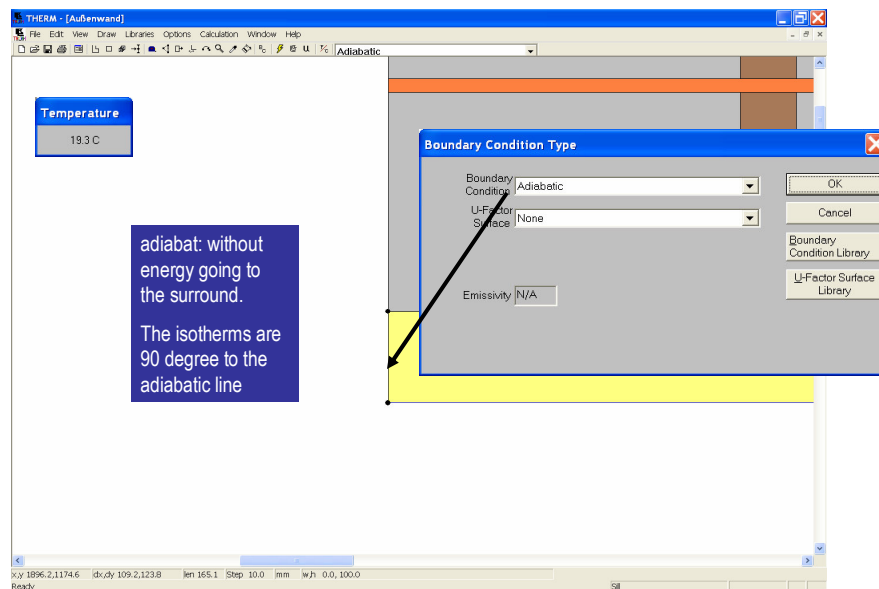


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finite element calculation

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define the boundary conditions



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finite element calculation

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read the U- value

The screenshot shows the THERM software interface. The main window displays a cross-section of a wall with a timber frame. Two 'U-Factors' dialog boxes are open. The top dialog box shows the 'Simulation' tab with 'Therm File Options' and 'Snap Settings'. It includes a 'Mesh Control' section with a 'Quad Tree Mesh Parameter' set to 10, a 'Run Error Estimator' checkbox checked, and 'Maximum % Error Energy Norm' set to 10. The bottom dialog box shows the 'U-Factors' results for 'eng_inside surface' and 'eng_outside surface', both with a U-Factor of 0.1033 W/m²K and a delta T of 30.0 C. The '% Error Energy Norm' is highlighted with a circle and shows a value of 2.23%.

„messure of the grill“

maximum error

number of iterationen

24 Ready X-Y 1980.2,2054.5 dx,dy -901.1,270.7 len 940.9 Step 10.0 mm U-factor results eite 21

Now we are able to calculate the Psi-value of a corner

The screenshot shows the THERM software interface with a corner window model. A blue box lists the steps to calculate the Psi-value of a corner:

1. define material
2. define boundary conditions
3. Simulation
4. read the U-value

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input in the exelfile linear-psi-value

Psi value		
U-Wert 1-dim	0,103	W/m2K
U-Wert 2-dim	0,084	W/m2K
length of construction	2,706	m
Q 1-dim	0,280	W/mK
Q 2-dim	0,227	W/mK
psi	-0,052	W/mK

$$\Psi = \frac{Q_{2Dim} - Q_{1Dim}}{l \times DJ}$$

simply

$$Q_{1Dim} = (l_1 \times h \times U_1 + l_2 \times h \times U_2) \times G_t$$

$$Q_{2Dim} = (l_1 \times h \times U_1 + l_2 \times h \times U_2 + h \times \Psi) \times G_t$$

precise

l: length of the thermal bridge

DJ: difference of temperature inside outside

Q_{2Dim}: stream of heat 2 dimensional (aus FEM)

Q_{1Dim}: stream of heat 1 dimensional (at an example out of PHPP)

Ψ: psi value (linear thermal bridge)

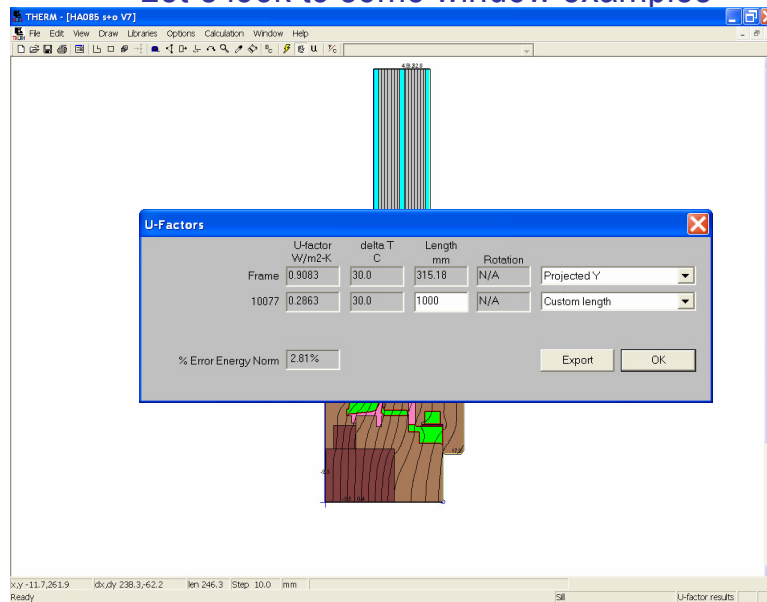
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finite element calculation

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Let's look to some window examples



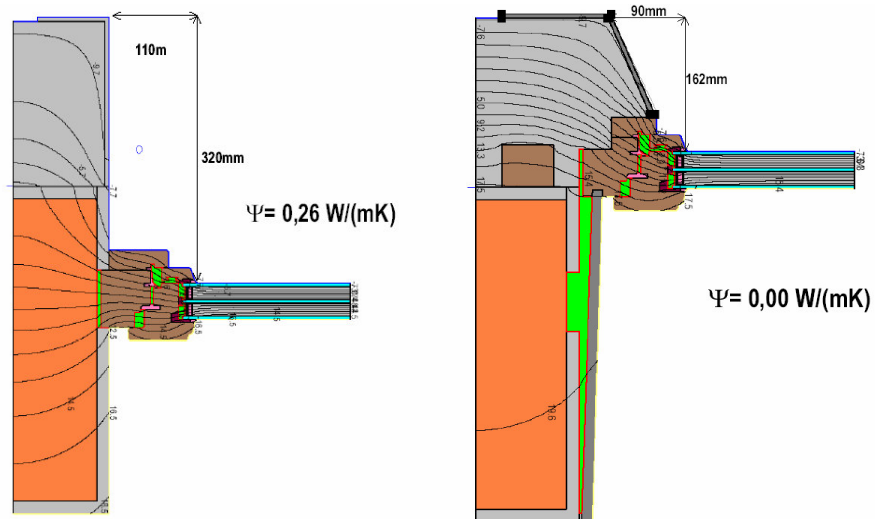
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finite element calculation

Seite 24

Renovation: most important for passive house windows



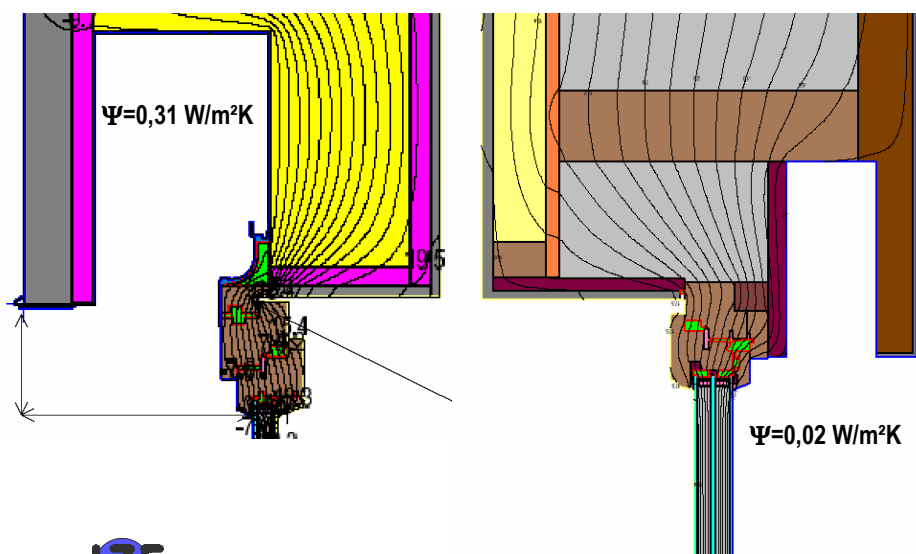
24.04.2006



finite element calculation

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Shading systems



24.04.2006



finite element calculation

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