03.03_PH-SUMMER SCHOOL

PH-CALCULATION – Thermal bridge coefficients with THERM

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Language support: Mark TOLSON
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CONTENT OF THIS PRESENTATION:

In the PH-calculation software PHPP, no thermal bridge coefficients are included. They can be taken from thermal bridge coefficient libraries or can be calculated by yourself.

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The THERM heat transfer software

Description

THERM

Analysis of two-dimensional heat transfer through building products. Includes a graphical user interface that allows users to draw cross sections of fenestration and other building products, which can then be analyzed by an automatic mesh generator and finite-element heat transfer algorithms. Results are displayed graphically.

Keywords

two-D heat transfer, building products, fenestration

Validation/Testing

N/A

Expertise Required

Understanding of heat flows through building products; knowledge of properties of materials useful.

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=136/pagename=alpha_list

The THERM heat transfer software

Description

Users
Version 5.2 in use by over 1000 users internationally.

Audience
Building product developers, designers, analysts determining window ratings (NFRC).

Input
Graphic user interface; user enters cross sections of the building products, can read .DXF files and bitmaps.

Output
U-factors, isotherms, color-flooded isotherms, heat-flux vector plot, and color-flooded lines of constant flux.

Computer Platform
Requires Windows 98, Windows NT, Windows 2000, or Windows XP. Pentium or better. At least 64MB of random access memory (RAM), 128 MB of RAM is preferred for optimum operation. Hard disk drive with at least 15 megabytes of available disk space.

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=136/pagename=alpha_list

The THERM heat transfer software

Description

Programming Language
C, FORTRAN

Strengths
State-of-the-art user interface; automatic meshing/re-meshing completely user transparent; advanced radiation and convection models can be incorporated into the finite element analysis algorithms used. The current version is 32-bit, which is faster than previous versions.

Weaknesses
...

Contact
Company: Lawrence Berkeley National Laboratory
E-mail: THERMHelp@lbl.gov
Website: http://windows.lbl.gov/software/therm/therm.html
Freeware

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=136/pagename=alpha_list

The THERM heat transfer software

Description

THERM is a finite element computer program for the calculation of two dimensional heat fluxes.

Features

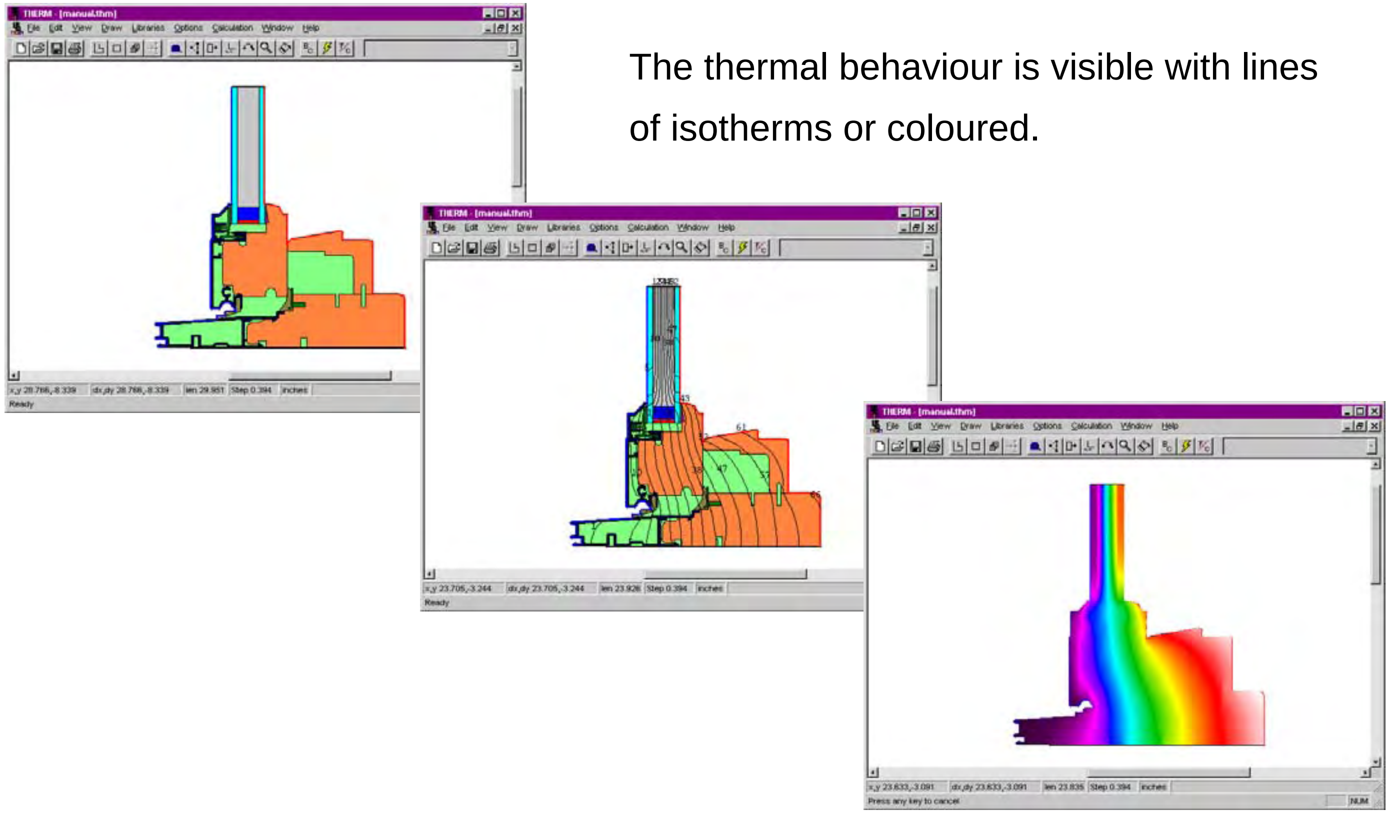
- Model one and two dimensional heat transfer effects
- Evaluate thermal bridges
- Optimize construction details (joints…)

Download link: http://windows.lbl.gov/software/therm/therm.html

Source:

The THERM heat transfer software

Description / Examples

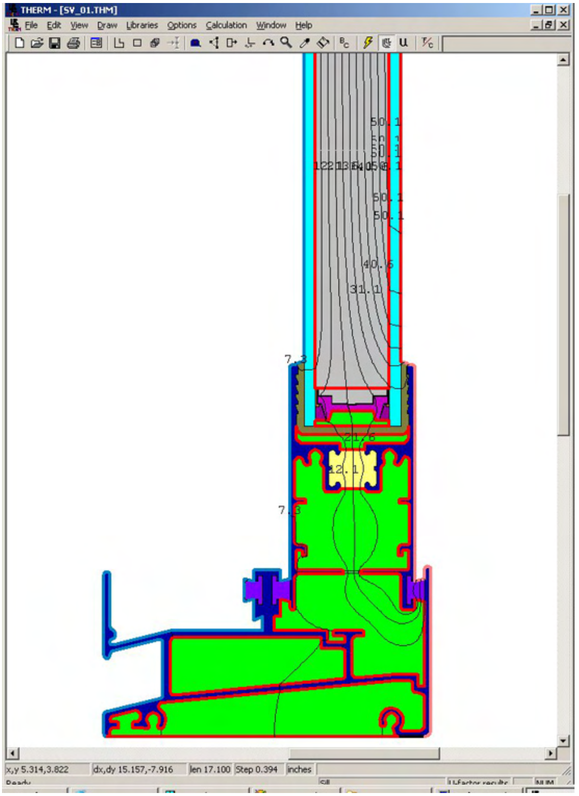


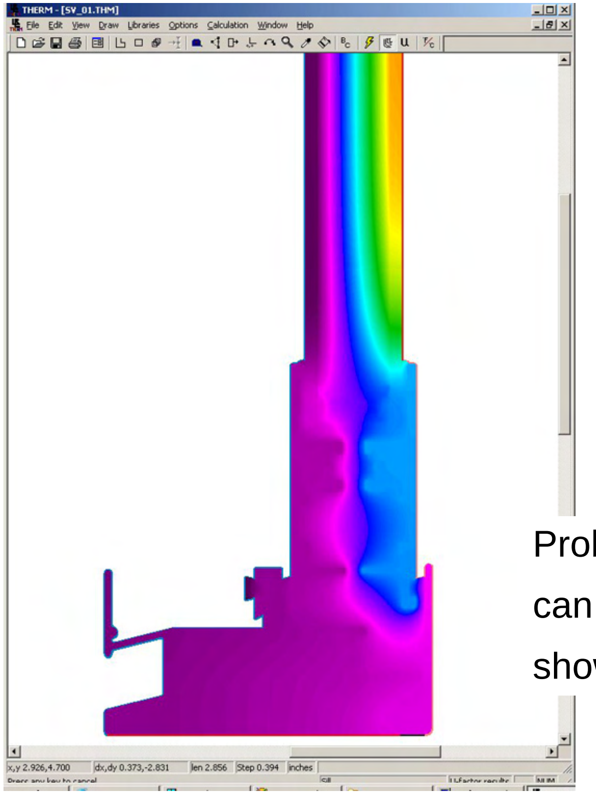
The thermal behaviour is visible with lines of isotherms or coloured.

Source: http://windows.lbl.gov/software/therm/images/therm2-1.gif

The THERM heat transfer software

Description / Examples





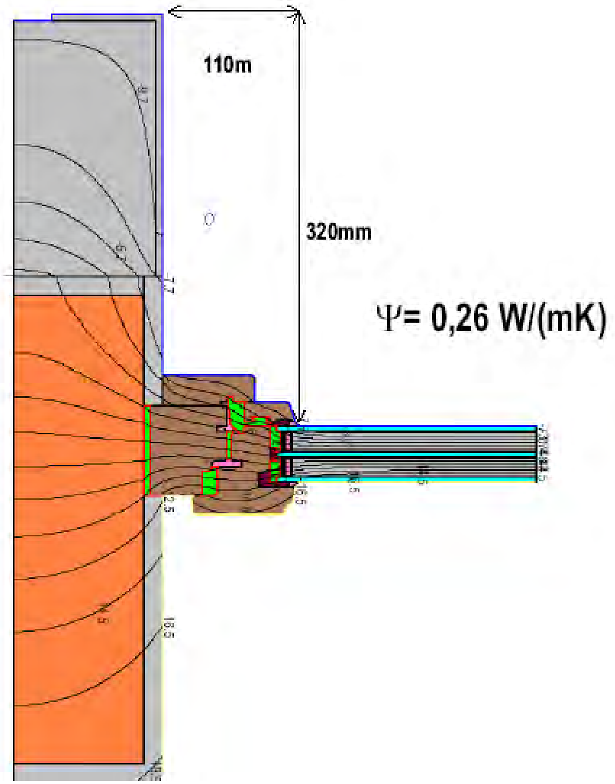
Problems can be shown

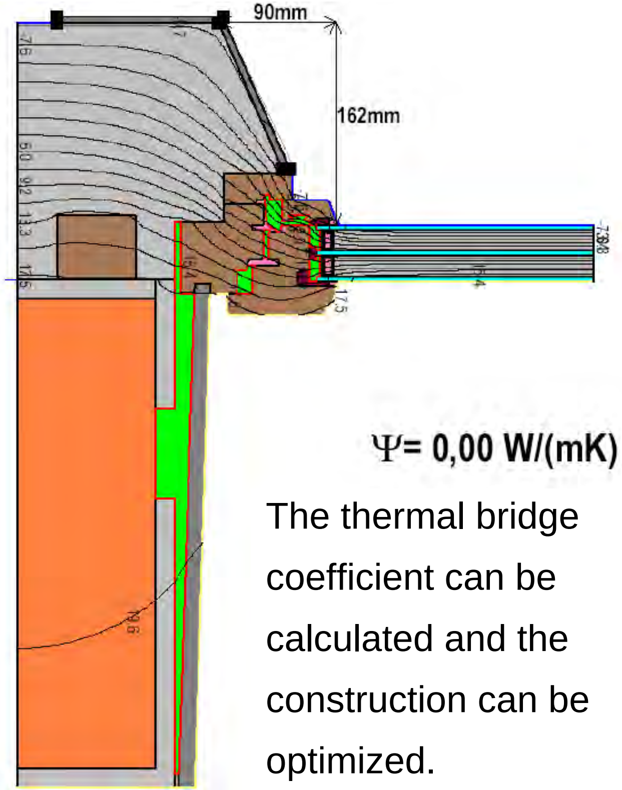
Source: http://apps1.eere.energy.gov/buildings/tools_directory/screenshots.cfm/ID=136/pagename_submenu=/pagename_menu=/pagename=alpha_list

The THERM heat transfer software

Description / Examples

Renovation: most important for passive house windows





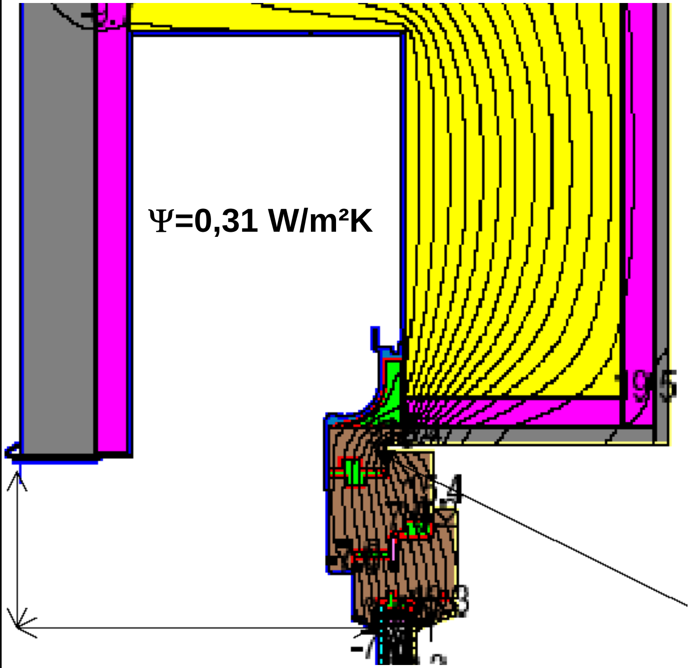
Ψ= 0,00 W/(mK)

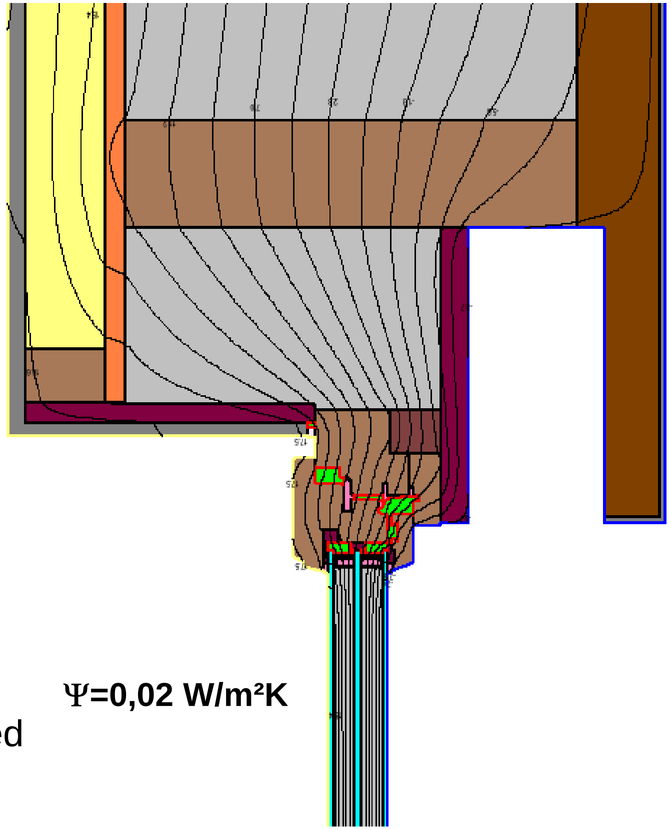
The thermal bridge coefficient can be calculated and the construction can be optimized.

Source:

The THERM heat transfer software
Description / Examples

Shadowing systems



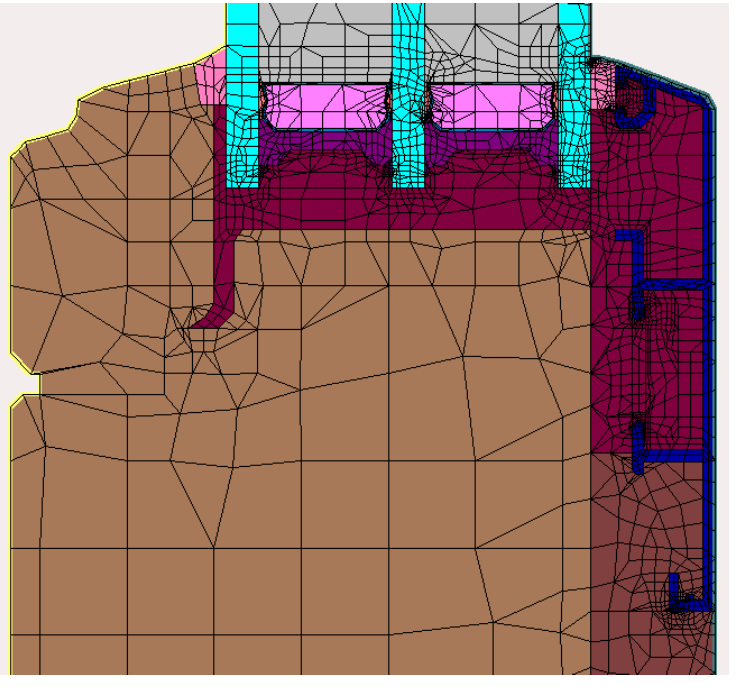


The thermal bridge coefficient can be calculated
and the construction can be optimized.

The THERM heat transfer software

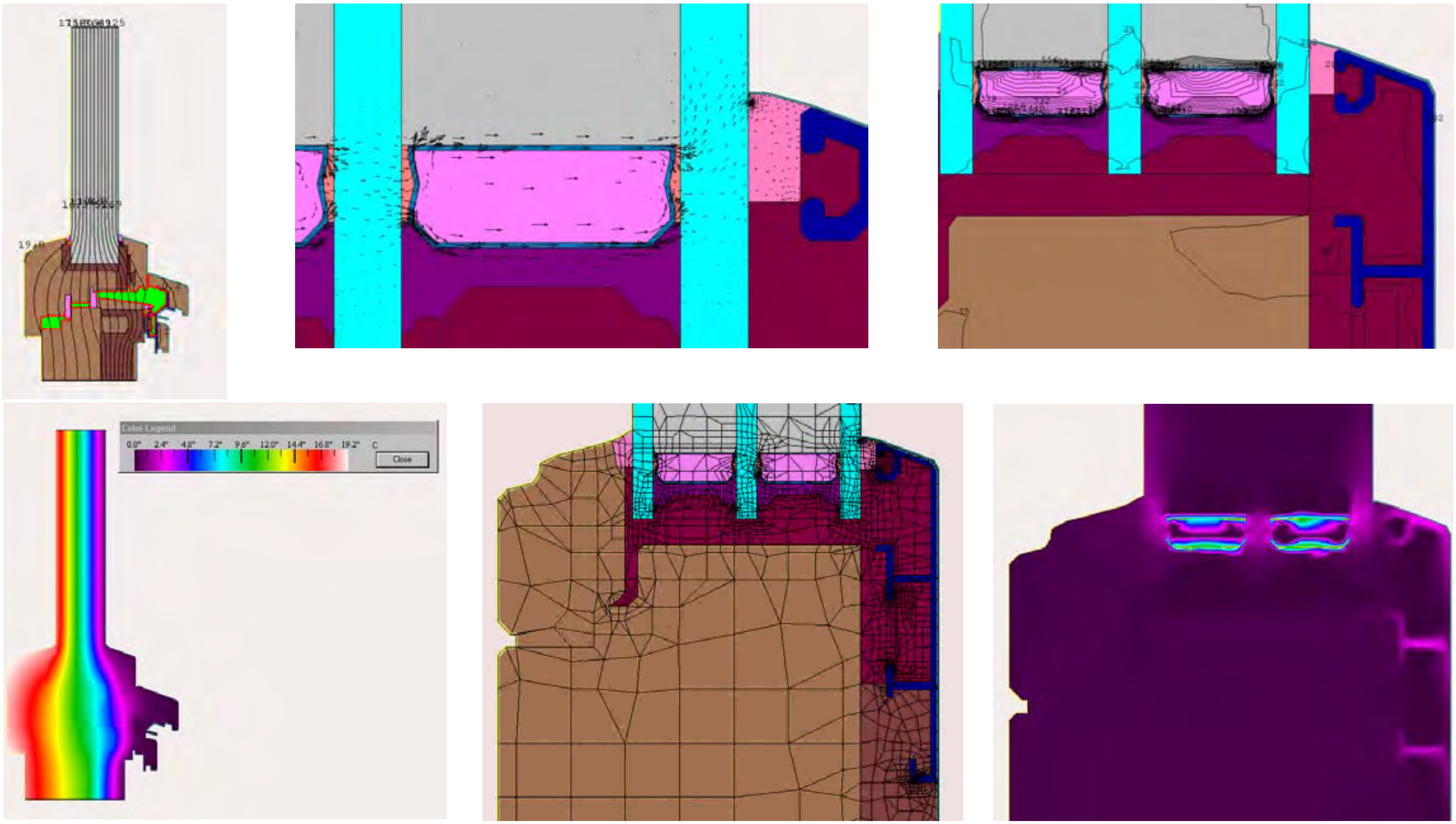
Description - Finite Element Method

- We make a calculation model for a structural element consisting out of small elements and we know their thermal quality exactly or nearly exactly.
- 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 grid.



The THERM heat transfer software

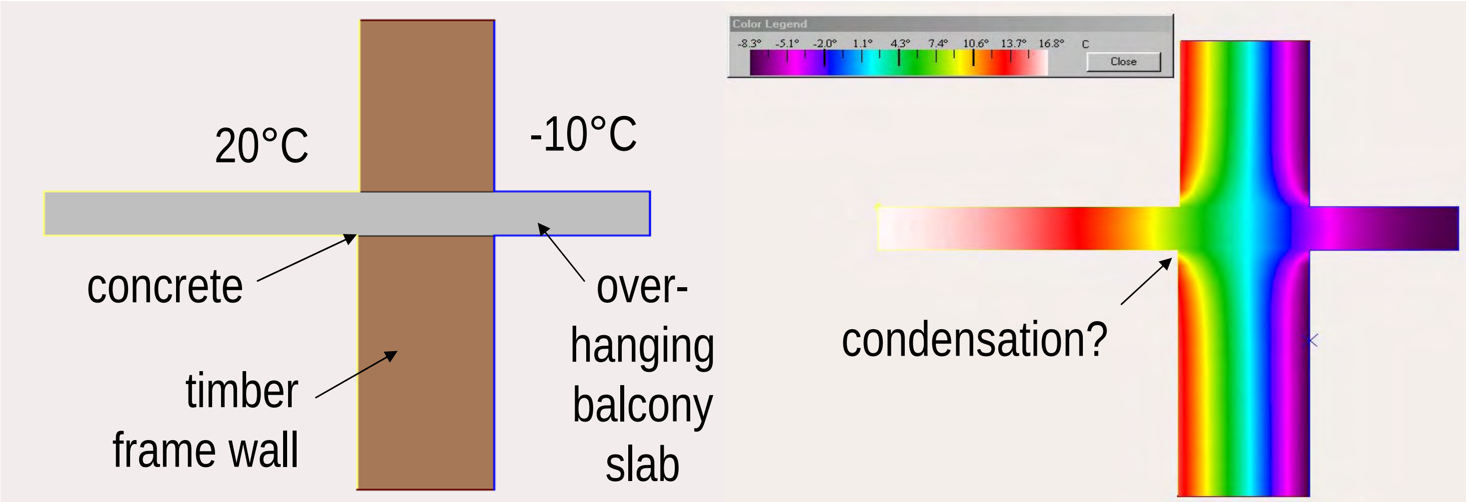
Description - Finite Element Method



The THERM heat transfer software

Description - Finite Element Method

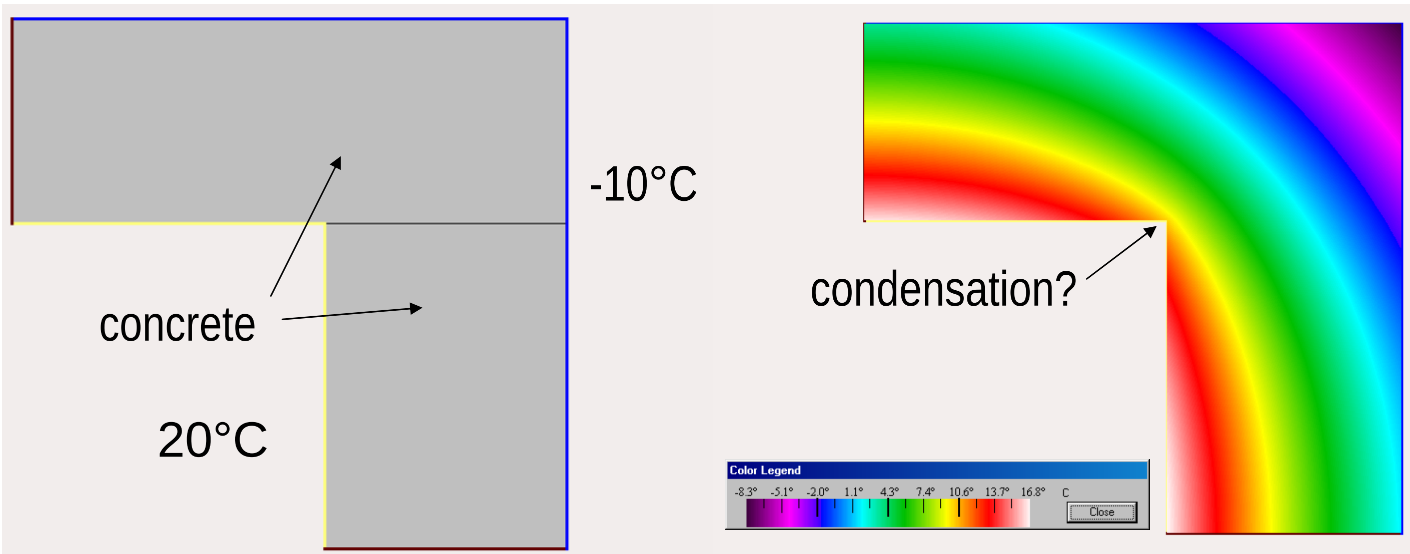
Example: thermal bridge - constructive



The THERM heat transfer software

Description - Finite Element Method

Example: thermal bridge - geometric



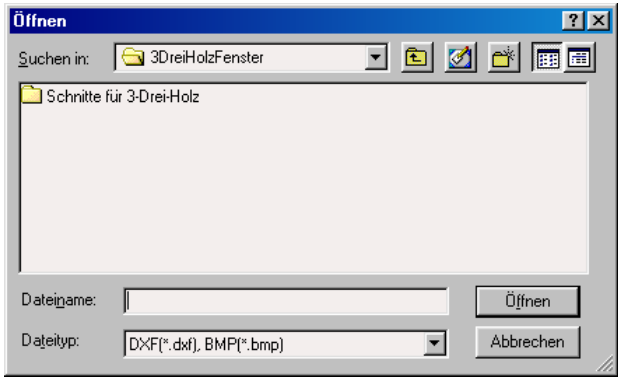
Source:

Working with THERM

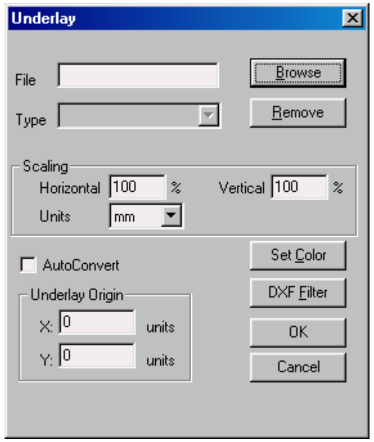
Generation of thermal bridge coefficients with “Therm”

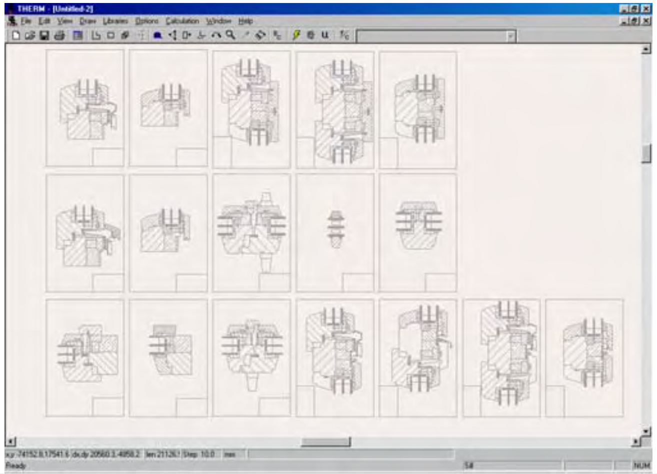
Working with THERM

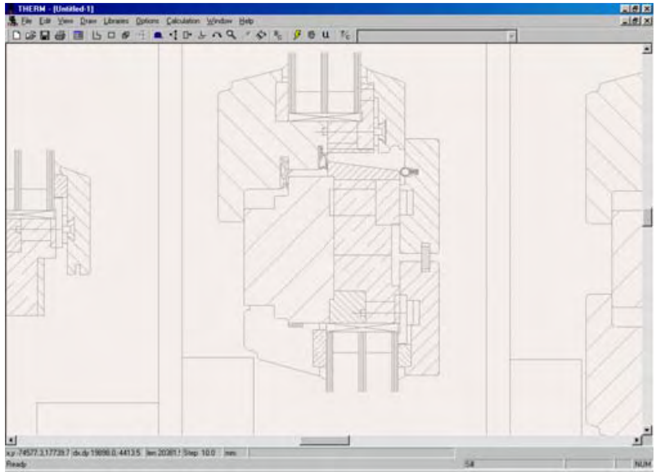
Inputs to THERM



Take a DXF file as underlay



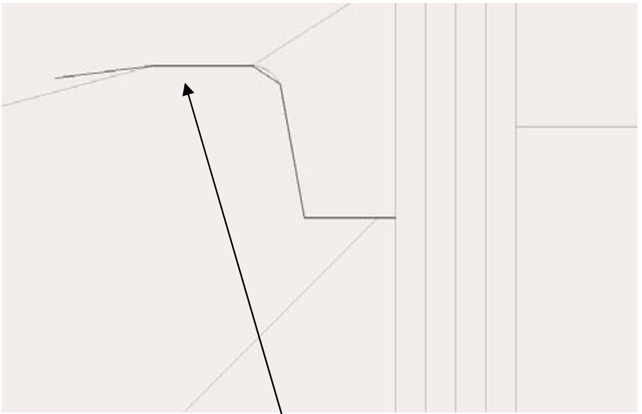


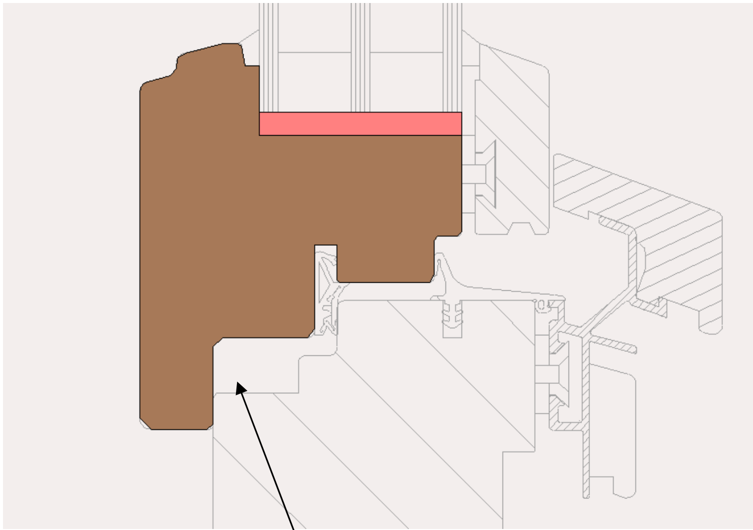


Working with THERM

Inputs to THERM

Start with drawing a contour





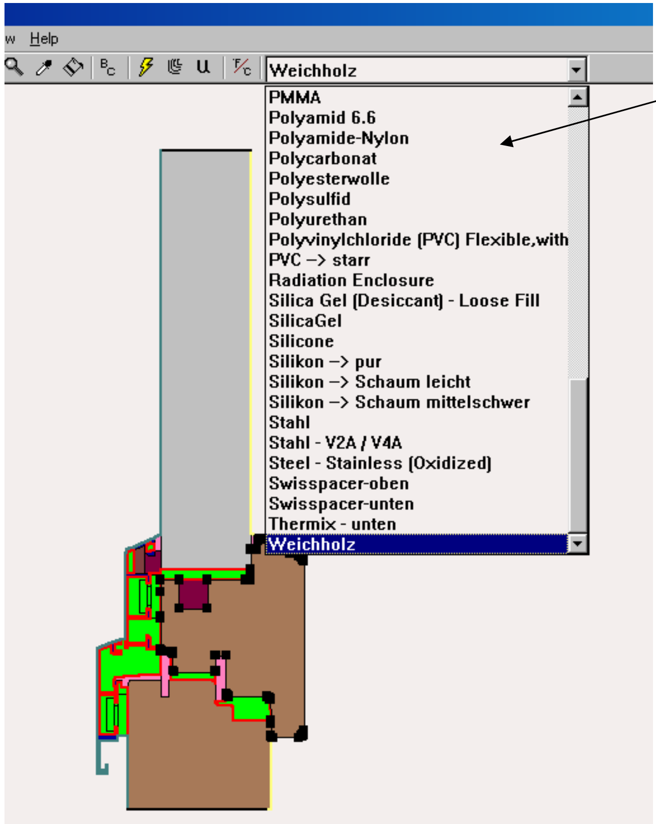
Redraw the contour

After the contour is finished,

define the thermal quality of the element

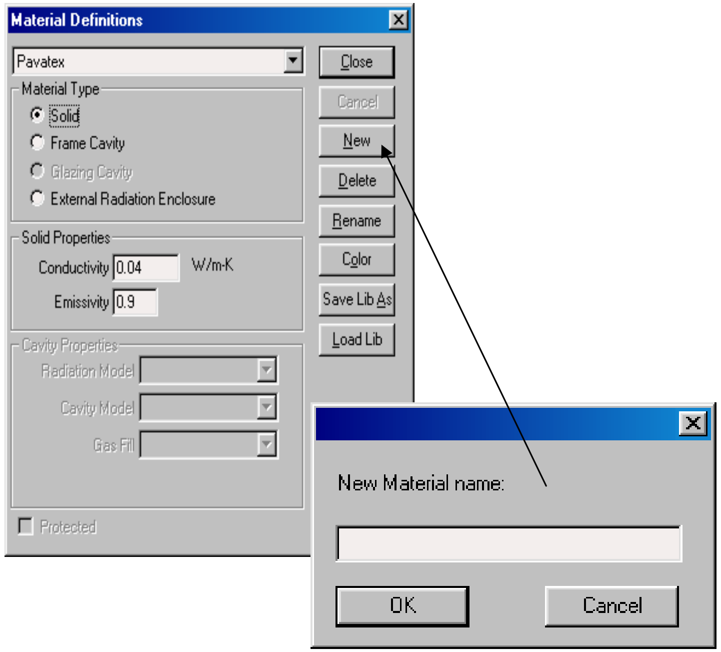
Working with THERM

Inputs to THERM



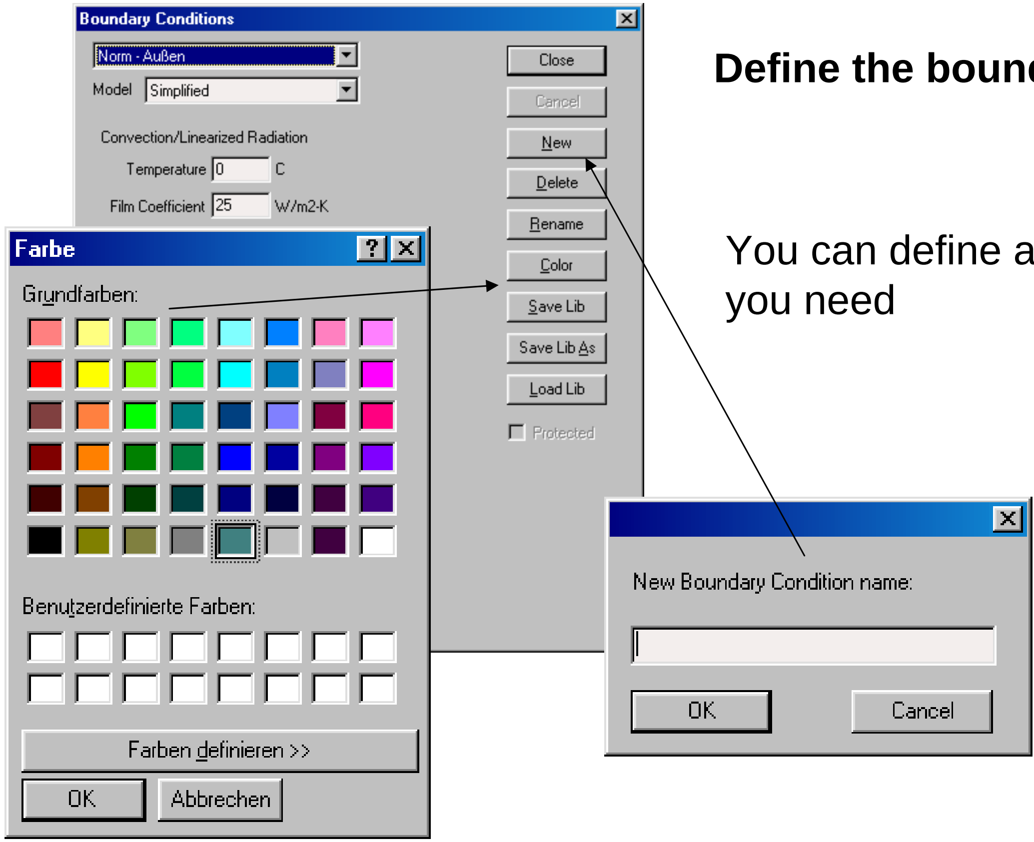
Finite element method

The thermal quality is defined in the material library



Working with THERM

Inputs to THERM



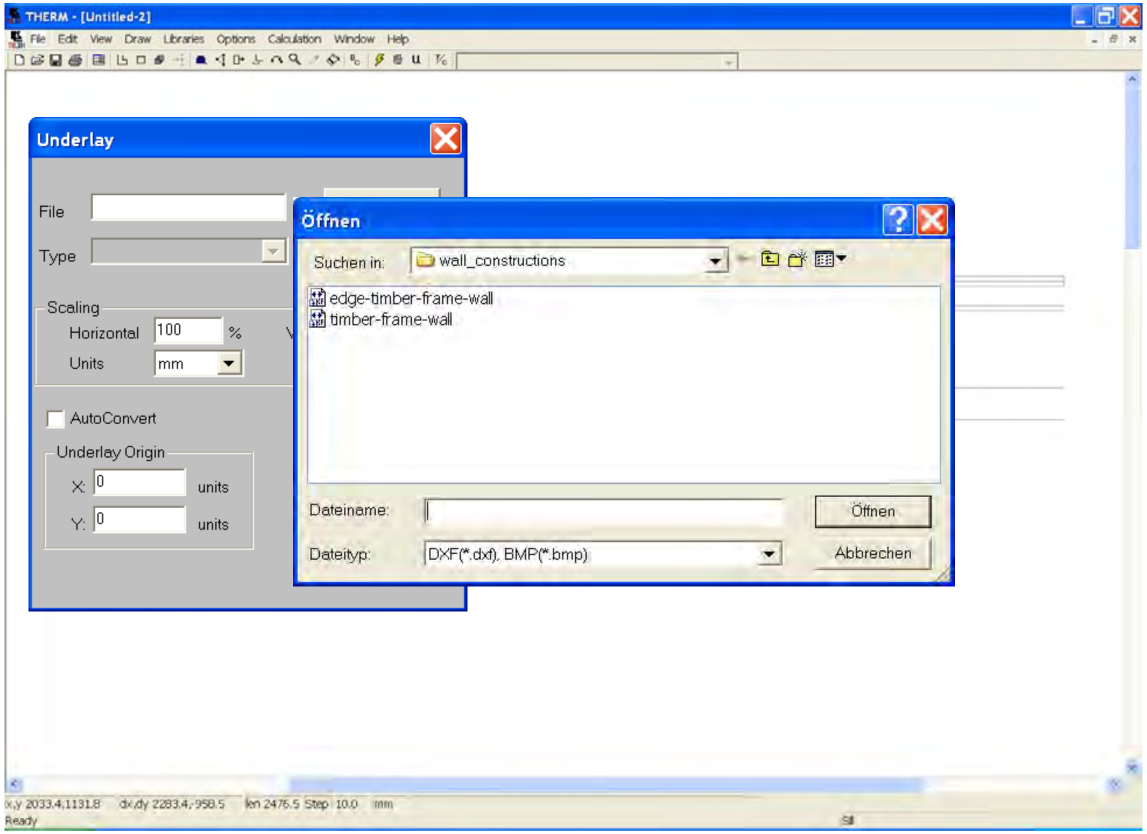
Define the boundary conditions

You can define all climate data you need

Working with THERM

Inputs to THERM

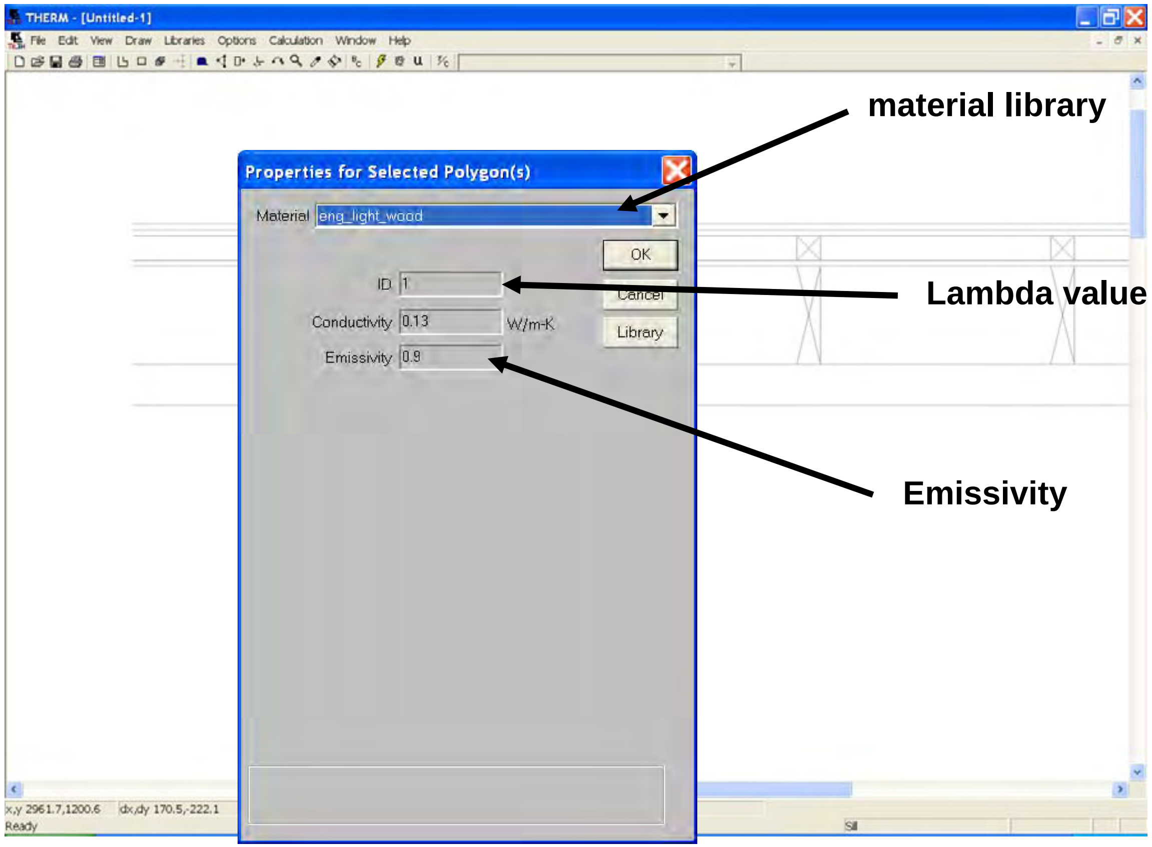
Now its your turn. Let´s call it "a timber frame wall"



Working with THERM

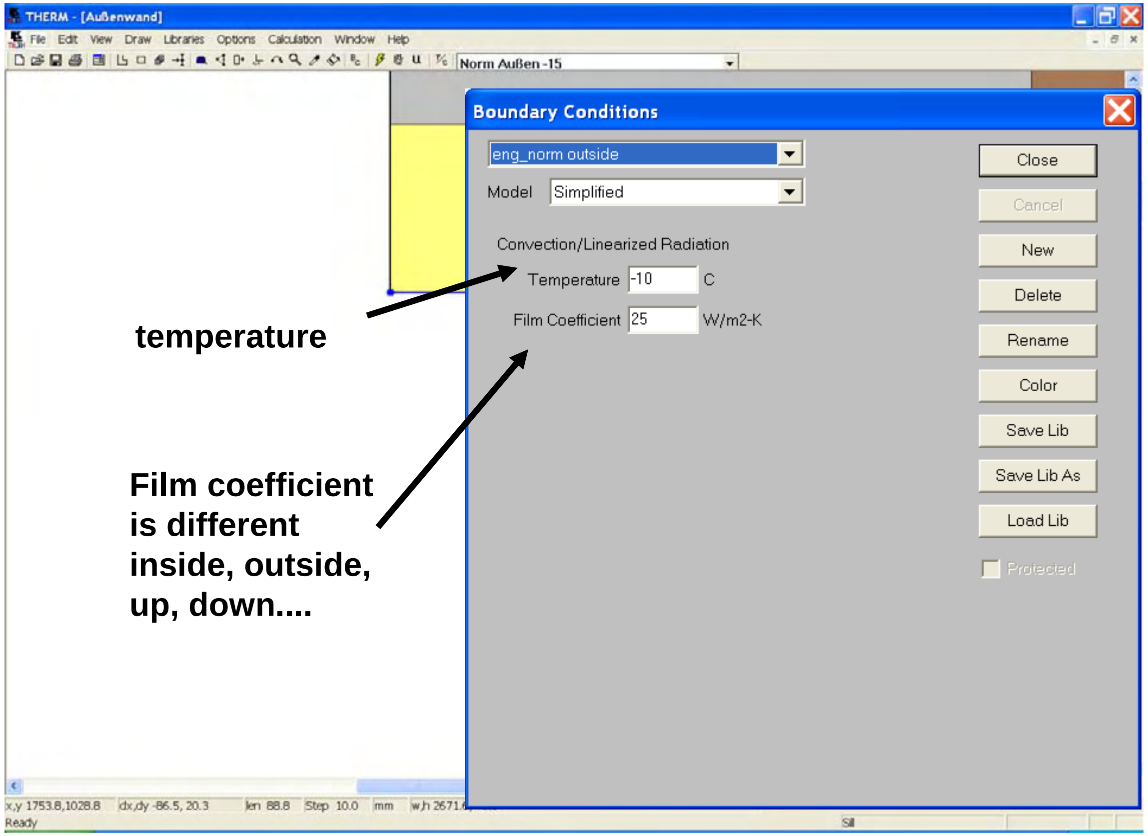
Inputs to THERM

…cover the construction with material



Working with THERM
Inputs to THERM

…define the boundary conditions

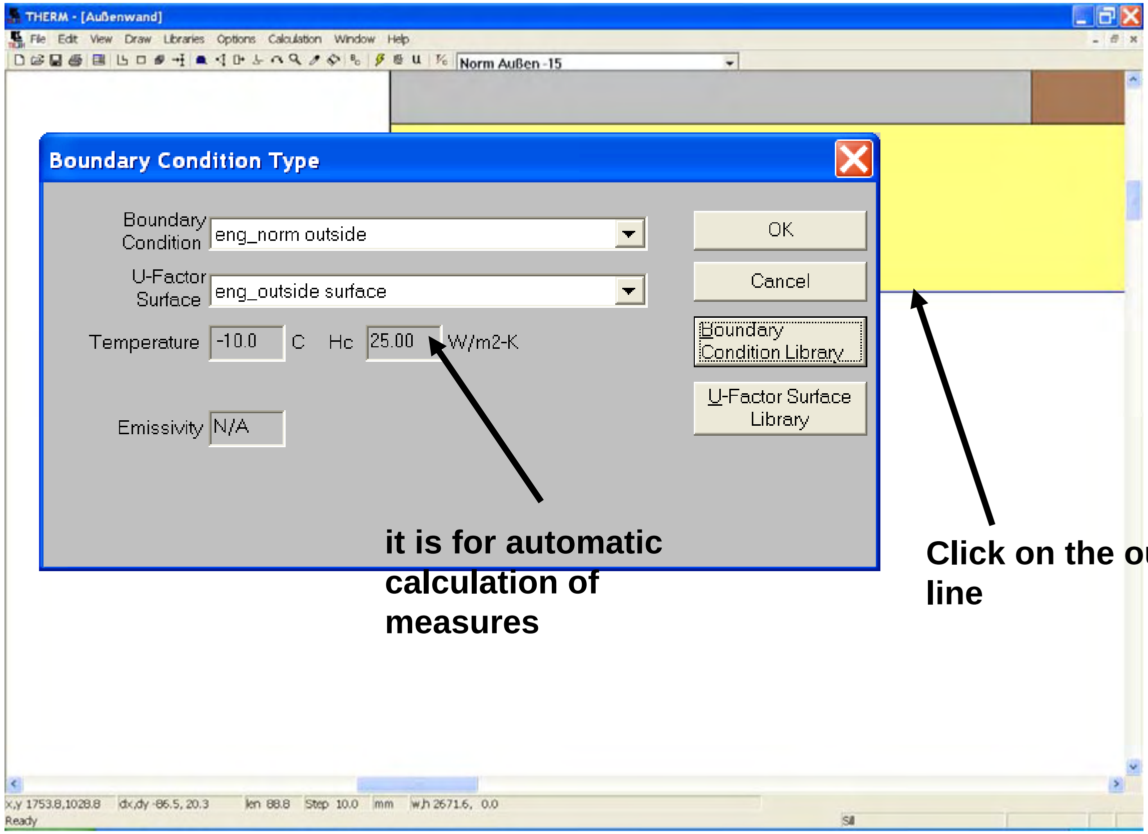


Source:

Working with THERM

Inputs to THERM

…now define the U-factor surface



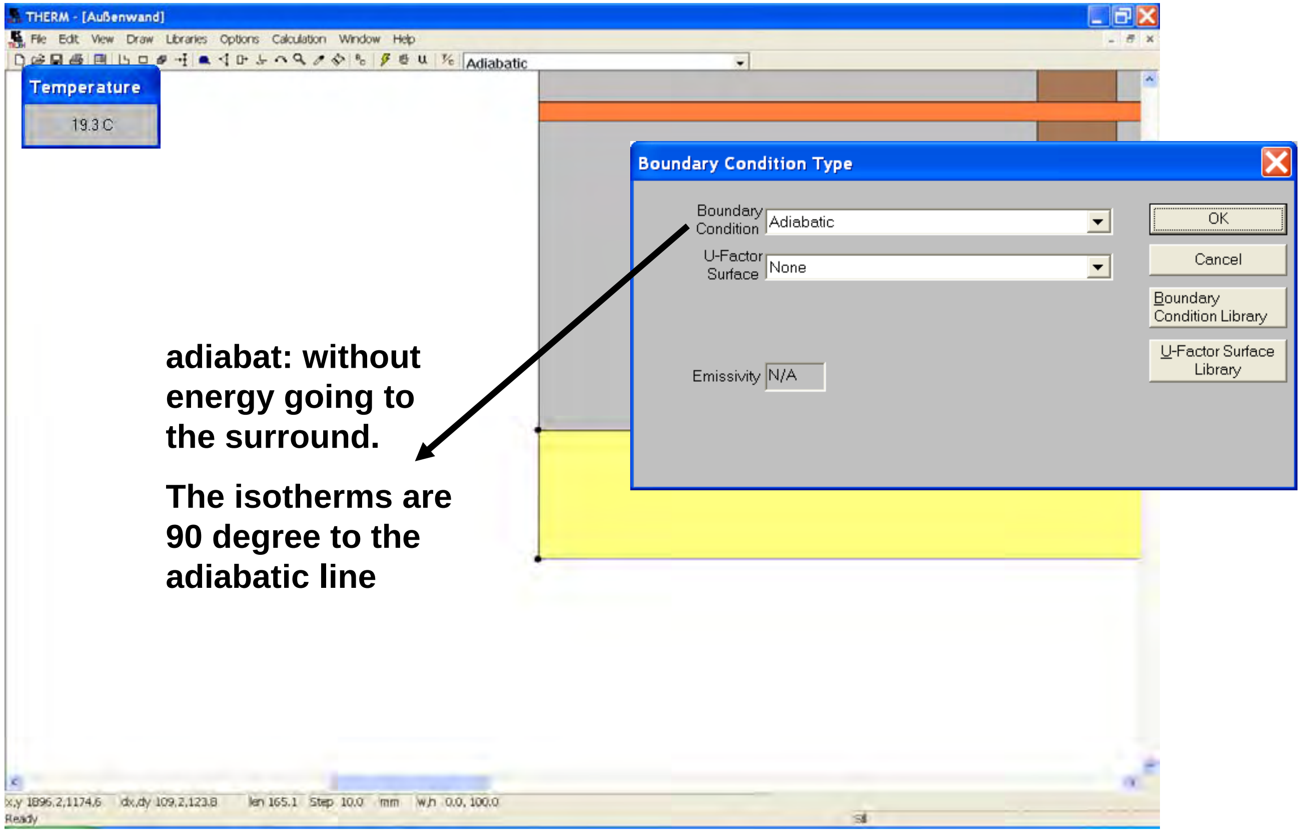
it is for automatic calculation of measures

Click on the outside line

Working with THERM

Inputs to THERM

…define the boundary conditions

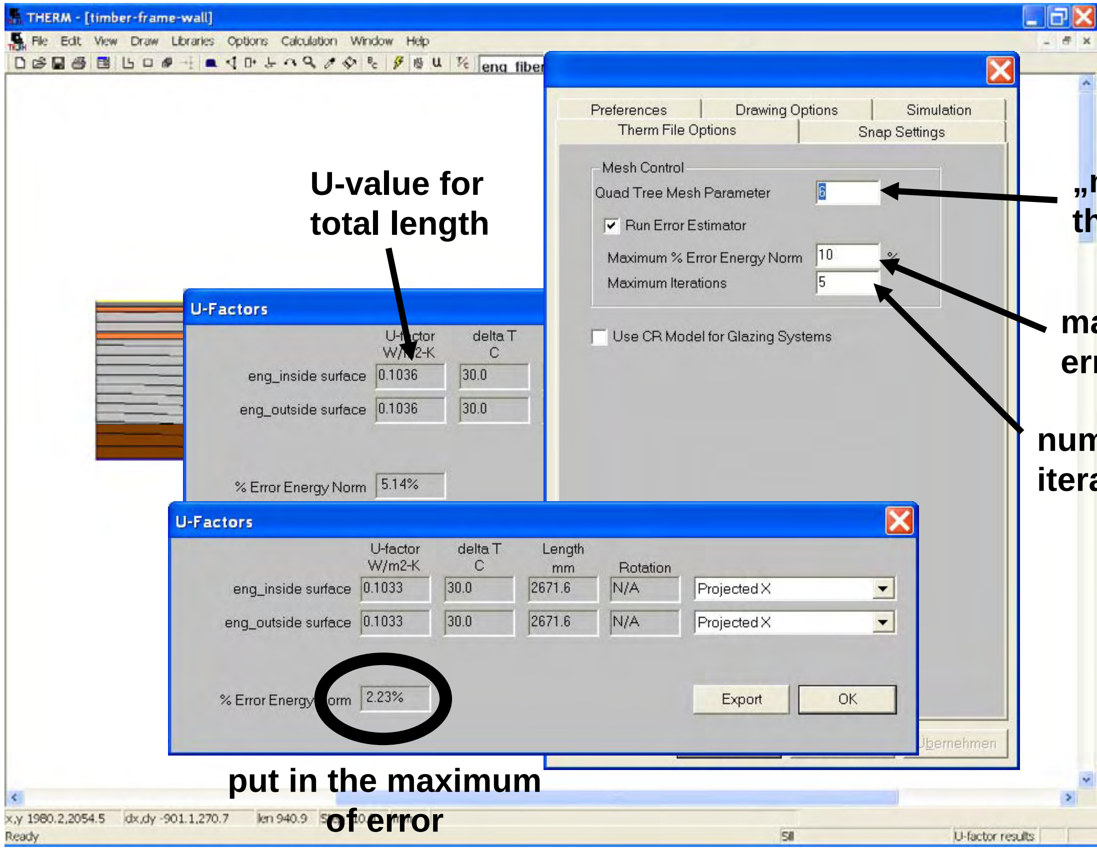


adiabat: without energy going to the surround.

The isotherms are 90 degree to the adiabatic line

Working with THERM

Inputs to THERM …read the U- value



U-value for total length

„measure of the grill“

maximum error

number of iteration

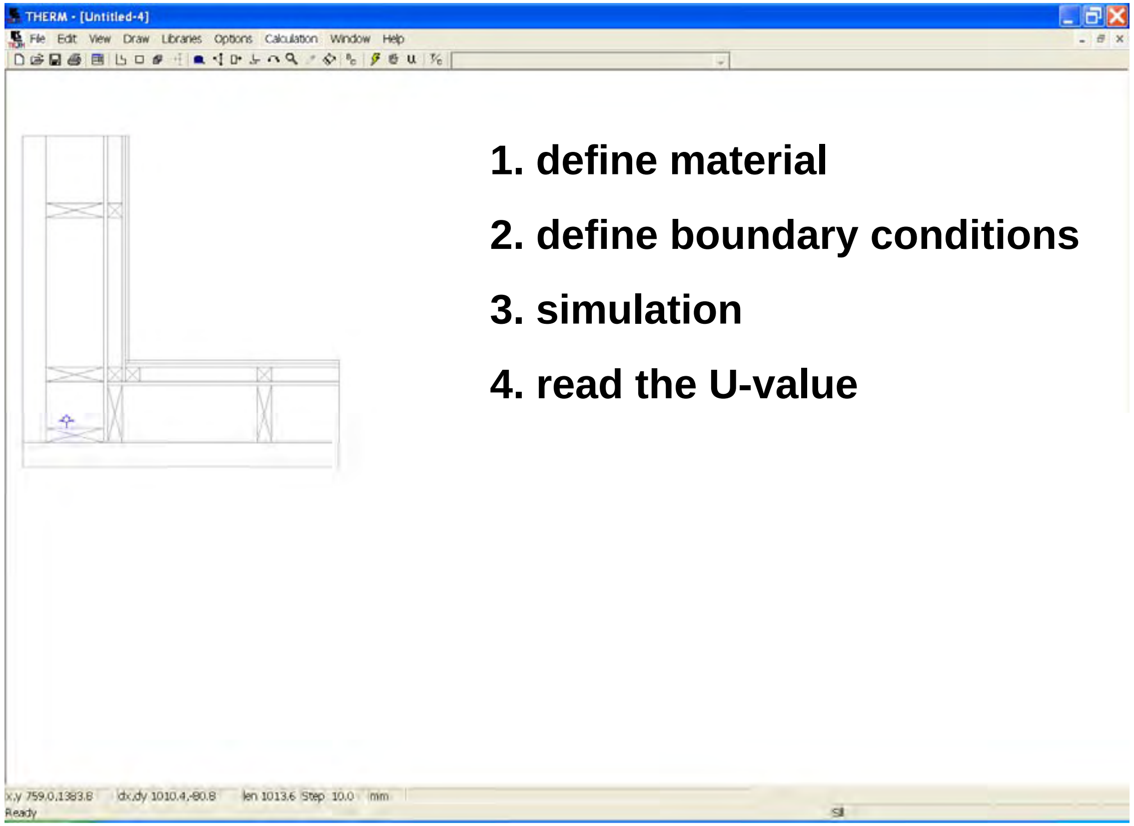
put in the maximum of error

Source:

Working with THERM

Inputs to THERM

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



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

Source:

Working with THERM

Inputs to THERM

…input the exel file 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

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

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

precise

l: length of the termal 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)

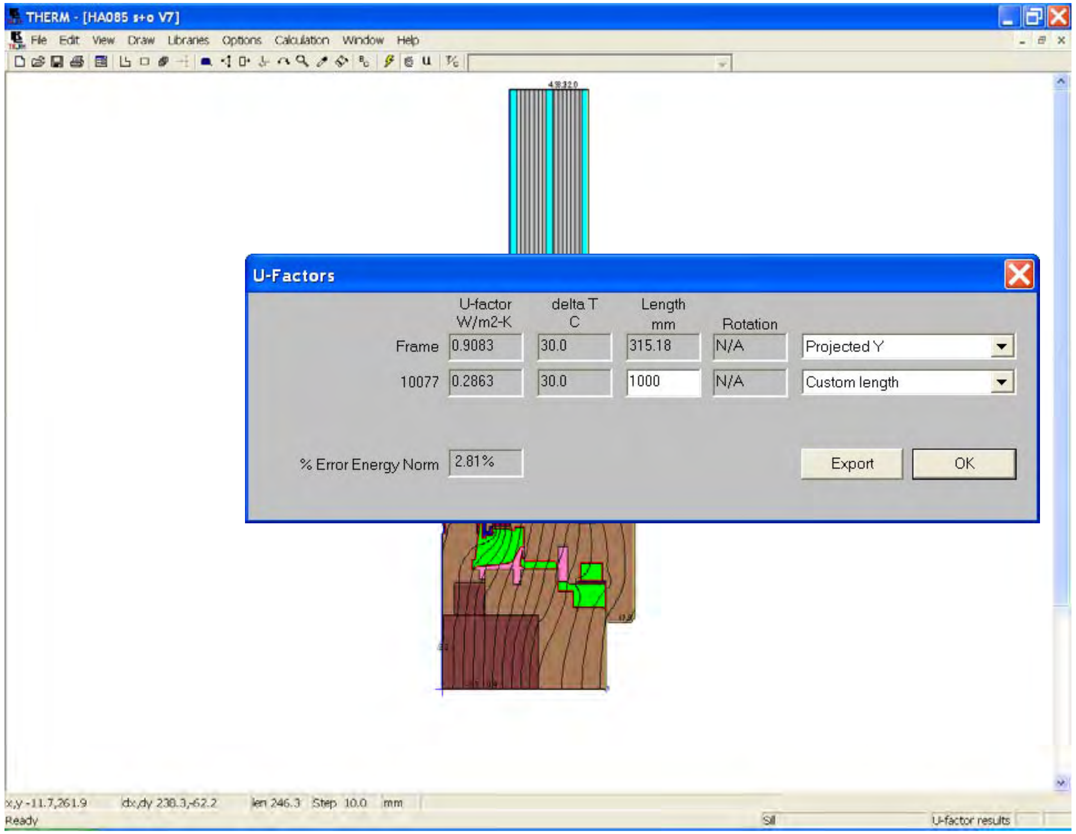
Ψ: psi value (linear thermal bridge)

Source:

Working with THERM

Inputs to THERM

A window example



Source: