DOF-THERM version 2.1

DOFTHERM 2.1: C:\DOFTECH\doftherm\Wall_ex1.lam

File   Structure   Calculation periods   Settings   Databases   Help

Structure | Calculation periods | Results | Additional information

Add layer... | Change layer... | Remove layer | Surface resistances...

Information:	Value:
Thermal transmittance:	0.28 W/m2K
External surface resistance:	0.040 m2K/W
Internal surface resistance:	0.130 m2K/W
Angle (0-90) deg. :	90.000
Area:	1.00 m2
Thickness:	212.200 mm
Steam resistance:	126137.566 m2hPa/g
Steam transmittance:	0.000008 g/hm2Pa

No.:	Layer:	T [mm]:	TC [W/mK]:	SR [-]	Price [euro/m3]:	N
1	Cladding (wood)	25.00	0.1400	7.200000e+01	0.00	6
2	Ventilated air layer	25.00	0.1390	1.090909e+00	0.00	0
3	ISOVER RKL-EJ	25.00	0.0370	1.904762e+00	0.00	1
4	ISOVER KL-C	125.00	0.0410	1.904762e+00	0.00	1

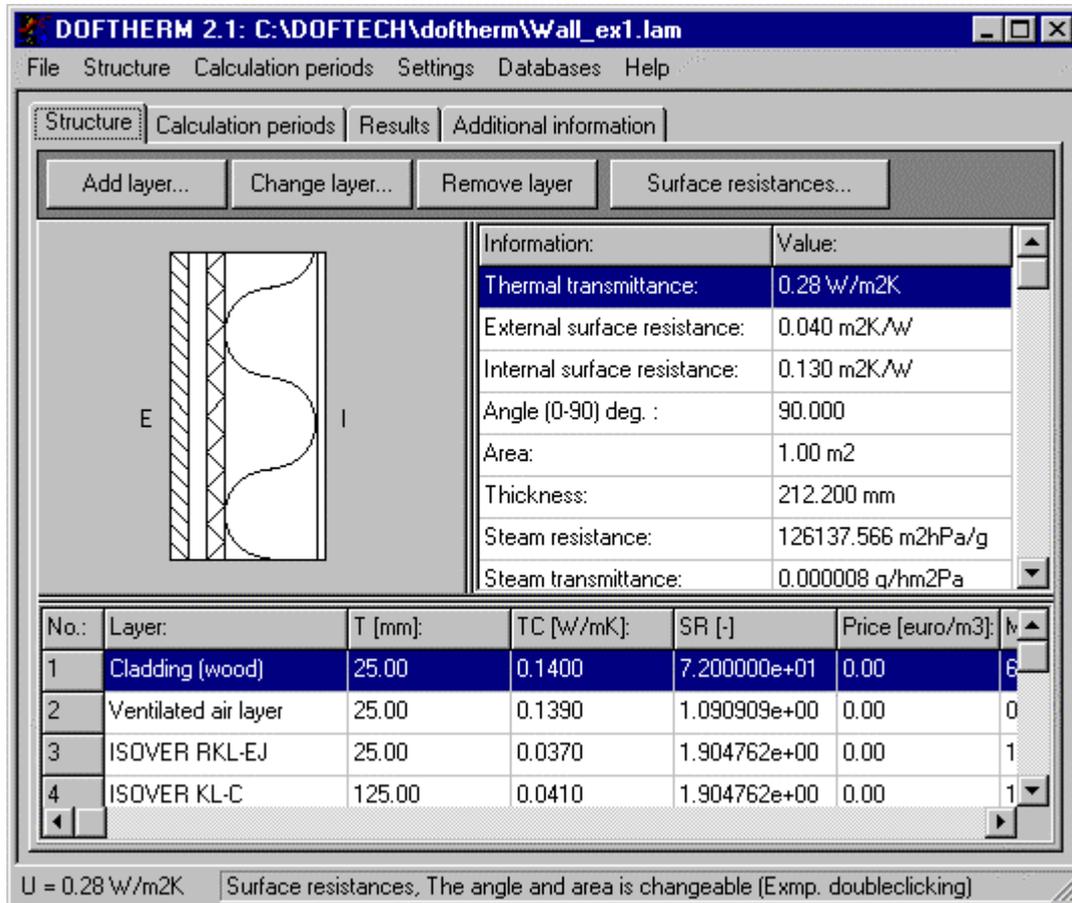U = 0.28 W/m2K | Surface resistances, The angle and area is changeable (Exmp. doubleclicking)

Layered structures (Walls, roofs):
U-value
Humidity distribution
Temperature distribution
Energy consumption

D.O.F. tech Oy

1 About DOF-THERM

DOF-THERM software (DEMO/ evaluation version) is free for testing purposes. If you are running the evaluation version, title bar of the software contain word "DEMO". DEMO version does NOT have all options available.

Registration of the software:
When you start the software, you see the "code number", deliver this code to D.O.F. tech Oy by email or post. After that, you will receive the "password" and invoice.
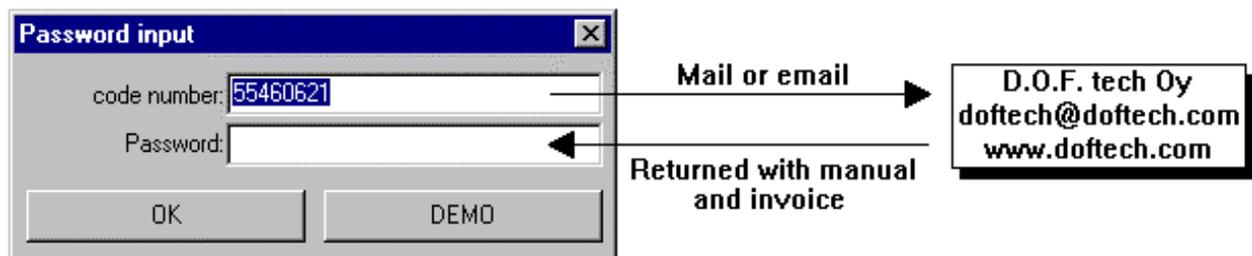
Every computer has unique code number and password. If you reinstall the software you have to remove old installation before asking new password (singe computer licence means that user can run registered software in one workstation/computer).

You can NOT use DEMO version professionally. You can NOT sell, rent or change the software.

2 Files used by the software

doftherm.exe	= DOF-THERM executable (For Win 95/98/NT)
doftherm.hlp	= Help file for the software
*.hlp	= Help files for material databases
*.mab	= Material databases
*.csv	= Databases for calculation periods and temperatures & humidities
*.lam	= Input files for the software
*.dat	= Databases used by the software

3 Usage of the software

The DOF-THERM software can be used for following purposes:
- You want to calculate thermal transmittance (U-value), for example for walls or roofs
- You want to calculate humidity conditions and evaluate condensation
- You want to calculate energy consumption through the structure
- You want to find structure which satisfy your U-value demand

4 Main parts of the program

The main window and menu is explained in paragraphs 4.1-4.2. The main window has several pages, which are explained in paragraphs 4.3-4.6. Separate windows (which activate from the buttons or the menu) are explained in paragraphs 4.7-4.13.

4.1 Main window

The main window has 4 pages: *Structure* page, *Calculation periods* page, *Results* page and *Additional information* page. You can switch between pages and insert the initial data any order you like.

The U-value of the structure can be seen at the bottom of the main window (left side). Title bar contain active file name (saved or opened).

If title bar contains word "DEMO", you are running DEMO version and some options are not available.

4.2 Main menu

File menu

New selection clears all data and starts from beginning.

Open... selection opens input file (*.lam file)

Save selection saves active data to active file.

Save as... selection saves active data to file by new filename.

Print submenu contain previewing, printing (to printer) and saving results to ASCII file (this is needed when user wants to combine text results and pictures for example in Office softwares). See Paragraph 4.13)

Close selection closes the software.

Structure menu
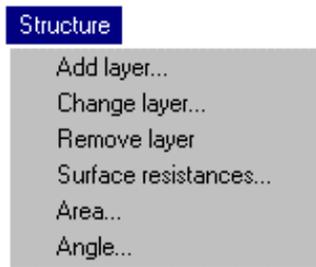
Add layer... selection lets you add new layers to the active structure. You can add layers by double-clicking last row too (* row).

Change layer... selection lets you change active layer. You can also change layers by double-clicking the layer you want to edit.

Remove layer... selection removes active layer from structure.

Surface resistances... selection lets you change surface resistances.

Area... selection lets you change area of structure (affecting energy consumption calculation and weight/price results).

Angle... selection lets you change direction of the picture. Angle can be between 0 and 90 degrees.

Calculation periods menu
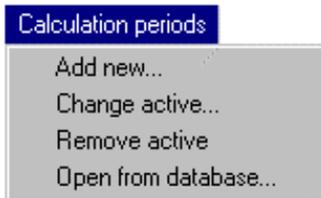
Add new... selection activates "Adding calculation period" window, see paragraph 4.10.

Change active... selection lets you change active calculation period in "Editing calculation period" window, see paragraph 4.10.

Remove active selection removes active calculation period.

Open from database... selection lets you read temperature and humidity values from ASCII database (*.csv file).

Settings menu

Calculation settings... selection activates "*Calculation settings*" window, see paragraph 4.12.

Databases menu

Material databases selection activates "*Edit database*" window, see paragraph 4.11.

Help menu

Help selection shows online help for the software.

4.3 Structure page

Structure page contains *picture area*, structures *Main information* table, *Layer information* table and 4 buttons. When user changes the structure, all main information update immediately.
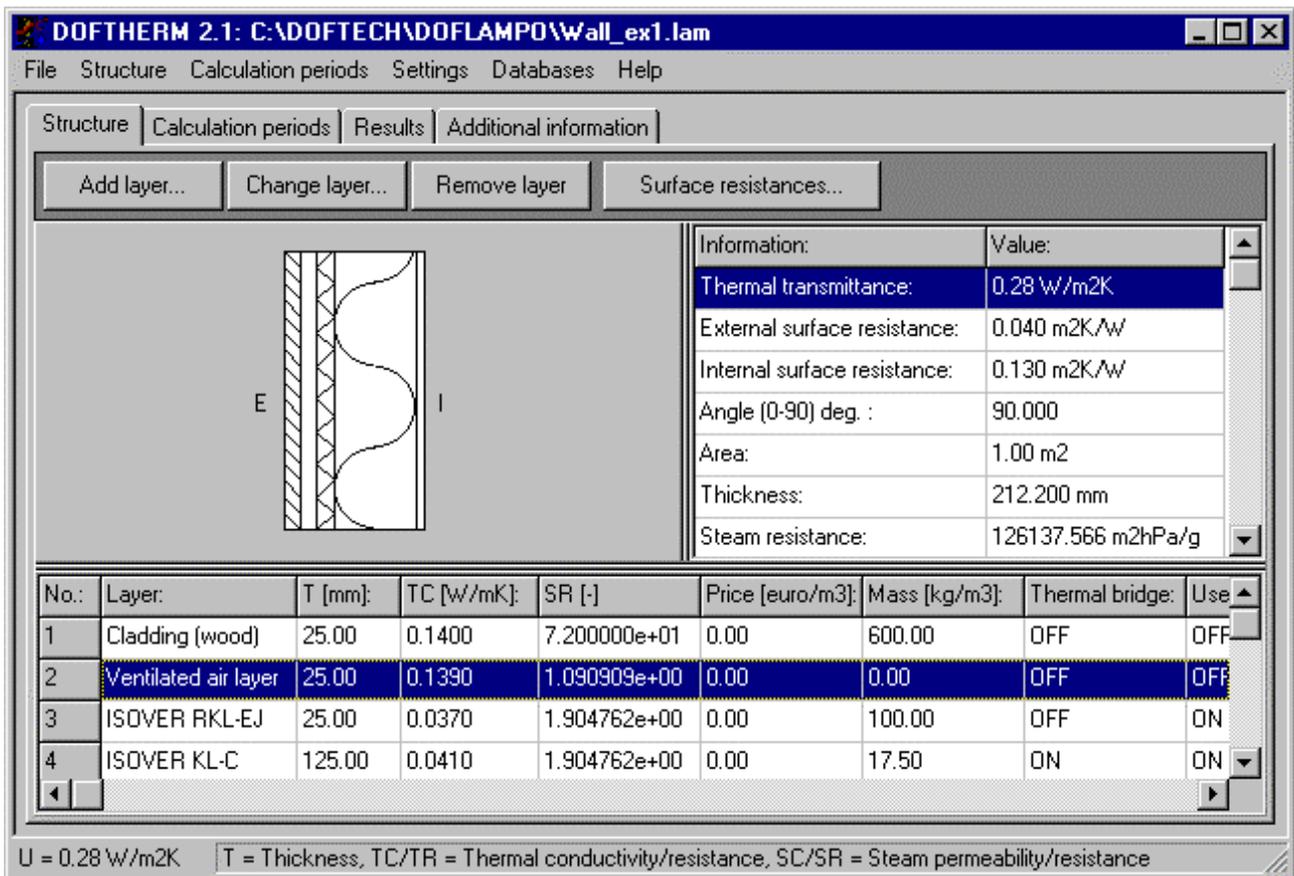
Picture area (left) contains picture of the structure. User can change the angle for the structure.

Main information table (right) contains information of the structure.

Layer information table (bottom) contains information of layers. User can change layers position by dragging it by mouse. User can copy layer similarly, only pressing Ctrl-key at the same time.

User can change units for some of the values by clicking right mouse and selecting desired unit (see next page).

Buttons of the *structure* page:

Add layer... button lets you add new layers to the active structure. You can add layers by double-clicking last row too (* row).

Change layer...   button lets you change active layer. You can also change layers by double-clicking the layer you want to edit.

Remove layer...   button removes active layer from structure.

Surface resistances...   button lets you change surface resistances.

Structure **page popup menu (Right mouse):**
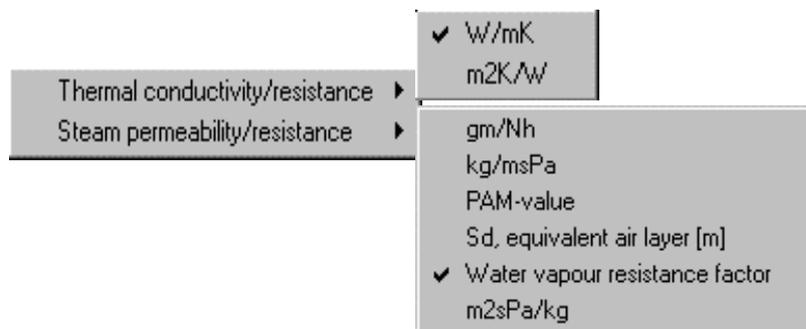
4.4 Calculation periods page

Calculation periods page contains *Calculation periods* table and 4 buttons.

User can add, change and remove periods. Every period has a duration, which affects energy calculation and calculation of condensation (if duration = 0, there is no affect on energy calculation).

User can change periods position by dragging it by mouse. User can copy layer similarly, only pressing Ctrl-key at the same time.

User can change units for some of the values by clicking right mouse and selecting desired unit.

Buttons of the *calculation periods* page:

Add… button lets you add new period. You can add periods by double-clicking last row too.

Change… button lets you change active period. You can also change period by double-clicking the period you want to edit.

Remove button removes active calculation period.

Get from database… button lets you read temperature and humidity values from ASCII database (*.csv file).

4.5 Results page

Results page contains two drop-down menu (*Picture content:* and *Calculation period:*), picture area, results table and 3 buttons (for different result units).
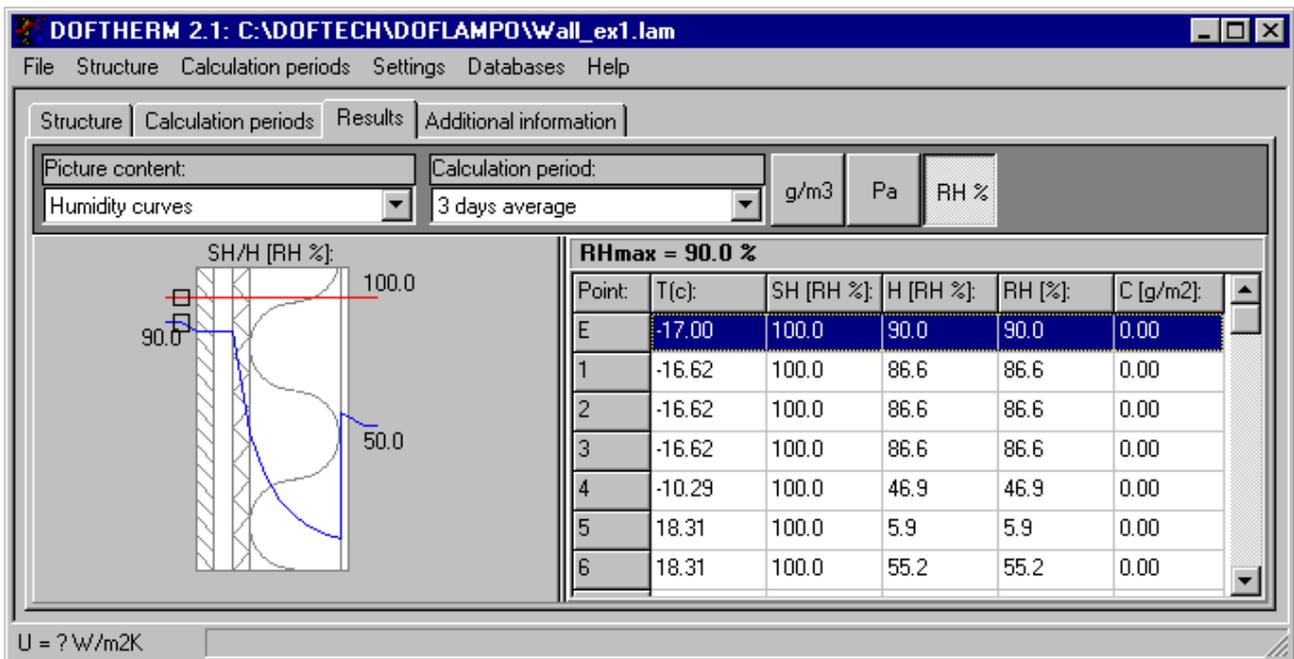

Picture content: menu lets you select following picture results:

- **Structure**   (Structure picture)
- **Thermal curve**   (Temperatures in all interfaces)
- **Humidity curves**   (Humidity and saturation humidity curves)
- **Thermal and humidity curves**
- **Structure and thermal curves**
- **Structure and humidity curves**
- **Energy consumption**   (diagram of energy consumption)

Calculation period: menu lets you select the period you want to examinate.

Right mouse click (on top of picture) gives you following popup menu:
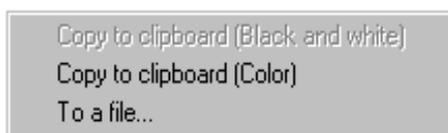
4.6 Additional information page

This page contains information you want to print and save with the structure information.

4.7 Add layers window

Add layers window contains information for the layer user want to add to the structure. Window has two pages, *Structure layer* and *Thermal bridge*. Thermal pridge page is visible only if *Layer has thermal bridge* check box is selected.

Buttons:

Add layer button accepts the information and adds new layer to the structure.

Back button closes *Add layers* window without adding new layer.

Material library button lets you change active database.

Library material menu contains all materials defined in active material library.

Info button gives additional information (if available) of selected material.

Structure layer **page input values and menus:**

Name defines layer name, user can change it even if using library material (max. 60 characters).

Thickness defines layer thickness in mm. User can change it even if using library material.

Thermal conductivity/resistance defines layer thermal property. unit can be changed like in *Structure* page (see below).

Vapour permeability defines layer diffusion property, unit can be changed like in *Structure* page (see below).
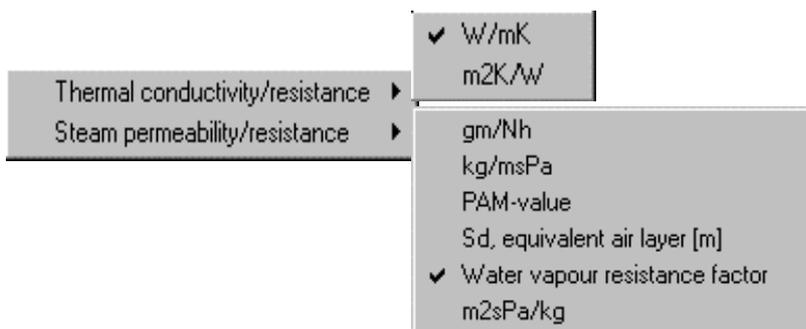
Graphic style defines the way how layer is drawn. User can see sample of style below of the menu.

Price defines the price for the layer. Unit is *euro/m^3*.

Weight defines the weight for the layer. Unit is *kg/m^3*.

Layer has thermal bridge check box determinates if layer contains thermal bridge. When selected, *Thermal bridge* page is visible.

Used in calculation check box determinates if the layer should be noticed when calculating U-value or temperature and humidity curves (layers are always active when calculating weight and price).

Structure layer **page popup menu (Right mouse):**

Thermal bridge **page input values and menus:**

Relative share check box determinates if thermal bridge is defined with relative area.

Extra conductance check box determinates if thermal bridge is defined with extra conductance and its amount per square metre.

Name defines name of the thermal bridge (max. 60 characters).

If *Relative share* check box is selected:

Persentual share defines relative area of the thermal bridge. E.g. timber column 45 mm c/c 600 would be 7.5 %.

Thermal conductivity defines thermal conductivity of the bridge. Unit is *W/mK*.

Price defines the price for the layer. Unit is *euro/m^3*.

Weight defines the weight for the layer. Unit is *kg/m^3*.

If *Extra conductance* check box is selected:

Extra conductance defines thermal conductance. Unit is *W/K*.
Notice: Extra conductance is calculated only for the layer, not for the whole structure !

Number of extra conductance defines amount of conductance's per square metre.

4.8 Changing layer data window

Changing layer data window contains information of the layer user want edit. This window is similar to *Add layers* window except that *Add layer* button is *Change layer* button.

Notice: Values and properties does not change if user don't select the *Change layer* button.

4.9 Surface resistance and angle window

This window contains external and internal surface resistances, correction term ΔU, structure angle, area and parameter which define the side of interior space.

EN ISO 6946 gives some surface resistance default values (below):

Surface resistance	Direction of heat flow		
	Upwards	Horizontal	Downwards
Rsi (internal)	0,10	0,13	0,17
Rse (external)	0,04	0,04	0,04

The values under "horizontal" apply to heat flow directions ±30 ° from the horizontal plane.

Correction term ΔU is added to thermal transmittance U. Correction term shall be used for mechanical fasteners, air gaps in insulation or precipitation on inverted roofs (see EN ISO 6946). Explanation text tells the reason of the correction term (for printout purposes).

4.10 Adding/editing calculation period window

This window contains temperatures, humidities and duration of the active calculation period. these values have no affect on thermal resistance (U-value) calculation.
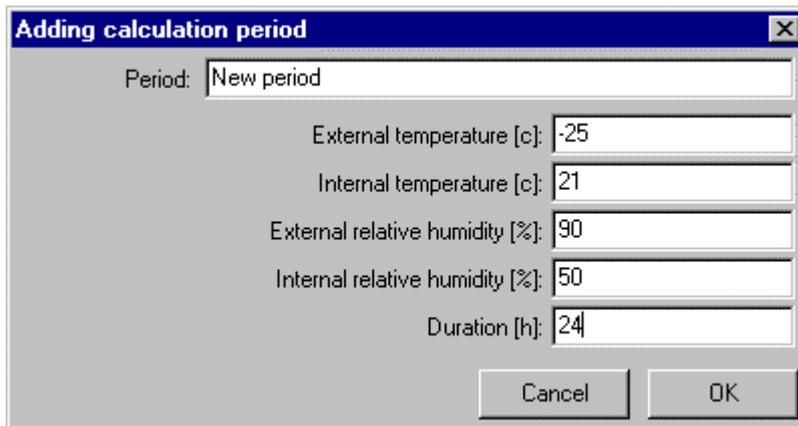

Temperatures must be between -50 and +100 degrees. Relative humidities must be between 0 and 100 %. If humidity unit is *g/m3* or *Pa*, software calculate the relative humidity internally.

Every period has a duration, which affects energy calculation and calculation of condensation (if duration = 0, period has no affect on energy calculation and condensation result will be zero).

Duration unit can be hour, second or day (selected in *Calculation periods* page).

4.11 Edit database window

With this window, user can add, change and remove library materials. There is several material libraries which all are editable. Input values are same as in *Add layers* window (see paragraph 4.7), except that there is no thermal bridge option/page.
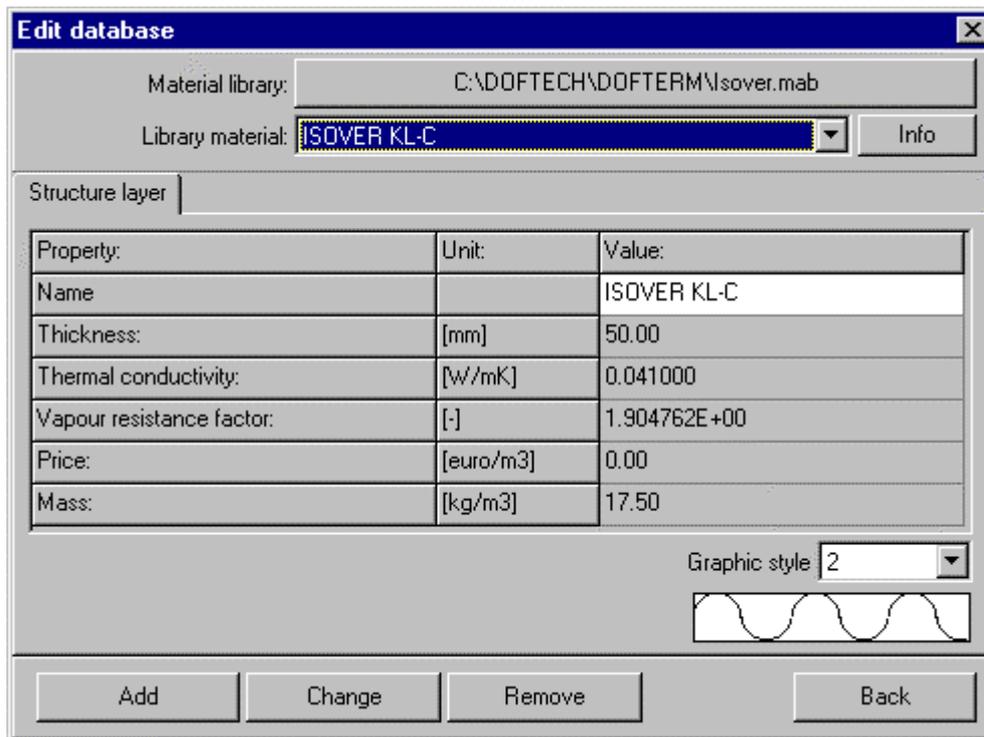
Buttons:

Material library button lets you change active database.

Library material menu contains all materials defined in active material library.

*Add* button inserts new material to the database (database is updated immediately).

Change button changes active material properties (database is updated immediately).

Remove button removes active material (database is updated immediately).

Back button closes *the* window.

4.12 Calculation settings window

In this window, you can select the way U value is calculated. These options affects only if structure contains thermal bridges with relative share.
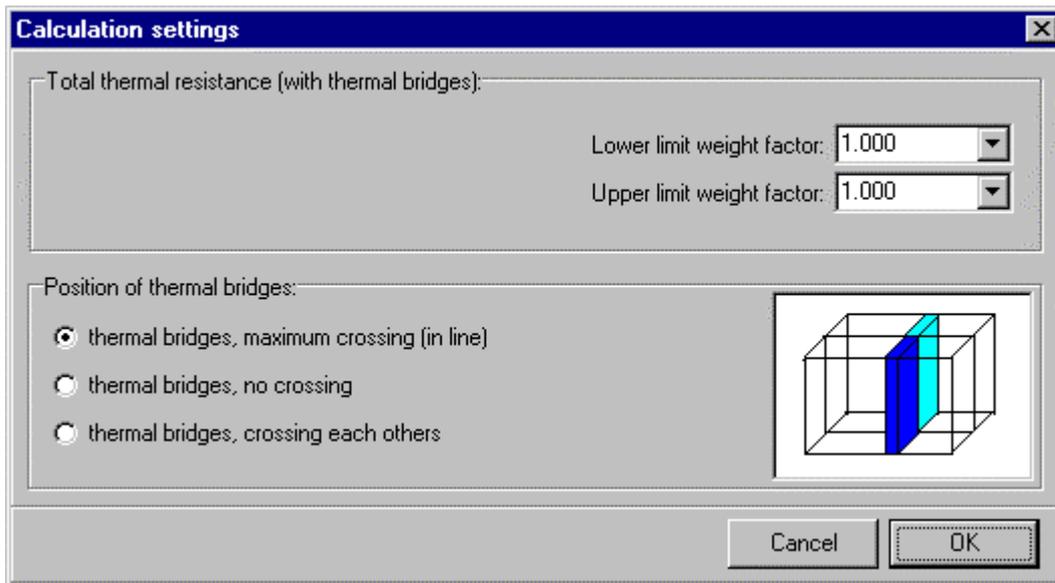
Lower limit weight factor (W_{lower}) and upper limit weight factor W_{upper} defines how to combine these two estimations (formula is below).

Total thermal resistance $R_T = (W_{lower}*R_T'' + W_{upper}*R_T')/ (W_{lower} + W_{lower})$

where
R_T'' = Lower limit of the total thermal resistance (see paragraph 5 and EN ISO 6946)
R_T' = Upper limit of the total thermal resistance (see paragraph 5 and EN ISO 6946)

EN ISO 6946 contains factors 1.0 and 1.0 (mean average) and these values are default.

Position of thermal bridges defines how bridges are positioned to each others.

4.13 Printing and previewing

Print submenu contain previewing, printing (to printer) and saving results to ASCII file (this is needed when user wants to combine text results and pictures for example in Office software).
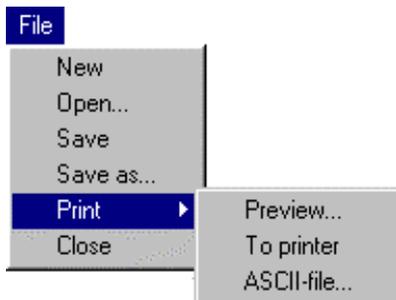
Preview and *To printer* options generate same kind of printout (you can print from preview window too).

ASCII file option generates results in ASCII file (*.txt) which will be opened for edition. User can open and edit this text file almost every word processing software.

What would you like to print ? window contains possible preview/print options:
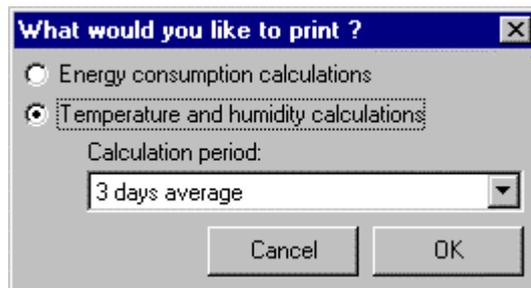
There is two main options, *Energy consumption calculations* and *Temperature and humidity calculations.* You must select calculation period (which results you want) too if you are using *Temperature and humidity calculations* option.

5 Calculation theory

Calculations are based on standards EN ISO 6946, prEN ISO 13788. Some of the factors are alterable which enables calculation with other standard environments.

5.1 Thermal transmittance U

Thermal transmittance is given by:

$U = 1 / R_T$ (W/m^2K)

where

Total thermal resistance is given by:

$R_T = (W_{lower}*R_T'' + W_{upper}*R_T')/ (W_{lower} + W_{lower})$ (see paragraph 4.12)

where

R_T'' = Lower limit of the total thermal resistance
R_T' = Upper limit of the total thermal resistance

Lower limit of the total thermal resistance is given by the following expression:

$R_T'' = R_{si} + R_1 + R_2 + \dots + R_n + R_{se}$

where

R_j is d_j / λ_j'' , and λ_j'' is $f_a*\lambda_{aj} + f_b*\lambda_{bj} + \dots + f_q*\lambda_{qj}$

Upper limit of the total thermal resistance is given by the following expression:

$R_T' = 1 / (f_a/R_{Ta} + f_b/R_{Tb} + \dots + f_q/R_{Tq})$

where

$R_{Ta}, R_{Tb}, \dots, R_{Tq}$ are the total thermal resistances from environment to environment for each section
$f_a, f_b, \dots, f_q$ are the fractional areas of each section

5.2 Temperature distribution

Program calculates temperature values without thermal bridge effect. If user wants temperatures from point where is a thermal bridge, structural layer must be changed. Temperatures in different interfaces is calculated by:

$\theta_{se} = \theta_e + R_{se}/R_T*(\theta_i - \theta_e)$

$\theta_1 = \theta_{se} + R_1/R_T*(\theta_i - \theta_e)$

$\theta_2 = \theta_1 + R_2/R_T*(\theta_i - \theta_e)$

etc.

θ_e, θ_i = external and internal air temperature
θ_{se} = external surface temperature
θ_j = temperature at interface j

5.3 Saturation humidity

Saturation humidity (pressure Pa) is given by:

$p_{sat} = 610.5 * e^{((17.269*\theta)/(237.3+\theta))}$ when θ is equal to and above 0 °C

and

$p_{sat} = 610.5 * e^{((21.875*\theta)/(265.5+\theta))}$ when θ is below 0 °C

If there is *kkvalues.dat* file in programs directory, it will be used instead or previous formulas (*kkvalues.dat* id ASCII file, where is 151 saturation humidity values in unit g/m^3)

5.4 Humidity distribution

Program calculates humidity values without thermal bridge effect. Humidities in different interfaces is calculated by:

$p_1 = p_e + Z_1/Z_T*(p_i - p_e)$

$p_2 = p_1 + Z_2/Z_T*(p_i - p_e)$

etc.

p_e, p_i = external and internal air humidities (Pa)
p_j = humidity at interface j   (Pa)

5.5 Condensation

Program use formulas and methods presented in prEN ISO 13788. Because at the moment prEN ISO 13788 is draft, results should be used as a approximation.

5.6 Energy consumption

Program calculate energy flow from inside to outside. If energy consumption is negative (flow inwards), it is assumed to zero (no gain allowed). Energy consumption is calculated by:

Energy consumption $_j$ = U * (θ_{ji} - θ_{je})*Duration $_j$ (for period j)

Total energy consumption is sum of all calculation periods multiplied by area [m^2]

6 Responsibility

Software is tested with several structures. D.O.F. tech Oy shall not be liable in any manner whatsoever for results obtained through the use of the software.

7 Contact information

D.O.F. tech Oy

Telephone:	**0208 - 363 001**
homepage:	**www.doftech.com**
Email:	**doftech@doftech.com**