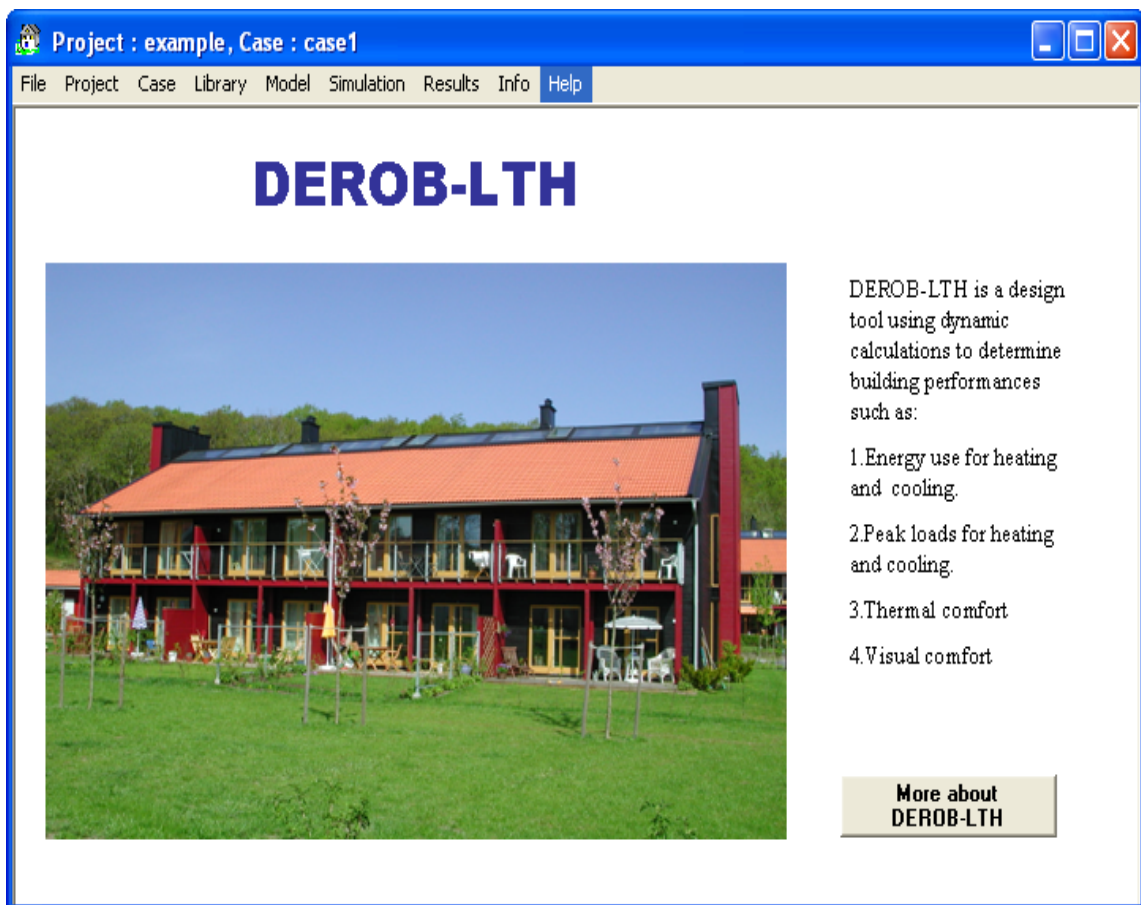


DEROB-LTH



Background

DEROB-LTH, which is an acronym for Dynamic Energy Response of Buildings, originates from the University of Texas and is written for the English language only. It is a design tool with possibilities to explore the complex dynamic behaviour of buildings for different designs. The tool is under continuous development at the division of Energy & Building Design at Lund University. The form of the building can be modelled in a flexible way with a number of 3-D surface geometries from triangles to five-sided polygons. The number of zones is maximized to 8. Libraries for opaque and transparent materials and constructions are included and can be modified according to special needs. The program has a semi-transparent building element type that can be used for modelling a shading screen, e.g. an awning. The calculations, based on an energy balance model, uses a time step of one hour and calculates different types of building energy performance parameters in response to hourly values of climatic data, scheduled input for indoor temperatures, max power for heating and cooling, internal loads, airflow rates and window openings.

The tool can simulate a wide spectrum of building types and is principally developed for target groups as students, researchers, architects and energy consultants.

Even if DEROB-LTH is relatively easy to use the advanced simulation models used demand that the users are familiar with the input parameters used and how they interplay.

A demo example is included with the installation of the program. This example is activated from the main function *File*.

Main functions

The work in DEROB-LTH is grouped into seven main functions: *File*, *Project*, *Case*, *Library*, *Model*, *Simulation* och *Results*.

More detailed information about the different functions is found in associated forms.

➤ File

Functions to select a project directory and to activate the demo example is included in the main function *File*. The project directory can be regarded as a container for a set of design projects. Each design project comprises building models and libraries global to a design project.

➤ Project

The main function *Project* manages design projects.

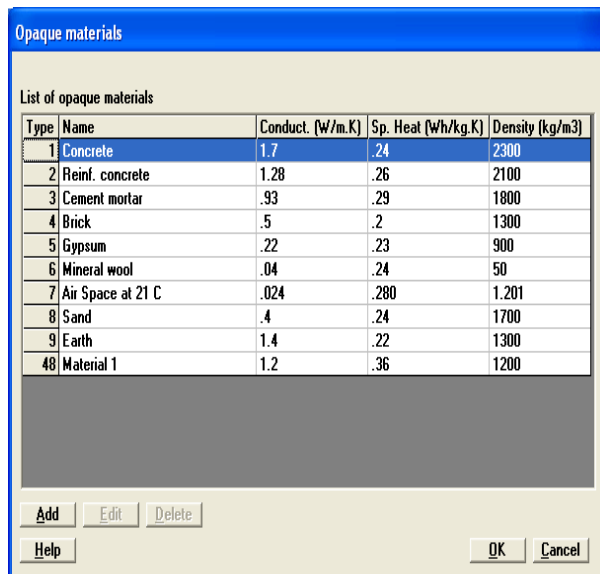
➤ Case

Case is used to manage individual building models in a design project and requires a design project to be activated (opened).

➤ Library

This main function manages libraries for materials, constructions for roofs/walls/floors, doors and windows. A library for curtains is also included. *Library* requires a design project to be activated (opened). Below are some examples of forms.

Opaque materials

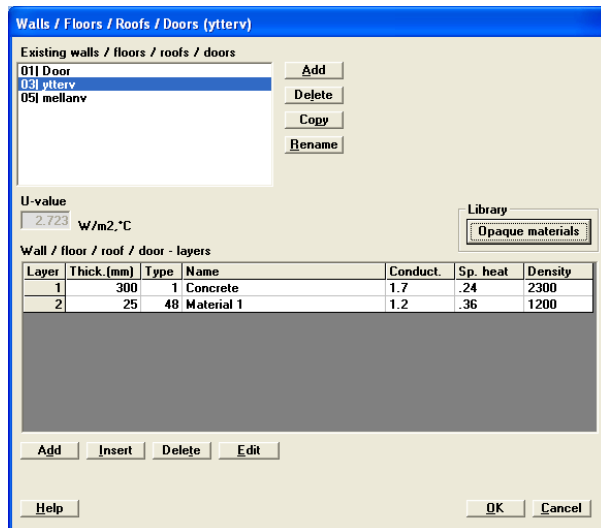


The screenshot shows a dialog box titled "Opaque materials" with a table listing various materials. The table has five columns: Type, Name, Conduct. (W/m.K), Sp. Heat (Wh/kg.K), and Density (kg/m3). The materials listed are Concrete, Reinf. concrete, Cement mortar, Brick, Gypsum, Mineral wool, Air Space at 21 C, Sand, Earth, and Material 1. Below the table are buttons for Add, Edit, Delete, Help, OK, and Cancel.

Type	Name	Conduct. (W/m.K)	Sp. Heat (Wh/kg.K)	Density (kg/m3)
1	Concrete	1.7	.24	2300
2	Reinf. concrete	1.28	.26	2100
3	Cement mortar	.93	.29	1800
4	Brick	.5	.2	1300
5	Gypsum	.22	.23	900
6	Mineral wool	.04	.24	50
7	Air Space at 21 C	.024	.280	1.201
8	Sand	.4	.24	1700
9	Earth	1.4	.22	1300
48	Material 1	1.2	.36	1200

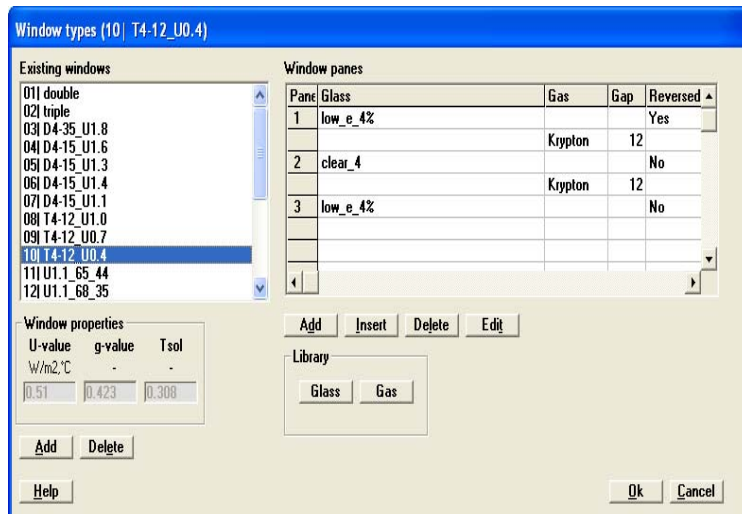
This form is activated from the form *Walls / Floors / Roofs / Doors*

Walls / Floors / Roofs / Doors



The function to manage opaque materials is included in this form.

Windows



When a window is selected a calculation of the U-value, g-value and Tsol-value for the window package is done. g-value stands for the total solar energy transmission and Tsol for the primary solar energy transmission. The calculation is done according to the standard ISO 15099.

➤ Model

Model manages the selection of a site and its climatic data, opaque/transparent building elements, the building geometry and hourly schedules for different input data with influence on energy performance and indoor climate.

DEROB-LTH uses relatively advanced models for natural ventilation. The choice of input data and the interpretation of the results demands satisfactory understanding of the underlying principles of building physics. Below are some examples of forms.

Site and climatic data

Site / Period / Climate

Latitude: 33.1 * (-90.0 to 90.0, positive to the north)
Longitude: 36.0 * (-180 to 180, positive to the east)
Time meridian: 30 * (-180 to 180, positive to the east)
Rotation of the x-axis from south: 0 * (-360.0 to 360.0, positive anti-clockwise, 0° if not set)

Solar radiation
 Use hourly values from the climatic file
 No sun

Outdoor temperatures
 Use hourly values from the climatic file
 Set temperature to _____ °C

Period of simulation: First date: 1995 01 01
Last date: 1995 12 31

(Postfix: CLI)
Climate data file: C:\DEROBV2.0\DEROBPROJ\StockholmW(SE).cli
Message: Hourly wind data is used in HVAC-calculations

c: \ C:\ DEROBV2.0 StockholmW(SE).cli
DEROBPROJ
Example

General parameters

Help OK Cancel

The climatic data file should include data for wind-speed and wind-direction to be used for the calculations of natural ventilation. It's however working even if these data are missing, but with loss of accuracy in the results.

Building elements and building geometry

Building element (S1)

Building elements
1 | S1
2 | V1
3 | N1
4 | E1
5 | R1
6 | F1
7 | S2
8 | R2
9 | F2
10 | E2
11 | MV12

2 | Shape index: 3 Rectangle with a hole
Zenith: 90 *
Azimuth: 0 *

Lower left corner
x: 4 m
y: 0 m
z: 0 m

Front facing Volume :
Outdoor

Back facing Volume :
Volume 1

Dimensions (m):					
A	B	C	D	E	F
10	4	1	4	3	6

Add Insert
Copy Delete
Rename Surfaces

Main wall (if opaque)
Construction type: 3 | ytterv
Absorptance front: 70 % back: 70 %
Emittance front: 87 % back: 87 %

Main wall (if transparent)
Window type:
Curtain type:

The hole (if opaque)
Construction type:
Absorptance front: 70 % back: 70 %
Emittance front: 87 % back: 87 %

The hole (if transparent)
Window type: 2 | triple
Curtain type:

Leakage flow at $\Delta P = 50 \text{ Pa}$ 1 l/sm2
Exclude floor elements

Assign value for leakage flow to all building elements excluding floors Assign

Help OK Cancel

The building geometry is flexible. At the beginning a new user can have a feeling that the way the 3-D geometry is specified is cumbersome. The user has to give some input data to locate the surfaces in 3-D. This requires some spatial thinking. After a while however this way of working is no obstacle to the user.

Shading screen (sunshade) is a type of building element with optical properties.

Schedules

HVAC - Schedules

Schedules
ScheduleA

Add Delete Copy Rename

Volume: 1 Type of operating periods: Weekend/Weekday
Weekend/Weekday Weekend

Copy

Hourly operating periods for loads

Hour	Mp-Heating(W)	Heating(°C)	Mp-Cooling(W)	Cooling(°C)	Internal loads(W)	Inflow(l/s)	Outflow(l/s)	Open window(%)
1		20			200			
2		20			200			
3		20			200			
4		20			200			
5		20			200			
6		20			200			
7		20			200			
8		20			200			
9		20			100			
10		20			100			
11		20			100			
12		20			100			
13		20			100			
14		20			100			
15		20			100			
16		20			100			
17		20			100			
18		20			300			
19		20			300			
20		20			300			
21		20			300			
22		20			300			
23		20			300			
24		20			300			

18 24 20 300

Fill Clear

Internal loads from

Heat exchanger
 No
 Yes Efficiency 44 %

Bypass function
 No Yes

Go to defined openings between volumes

Help Ok Cancel

The number of schedules is limited to 4 and there are three types of schedules: *Weekend/Weekday*, *Daily* and *Monthly*. Each volume (room) is assigned one of these types.

It's among other things possible to specify hourly operating periods for

- 1) opening percentage of external windows / doors
- 2) opening percentage of internal doors / windows between volumes (rooms).

➤ Simulation

Simulation includes functions to specify type of results and to start a simulation. Below are some examples of forms.

Output specification

Output Specification

Output type

Monthly and yearly summaries
 Detailed data one day per month
 Hourly values

Output parameters

Volumes	Temperature	Heating	Cooling	Sol(out)	Sol(in)	Sol(abs)
1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Comfort

Volumes

1
 2

Help OK Cancel

Results can be written on a monthly or hourly basis depending on the user's need. Output parameters can be selected for each volume (room) in the building.

Simulate

Simulation - Project : example

Case	Include case	DIG	GF	LUM	WAL	SOL	TL
case1 - Demonstration 1	<input checked="" type="checkbox"/>	X	X	X	X	X	X

Fill Clear

Simulate

Help Cancel

The DEROB-LTH program is built up of six different calculation modules. The models are automatically checked. A complete simulation includes all modules. It's however possible for an experienced user to manually select modules to be run. The list 'Existing cases' contains one or more cases (building models) located in the opened design project. One or more of these can be checked to be simulated.

➤ Results

The main function *Results* manages the presentation of simulated results. Results are presented in different ways such as listings, Excel sheets, diagrams and a 3-D picture of the building geometry.

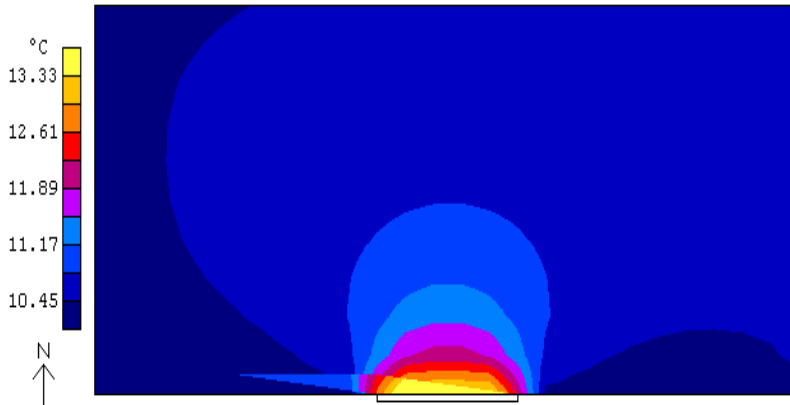
If hourly output is selected then it's possible to run two post-processors for calculation of thermal- and visual comfort in one of the volumes (rooms) in the building. The two post-processors limit the geometry of the studied room. It must be

rectangular with its surfaces parallel to the axes in the right-angled building coordinate system. Only one room can be studied at a time.

Below are some results from the two post-processors and a 3-D picture of the building model.

Post-processor: Thermal comfort

Demonstration 1
 Global Operative Temperature
 May 8, 9.00 Room Air: 10.40°C Level: 1.20 m Calc.Step: 22 pixels
 1.0 clo Abs: 70% Emis: 50% MR: 1.0 met WR: 0.0 met WS: 0.0 m/s RH: 60%



The installation of DEROB-LTH include a technical description of the post-processor for thermal comfort. The name of the document is *CD_Kgkcomf.doc* and is located in the directory *\Document*.

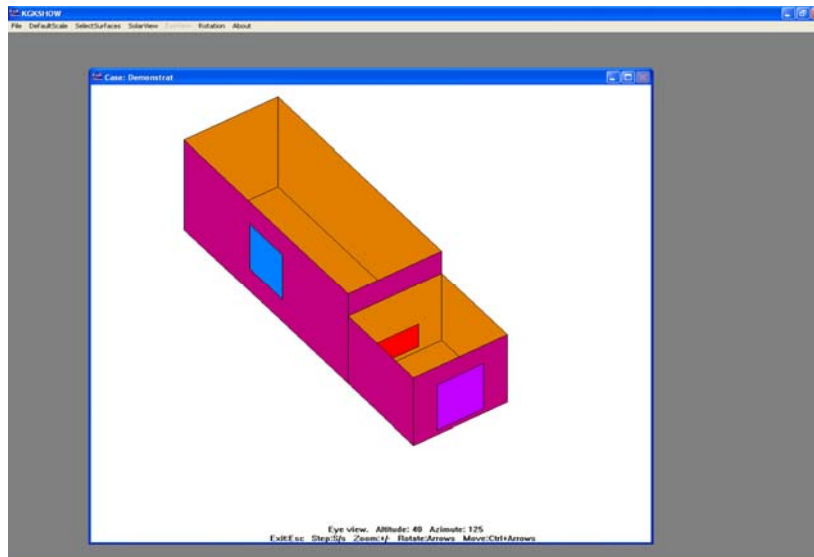
Post-processor: Visual comfort

Demonstration 1
 Illuminance at Front Side, Mar 21 13:00, Dir.rad. 114 W/m2
 Clear Level: 200 W/m2, Used factors: 148 & 121 lux/W,m2, Tv/Ts: 1.00
 0.80 m above floor, Calc.steps 16 pixels(0.29 m)



The theory behind the calculation of indices for visual comfort is described in the report *Energy-Efficient Window Systems (TABK-01/1022)* by Helena Bülow-Hübe, Energy and Building Design.

3-D view



With this function it's possible to rotate the building in all directions and visibly remove arbitrary surfaces to be able to look into the building. The 3-D view function is especially useful in the build-up of the building geometry. Then it's important to check that surfaces are located in the correct position and orientated as intended.

Downloading DEROB-LTH

The program can be downloaded from the adress: <http://www.derob.se/>.

DEROB-LTH is not free of charge and a userid and password are needed. If you get in contact with Energy and BuildingDesign it's possible to download a demo version of the program.