

1. Introduction

[Ground_heat_losses.tr2](#)

This tutorial explains how to calculate the ground heat losses of a slab-on-ground floor.

Key elements:

- Creating a geometrical model starting from scratch
- Interpretation of numerical output
- Derived thermal properties: equivalent thermal transmittance of a floor on the ground

More details about deriving the equivalent and linear thermal transmittance according to EN ISO 13370 and EN ISO 10211 can be found in the Knowledge Base document B6¹.

Note: this tutorial is partly assembled from:

- How to create the design grid for a geometrical model from scratch or with a .dxf underlayer?
- How to add materials and boundary conditions to a geometrical model?

2. Case study data

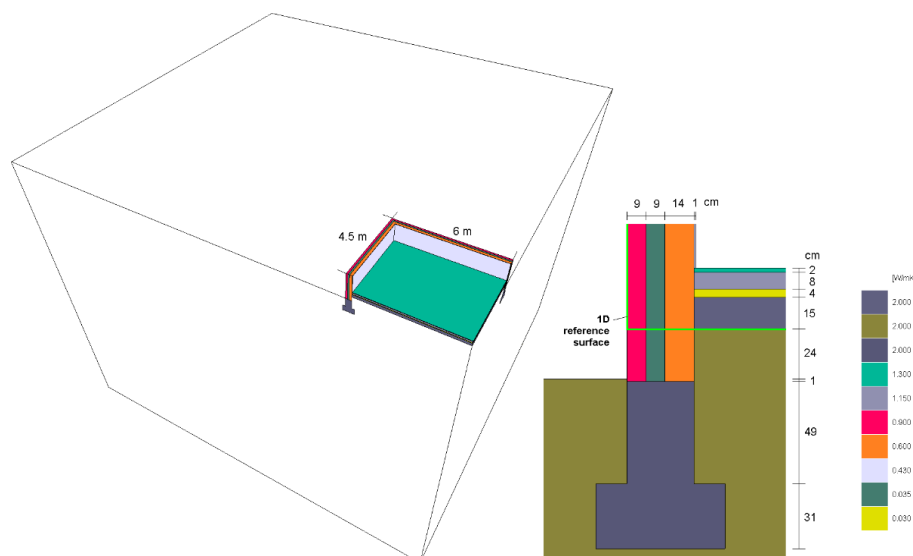


Figure 1: case study data






A building with external dimensions length = 12 m and width = 9 m is considered. Figure 1 shows the geometrical data and the thermal conductivities of the materials. The boundary conditions are:

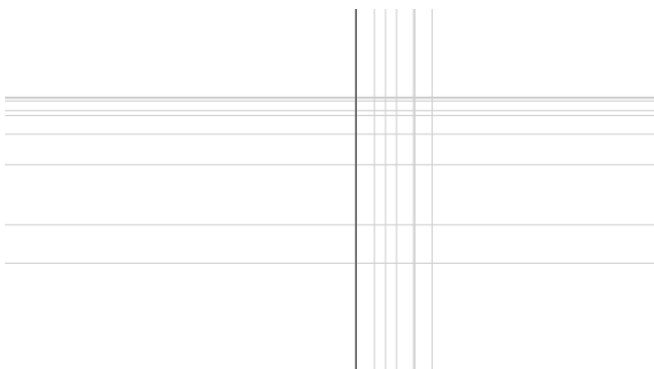
- Outdoors: temperature $\theta_e = 0$ °C, surface heat transfer coefficient = 25 W/m²K,

¹ B6 - FLOOR THERMAL TRANSMITTANCE AND FOUNDATION LINEAR TRANSMITTANCE

- Indoors: temperature $\theta_i = 20 \text{ }^\circ\text{C}$, wall surface heat transfer coefficient = $7.7 \text{ W/m}^2\text{K}$, floor surface heat transfer coefficient = $5.9 \text{ W/m}^2\text{K}$.



3. Creating the model

- Open Trisco2D and adjust optionally the model unit: *Grid* → *Grid Unit...*
- Activate a grid mesh in the **Grid window** by clicking with the left mouse button within.
- Insert a new line in the **Grid window**   ("insert before" or "insert after").
Alternatively, new grid lines can be added by clicking with the left mouse button in the **Image window** after activating   ("set vertical grid line" or "set horizontal grid line").
- In the **Grid window** the dimensions can be adjusted.
Alternatively, the grid lines can be moved by clicking (left mouse button) on a grid line with the cursor after activating  ("move grid line") and holding the left mouse button. Meanwhile the status bar (bottom left) indicates the new position of the grid line.

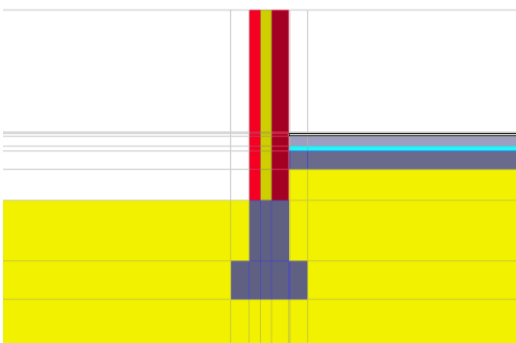


No.	ΔX [cm]	ΔY [cm]
0-1	1270.000	99.000
1-2	15.000	1.000
2-3	9.000	2.000
3-4	9.000	8.000
4-5	14.000	4.000
5-6	1.000	15.000
6-7	14.000	25.000
7-8	210.000	49.000
8-9		31.000
9-10		1151.000
Sum	1542.000	1385.000

4. Adding materials

- Select *Colours* → *List Defined*
- Materials and boundary conditions can be added to the model by first selecting the desired colour in the **Colours window** and then pick the desired grid cells with  ("Draw") or select a desired zone  ("Fill").
 - o To colour multiple grid cells with the "Draw" function: hold the left mouse button down while moving the cursor over the model.
 - o To colour a line of grid meshes with the "Draw" function: select the starting grid cell with the left mouse button and hold down <Shift> while selecting the end point grid cell with the left mouse button.

Note: when selecting materials with the "Draw" option the number of blocks can increase rapidly. To reduce the number of blocks it is advisable to intermediately optimise the number of blocks by *Blocks* → *Optimise Blocks*.

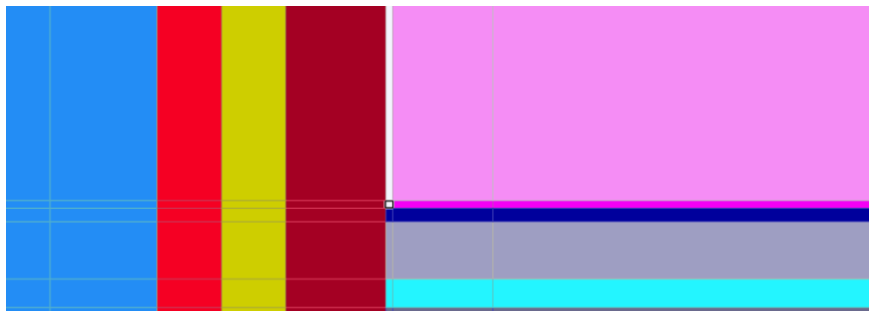


Col.	Type	Subtype	Physical flow dir.	Geometrical flow dir.	Name	λ [W/mK]	θ [$^\circ\text{C}$]	h [W/m 2 K]	q [W/m 2]
23	MATERIAL				sand and gravel	2.000			
26	MATERIAL				ceramic/porcelain tiles	1.300			
120	MATERIAL				concrete density 2400 kg/m 3	2.000			
129	MATERIAL				gypsum 900 kg/m 3	0.430			
133	MATERIAL				insulation 0.030 W/mK	0.030			
137	MATERIAL				cement-bonded particleboard	1.150			
151	MATERIAL				insulation 0.035 W/mK	0.035			
164	MATERIAL				masonry semi-heavy	0.600			
166	BC_SIMPL	HI	DOWN		indoors, downwards heat flow		20.0	5.90	0
170	BC_SIMPL	HE			exterior		0.0	25.00	0
174	BC_SIMPL	HI	HOR		interior (normal)		20.0	7.70	0
180	MATERIAL				masonry heavy	0.900			






5. Adding boundary conditions

- Boundary conditions can be added in the same way as material properties (but with colour “type” BC_SIMPL).
- Predefined boundary conditions are available in the colour database which can be adjusted by double clicking with the left mouse button on “Subtype” and/or “Physical flow direction” in the **Colours window**.
- Use colour 170 for the outdoor boundary condition colour.
- The indoor boundary condition depends on the heat flow direction:
 - o Use the downward heat exchange coefficient for the lower part (e.g. 1 cm) of the inner area (colour 166 here).
 - o Use the horizontal heat exchange coefficient for the upper (e.g. 99 cm) of the inner area (colour 174 here).


Colours								
Col.	Type	Subtype	Physical flow dir.	Geometrical flow dir.	Name	λ [W/mK]	θ [°C]	h [W/m²K]
166	BC_SIMPL	HI	DOWN		indoors, downwards heat flow		20.0	5.90
170	BC_SIMPL	HE			exterior		0.0	25.00
174	BC_SIMPL	HI	HOR		interior (normal)		20.0	7.70



6. Start simulation

- Run the simulation by pressing the magic wand 
- Before the simulation starts an automatic grid discretisation is proposed: click “yes”.
- A grid base size of 10 cm is proposed by the software (based on the dimensions of the model). This can for example be reduced to 1 cm. An automatic variable mesh will then be created with a grid base size of 1 cm and a splitting ratio of 1.5.
Note: the grid can be customised using the split functions (*'Grid→Split...'*).
- The simulation automatically starts and the Image window shows the temperature field.
- Within the **Image window** the user can switch to:
 - o Show Materials 
 - o Show Temperatures 
 - o (Adjust)Temperature Range 
 - o Show (discretisation) Grid 

7. Output

- The numerical results can be consulted in the **Text Output window**: 
- Amongst others, the **Text Output window** lists:
 - o Minimum and maximum temperatures per material (= colour number);
 - o Heat flows through each boundary condition.

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Triso2D - Text Output [Ground_heat_losses2]
File Edit View Settings
[Icons]
Triso2D - Calculation Results
Triso2D data file: Ground_heat_losses.tr2
Number of nodes = 34122
Heat flow divergence for total object = 0.00071191 %
Heat flow divergence for worst node = 0.0237846 %

Col. Type Name tmin X Y tmax X Y
[°C] [°C]
23 MATERIAL sand_and_gravel 0.01 0 82 9.25 130 62
26 MATERIAL ceramic_porcelo 14.22 88 26 18.90 130 22
120 MATERIAL concrete_gesalt 1.11 88 82 9.79 88 46
129 MATERIAL gypsum_900_kg/m 16.56 88 22 19.16 90 0
133 MATERIAL insulation_0.03 9.34 115 46 18.38 130 36
137 MATERIAL cement-bonded_p 14.15 88 38 18.90 130 26
151 MATERIAL insulation_0.03 0.48 60 60 17.50 72 0
166 MATERIAL masonry_semi-he 3.79 72 82 19.01 88 0
166 BC_SIMPL indoors_dowmwa 16.69 90 22 18.90 130 22
170 BC_SIMPL exterior 0.01 0 82 1.11 48 82
174 BC_SIMPL interior_inorma 17.19 90 20 19.16 90 0
180 MATERIAL masonry_heavy 0.15 48 57 1.27 60 82





Col. Type Name Flow in Flow out
[W] [W]
166 BC_SIMPL indoors_dowmwa 17.51 0.00
170 BC_SIMPL exterior 0.00 25.55
174 BC_SIMPL interior_inorma 8.04 0.00
  
```

- The total heat flow (Q_{2D}) from inside to outside equals 25.555 W/m from which the equivalent thermal transmittance of the floor can be derived by (according to EN 13370 and EN 10211)²:

$$U'_g = \frac{Q_{2D}/\Delta\theta_{ie} - U_w h_w}{b_g} = \frac{L_{2D} - U_w h_w}{b_g}$$

Q_{2D} [W/m]	$\Delta\theta_{ie}$ [K]	L_{2D} [W/mK]	b_g [m]	U_w [W/m ² K]	h_w [m]	U'_g [W/m ² K]
25.555	20.0	1.2778	2.57	0.323	1.290	0.335

² Check Knowledge Base document B6 (FLOOR THERMAL TRANSMITTANCE AND FOUNDATION LINEAR TRANSMITTANCE) for more details

- The graphic results can be consulted within **Graphic Output window**: 
- Here .png files can be generated:
 - o Geometry and material properties: 
 - o Boundary conditions: 
 - o Filled temperatures: 
 - o Heat flow lines and Isothermal lines: 