THE LINEAR TRANSMITTANCE OF A GROUND FLOOR - WINDOW SILL CONSTRUCTION DETAIL

1. Introduction

A procedure to calculate the linear thermal transmittance of a ground floor – window sill construction detail is explained using a case study.

2. Case study data

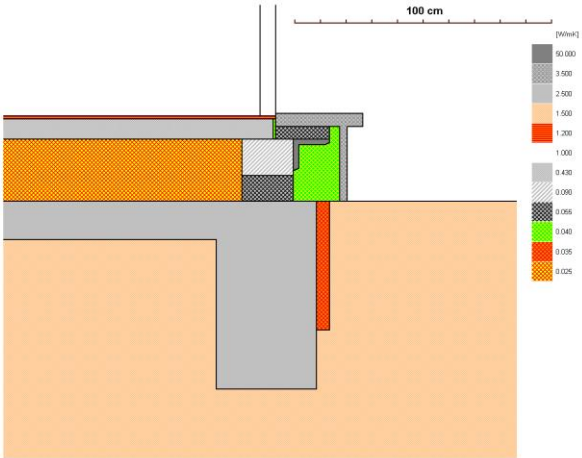

Figure 1: ground floor – window sill connection

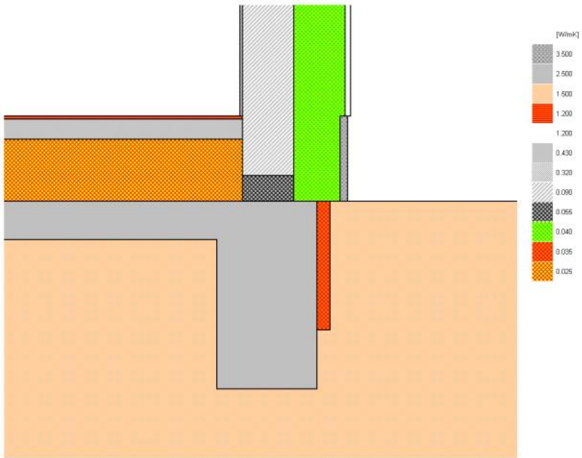

Figure 2: ground floor wall connection

A ground floor – window sill construction detail is shown in Figure 1. The 2 vertical lines at the top show the window (or door) frame connection position. The thermal interaction between the window frame and the floor is not considered and therefore the window frame is not drawn in detail. In the direction perpendicular to the section, the window is connected to a wall. The ground floor wall connection is shown in Figure 2. As shown further, the knowledge of this second construction detail is of importance for the correct calculation of the linear thermal transmittance of the first detail.
The details are assumed to occur in a building with a characteristic floor width of 10.7 m (external dimension). A half building section is shown in Figure 3.

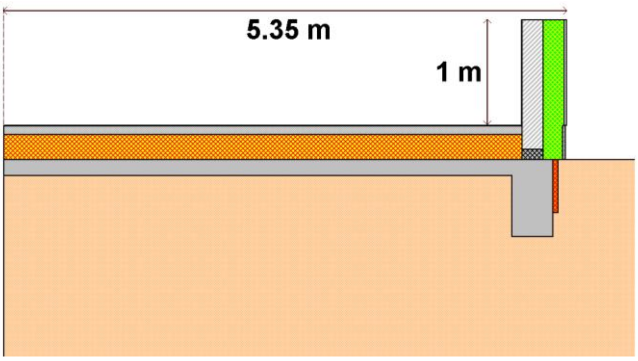

Figure 3: half building section

3. Step 1. Calculating the floor thermal transmittance

BISCO data floor_no_wall_detail.bsc

In order to calculate the floor thermal transmittance U_{floor}[1]:

- No wall junction is considered. The wall is replaced by an adiabatic boundary condition and the foundation under the wall is replaced by ground (Figure 4), according to ISO 13370.
- The 2D geometrical modelling rules according to EN 10211 are used. See Figure 5 and Figure 6.

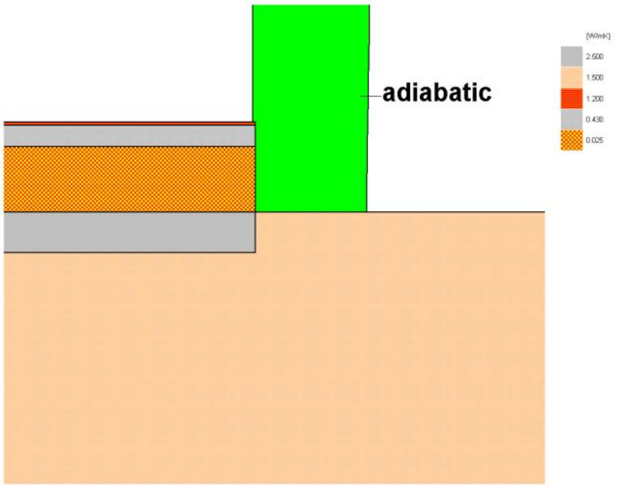

Figure 4: detail used to calculate U_{floor} (zoomed)

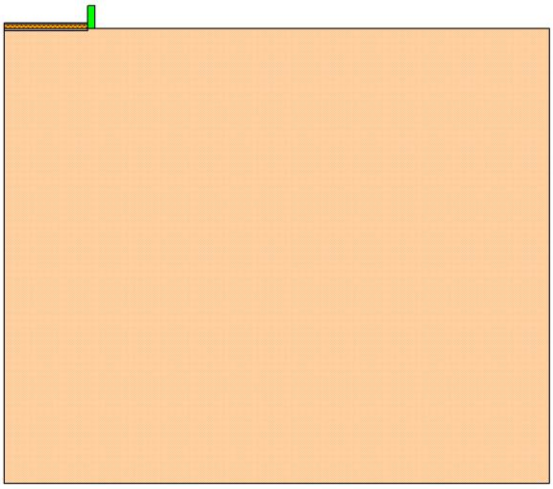

Figure 5: detail used to calculate U_{floor}

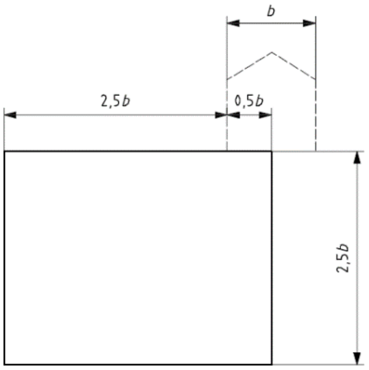

Figure 6: 2D geometrical modelling rules according to ISO 10211

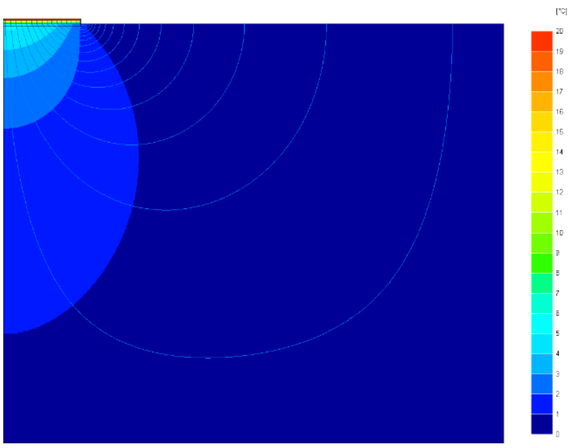

Figure 7: Isotherms (increment 1 °C) and heat flow lines (increment 0.5 W/m)

Figure 7 shows the graphic result of the thermal simulation.
The thermal transmittance of the floor can be calculated using the formula

$$U_{floor} = \frac{Q_{2D}}{\Delta\theta_{ie} B}$$

[1] See Physibel Knowledge Base document: B6-Floor thermal transmittance and foundation linear transmittance (EN ISO 13370 and EN ISO 10211)

Q_{2D}	[W/m]	total heat loss from indoors to outdoors	= 7.685 W/m
$\Delta\theta_{ie}$	[K]	assumed temperature difference	= 20 K
B	[m]	half building width	= 5.35 m

U_{floor} = 0.072 W/m²K

4. Step 2[2]. Calculating the linear thermal transmittance of the floor wall connection

BISCO data floor_wall_detail.bsc

In order to calculate the linear thermal transmittance of the floor wall connection a numerical simulation of the detail as shown in Figure 2 is required, again using the modelling rules as shown in Figure 6.

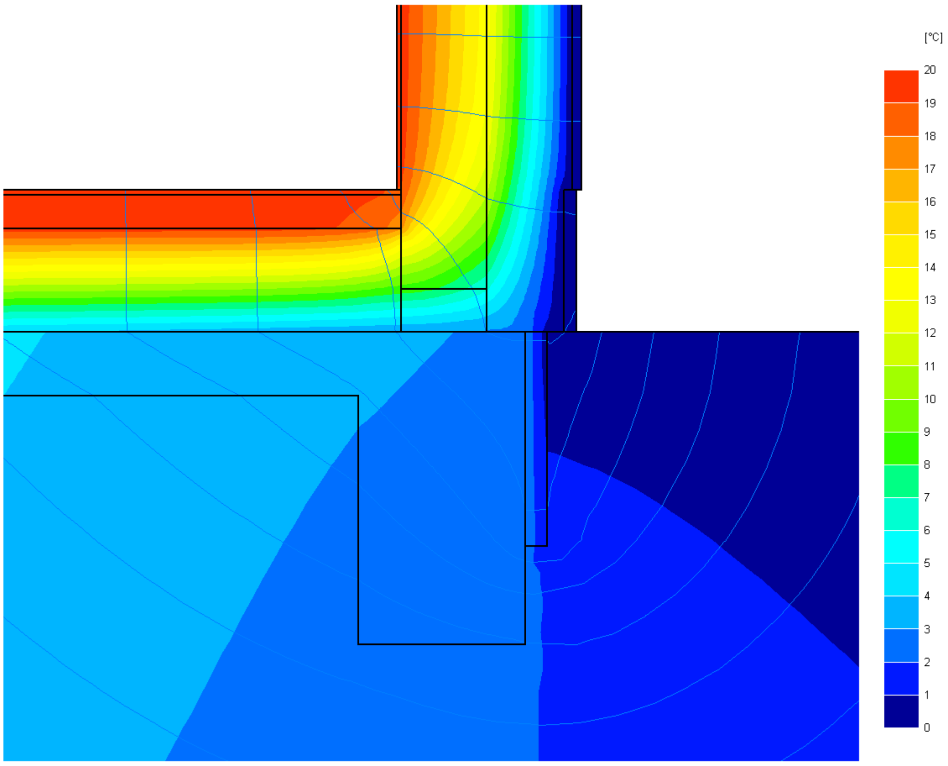

Figure 8: Isotherms (increment 1 °C) and heat flow lines (increment 0.5 W/m) (zoomed view).

Figure 7 shows the isotherms and heat flow lines around the connection detail.

The linear thermal transmittance of the floor wall connection can be calculated using the formula

$$\psi_{floor-wall} = \frac{Q_{2D}}{\Delta\theta_{ie}} - U_{floor}B - U_{wall}H$$

Q_{2D}	[W/m]	total heat loss from indoors to outdoors	= 11.153 W/m
$\Delta\theta_{ie}$	[K]	assumed temperature difference	= 20 K

[2] Step 2 can be skipped if only the linear thermal transmittance of the floor window connection is required.

U_{floor}	[W/m²K]	floor thermal transmittance (from step 1)	= 0.072 W/mK
B	[m]	half building width	= 5.35 m
U_{wall}	[W/m²K]	wall U-value (by hand or read in BISCO)	= 0.134 W/mK
H	[m]	wall height (see Figure 3)	= 1 m

$\psi_{floor-wall}$ = 0.038 W/mK

5. Step 3. Calculating the linear thermal transmittance of the floor window connection

BISCO data floor_window_detail.bsc

In order to calculate the linear thermal transmittance of the floor window connection a numerical simulation of the detail as shown in Figure 1 is required, again using the modelling rules as shown in Figure 6.

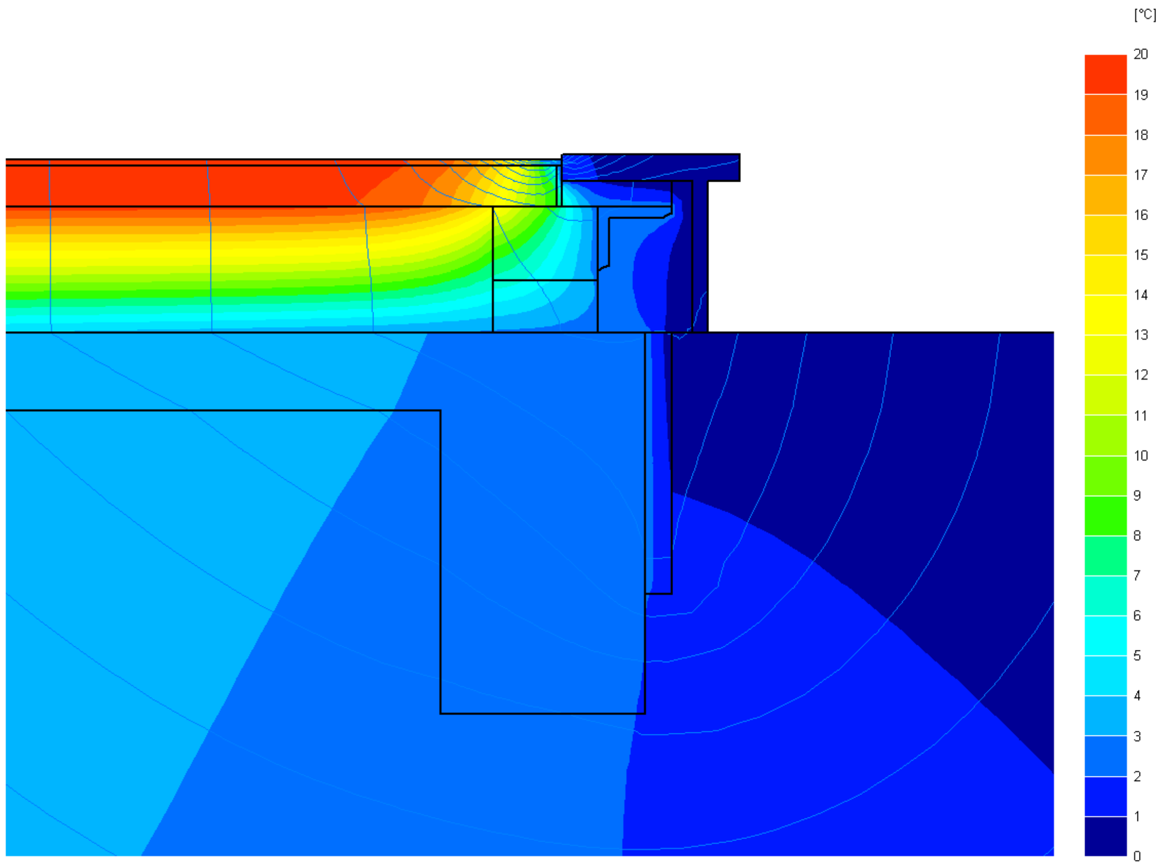

Figure 9: Isotherms (increment 1 °C) and heat flow lines (increment 0.5 W/m) (zoomed view).

Figure 9 shows the isotherms and heat flow lines around the connection detail.

The linear thermal transmittance of the floor window connection can be calculated using the formula

$$\psi_{floor-window} = \frac{Q_{2D}}{\Delta\theta_{ie}} - U_{floor}B$$

Q_{2D}	[W/m]	total heat loss from indoors to outdoors	= 12.126 W/m
$\Delta\theta_{ie}$	[K]	assumed temperature difference	= 20 K

U_{floor} [W/m²K] floor thermal transmittance (from step 1) = 0.072 W/mK
B [m] half building width = 5.35 m

$\psi_{floor-window}$ = 0.221 W/mK

Notice that the building width B value isn't clear from the floor window connection detail. This makes the linear thermal transmission calculation of the floor window connection somewhat special compared to the one of the floor wall connection !

6. Application

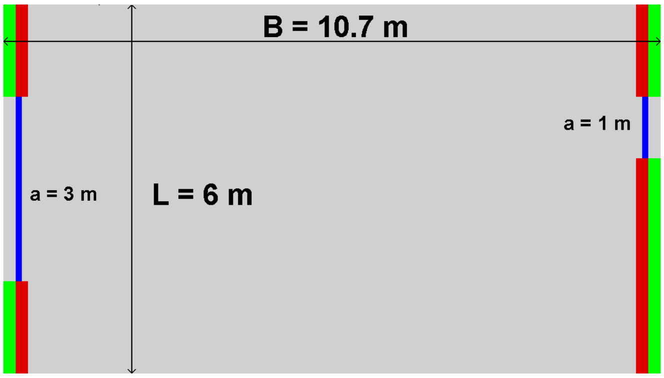

Figure 10: Ground floor plan example

Assume a ground floor plan as shown in Figure 10. Left and right walls occur with 2 windows in it with lengths a = 3 m and b = 1 m.

The thermal transmittance of the floor, including the thermal bridge effect of the wall and window connections can now be calculated:

$$U = \frac{BLU_{floor} + (2L - a - b)\psi_{floor-wall} + (a + b)\psi_{floor-window}}{\mathrm{BL}}$$

U = 0.091 W/m²K

This value is 26 % higher than the floor U value in absence of the junction thermal bridge effect (0.072 W/m²K).

7. References

ISO 13370:2017 Thermal performance of buildings - Heat transfer via the ground - Calculation methods.

ISO 10211:2017 Thermal bridges in building construction — Heat flows and surface temperatures - Detailed calculations.