

1. Introduction

Heat transfer by convection and radiation can be simulated:

- in a simplified way using a global surface heat transfer coefficient,
- in a more detailed way considering heat transfer by radiation and convection separately.

For a wall window junction both methods are experimentally validated.

2. Wall window junction data

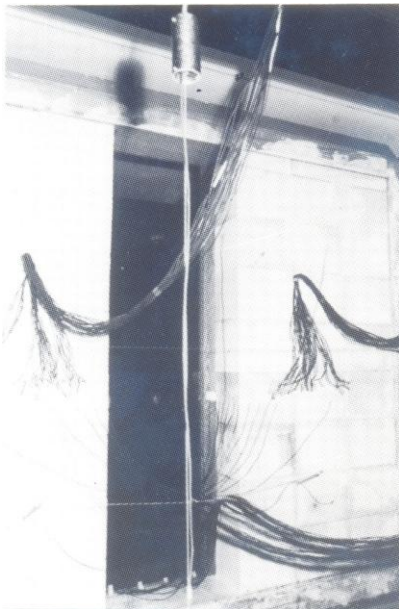


Figure 1. Wall window junction internal view.

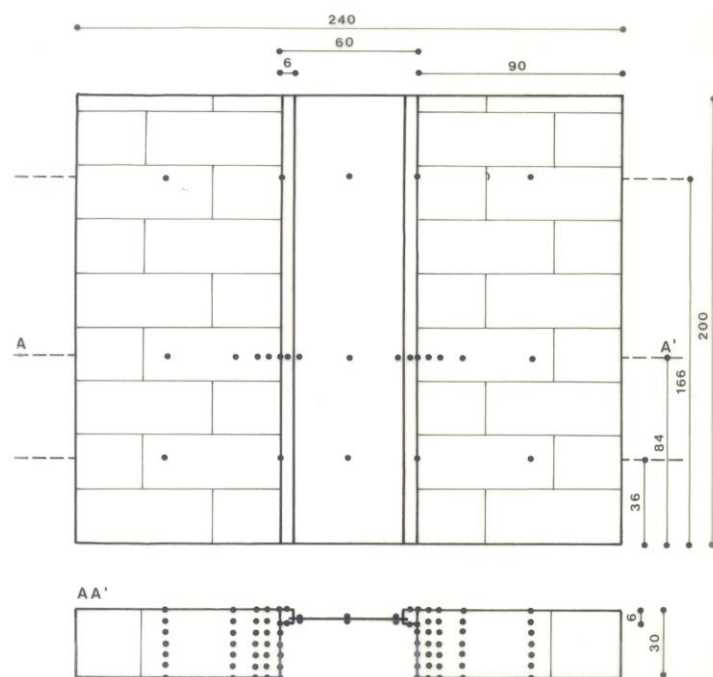


Figure 2. Internal view and horizontal section of a wall window junction with thermocouple positions.

The wall window junction shown in Figure 1 and Figure 2 was measured in a climatic chamber at the University of Leuven.

The materials used are:

- | | | |
|---------------------|--------------------------------------|---|
| - cellular concrete | density $\rho = 690 \text{ kg/m}^3$ | thermal conductivity $\lambda = 0.28 \text{ W/mK}$ |
| - wood | density $\rho = 490 \text{ kg/m}^3$ | thermal conductivity $\lambda = 0.12 \text{ W/mK}$ |
| - glazing | density $\rho = 2400 \text{ kg/m}^3$ | thermal conductivity $\lambda = 0.8 \text{ W/mK}$. |

At the external side the temperature is -0.2°C . The wind speed is about 4 m/s .

At the internal side

- the resulting temperature at 0.95 m from the wall is 20.6 °C,
- the average air temperature is 21.5 °C,
- the average surface temperature of the hot box walls is 21.0 °C.

3. 2D steady state simulation with global internal heat transfer coefficient

BISCO data [wall_window 1b.bsc](#)

TRISCO data [wall_window 1b .trc](#)

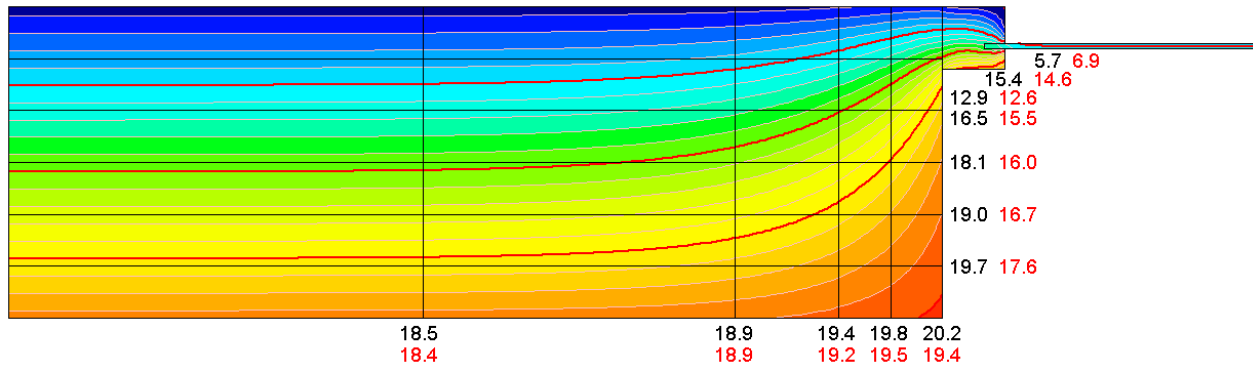


Figure 3: isotherms (red line increment 5 °C, colour increment 1 °C)

The boundary conditions used are

- Outside: type = BC_SIMPL
temperature $\theta_e = -0.2$ °C, global heat transfer coefficient $h_e = 25$ W/m²K
- Inside: type = BC_SIMPL
temperature $\theta_i = 20.6$ °C, global heat transfer coefficient $h_i = 7.7$ W/m²K.

Figure 3 shows the isotherms and both simulated (top) and measured (bottom) temperatures on the internal surface.

4. 2D steady state internal separated radiation and convection

BISCO data [wall_window 2.bsc](#)

TRISCO data [wall_window 2 .trc](#)

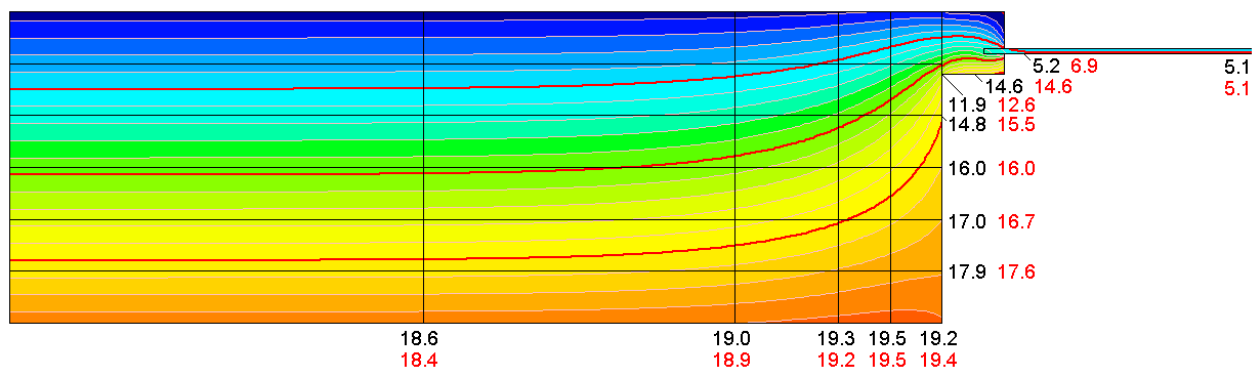


Figure 4: isotherms (red line increment 5 °C, colour increment 1 °C)

The boundary conditions used are

- Outside: type = BC_SIMPL
temperature $\theta_e = -0.2\text{ °C}$, global heat transfer coefficient $h_e = 25\text{ W/m}^2\text{K}$
- Inside: type = **BC_SKY** (requires RADCON-module)
air temperature $\theta_{\text{air}} = 21.5\text{ °C}$
convective heat transfer coefficient $h_{ci} = 1.2 \Delta\theta^{1/3}\text{ W/m}^2\text{K}$; 2 h_{ci} -values are

used:

one at the indoors oriented wall surface: $h_{ci1} = 1.7\text{ W/m}^2\text{K}$

another at the surfaces around the window: $h_{ci2} = 3.05\text{ W/m}^2\text{K}$.

sky temperature $\theta_{\text{sky}} = 21.0\text{ °C}$ (average hot box wall temperature)

surface emissivity = 0.9 for cellular concrete and wood

surface emissivity = 0.84 (EN 673) for glass.

Figure 4 shows the isotherms and both simulated (top) and measured (bottom) temperatures on the internal surface.

5. Discussion

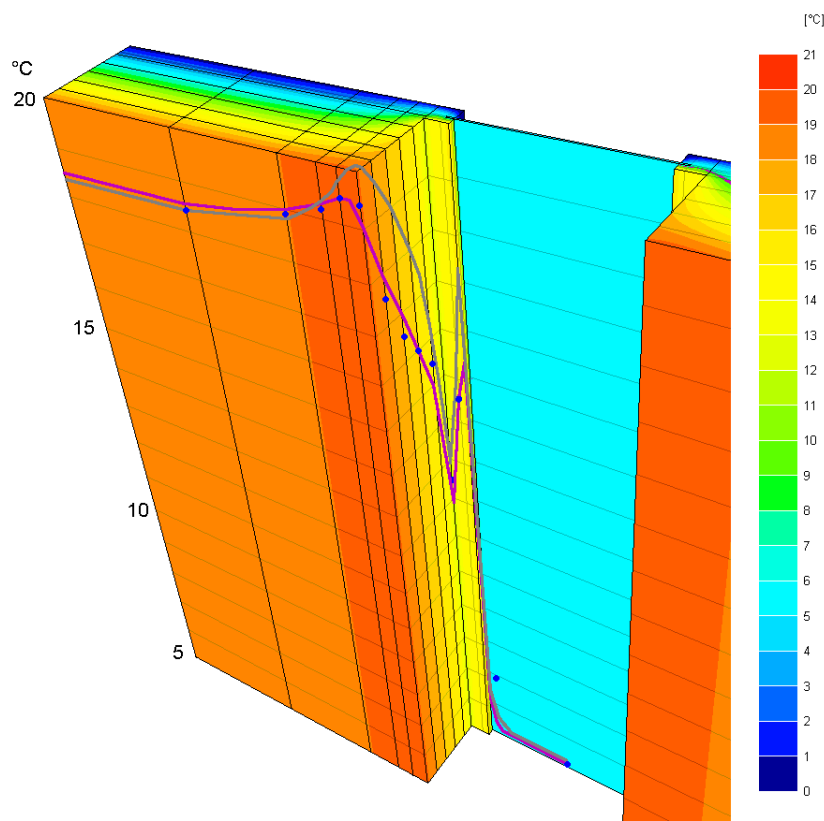


**Figure 5: Internal surface temperature course: simplified (grey) and detailed simulation (purple).
Measured temperatures (blue dots).
Isotherms (colour increment 1 °C) correspond to the detailed simulation results.**

Figure 5 allows comparing the results of the simulations done. The simulation with the separated convection and radiation fits much better to the measurement. The radiation exchange between the wall side surface and the single glazing causes a local lower temperatures than those that are obtained using a simulation using an internal global surface coefficient.