LINEAR AND POINT THERMAL TRANSMITTANCE OF THERMAL BRIDGES

1. Introduction

The linear thermal transmittance and the point thermal transmittance for an external wall containing both a linear thermal bridge and a point thermal bridge are calculated using the program TRISCO.

2. Data

TRISCO data detail_full.trc

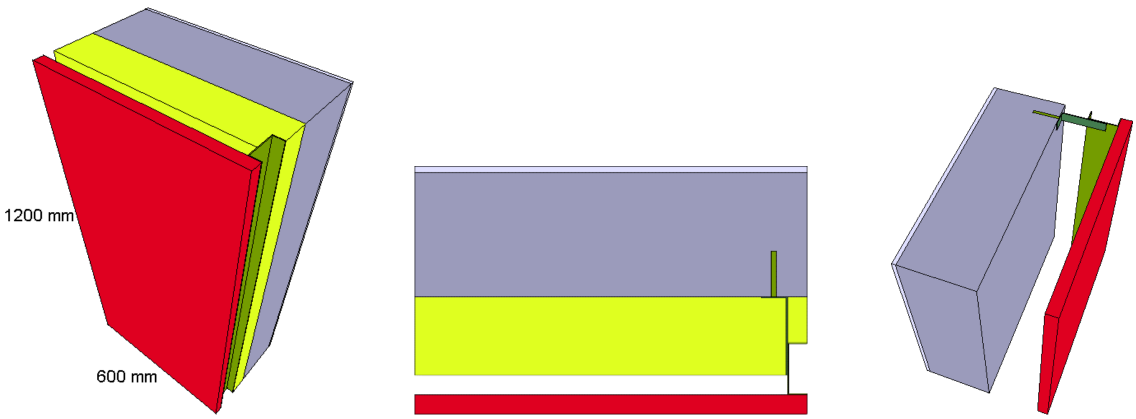

Figure 1: perspective view (left), horizontal section at h= 600 mm (centre) perspective view of half object with removed insulation (right)

Figure 1 shows a concrete wall (thickness 190 mm) with thermal insulation (thickness 120 mm) and external non-ventilated terra cotta cladding (thickness 300 mm). The cladding is supported by steel frames (distance between 2 frames of 1200 mm) fixed to the concrete wall by small metal L-shaped brackets fixed on the concrete wall. Because of symmetry it is sufficient to consider a section of b = 600 mm width. A height h = 1200 mm is considered. The full geometrical and thermal data are listed in the TRISCO data file detail_full.trc.

3. Results

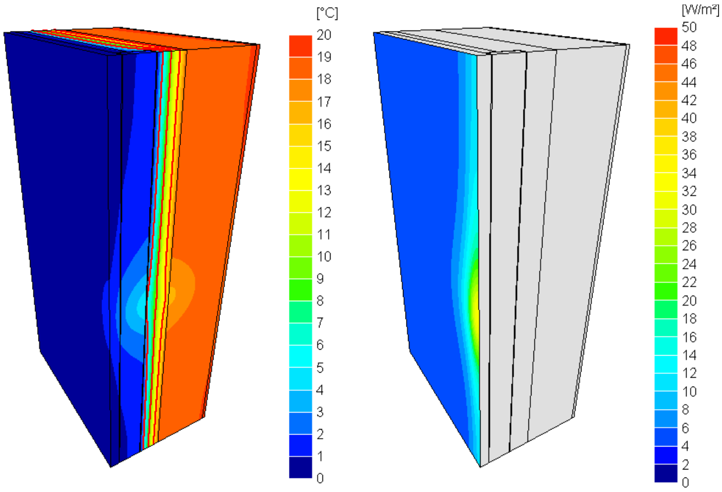

Figure 2: isotherms (left) and heat flow density (right)

Figure 2 shows the graphic results of a 3D steady state analysis. From the total heat loss Q_{3D} = 4.5323W, the mean thermal transmittance U of the wall can be derived:

$$U = \frac{Q_{3D}}{bh\Delta\theta_{ie}} = 0.315\, W/m^2K$$

This U-value is valid for a cladding wall with metal frames each 1200 mm and brackets each 1200 mm. For other distances, of course a new 3D simulation can provide the thermal transmittance, but an alternative solution is to derive the linear thermal transmittance ψ of the steel frame and the point thermal transmittance χ of the steel bracket.

4. The linear thermal transmittance ψ of the steel frame, the point thermal transmittance χ of the steel bracket

The derivation of the ψ-value and of the χ-value requires 2 additional simulations:
1) wall with vertical frame, without bracket TRISCO data detail_no_bracket.trc
2) wall without vertical frame, without bracket TRISCO data detail_no_bracket_no_frame.trc

The first simulation is 2D, the second is 1D only and of course could be done by hand.

The spreadsheet calc_psi_chi_from_TRISCO.xlsx (Table 1) is used to derive the ψ-value of the half frame and the χ-value of the half bracket.

without vertical frame; without bracket

TRISCO data	n	Q [W]	Δθ [K]	L [W/K]	l [m]	h [m]	S [m²]	U [W/m2K]
detail_no_bracket_no_frame.trc	36	3,6824	20,0	0,1841	0,600	1,200	0,720	**0,256**

with vertical frame; without bracket

TRISCO data	n	Q [W]	Δθ [K]	L [W/K]	l [m]	h [m]	S [m²]	U [W/m2K]	ψ frame [W/mK]
detail_no_bracket.trc	21774	3,9307	20,0	0,1965	0,600	1,200	0,720	**0,273**	**0,0103**

with vertical frame; with bracket

TRISCO data	n	Q [W]	Δθ [K]	L [W/K]	l [m]	h [m]	S [m²]	U [W/m2K]	χ bracket [W/K]
full_detail.trc	729429	4,5323	20,0	0,2266	0,600	1,200	0,720	**0,315**	**0,0301**

Table 1. Derivation of ψ and χ

For a façade with height H and width B, with a total steel frame length L and with n steel brackets, the U-value can now be calculated using

$$U = \frac{BHU_0 + 2L\psi + 2n\chi}{BH}$$