VALIDATION OF THE PROGRAMS BISCO & TRISCO ACCORDING EN 1745

Introduction

Annex D of the standard EN 1745:2012 "Masonry and masonry products – Methods for determining thermal properties" contains 3 test reference cases (1 2D and 2 3D). The tests are done using the programs BISCO and TRISCO.

Test reference case 1

BISCO data EN1745_case1.bsc and EN1745_case1_clustered.bsc

Calculation of the thermal resistance R and the thermal conductivity $\lambda_{10,dry,unit}$ of a masonry unit (vertically perforated unit)

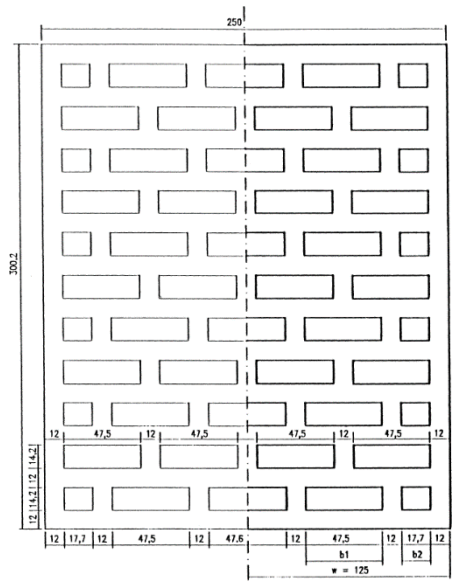


Figure 1. Test reference case 1

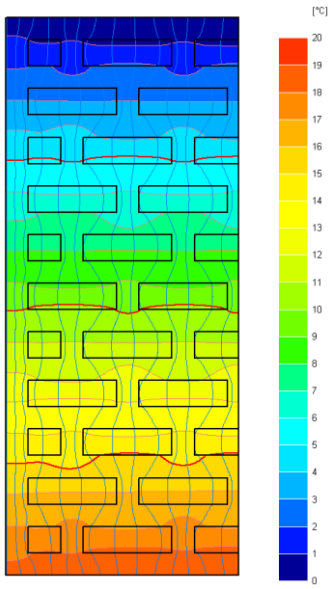


Figure 2. Results obtained by BISCO

The masonry unit to be calculated is shown in Figure 1.
The thermal conductivity of the fired clay is 0.35 W/mK.
At the external side the temperature is 0°C, with a surface heat transfer coefficient h_e = 25 W/m^{2}K.
At the internal side the temperature is 20°C, with a surface heat transfer coefficient h_e = 7.7 W/m^{2}K.
The equivalent thermal conductivity of the voids has to be calculated according to EN ISO 6946:2017.
Figure 2 shows isotherms and heat flow lines (increment 0.1) obtained with the program BISCO.
Table 1 (upper part) contains the relevant thermal results and compares them with the standard results. The deviation between BISCO and standard values is within the requested deviation of 2%.

	n	Q [W]	Dq [K]	L [W/K]	l [m]	h [m]	S [m²]	U [W/m2K]		U [W/m2K]	difference [%]
BISCO data EN1745_case1.bsc	42771	1,394	20,0	0,0697	0,125	1,000	0,125	0,558	EN 1745	0,566	1,4
					d [m]	h_e [W/m²K]	h_i [W/m²K]	$\lambda_{10,dry,unit}$ [W/mK]		$\lambda_{10,dry,unit}$ [W/mK]	
					0,3002	25,0	7,7	0,185		0,188	

	n	Q [W]	Dq [K]	L [W/K]	l [m]	h [m]	S [m²]	U [W/m2K]		U [W/m2K]	difference [%]
BISCO data EN1745_case1_bis.bsc	42771	1,418	20,0	0,0709	0,125	1,000	0,125	0,567	EN 1745	0,566	0,3
					d [m]	h_e [W/m²K]	h_i [W/m²K]	$\lambda_{10,dry,unit}$ [W/mK]		$\lambda_{10,dry,unit}$ [W/mK]	
					0,3002	25,0	7,7	0,188		0,188	

Table 1

The standard mentions the equivalent thermal conductivity of the 2 types of voids: λ = 0.082 W/mK (large void) and λ = 0.074 W/mK (small void). These values should be according to B.3 of EN ISO 6946:2017, but according to our calculations they don't. We found slightly lower values: λ = 0.078 W/mK (large void) and λ = 0.071 W/mK (small void), and used these values in the BISCO data EN1745_case1.bsc.
A second BISCO calculation was done using the equivalent thermal conductivities of the voids as listed in the standard: data EN1745_case1_clustered.bsc. Table 1 (lower parts) shows that in this case the deviation between BISCO and standard values is limited to 0.3 %.

Test reference case 2

TRISCO data EN1745_case2.trc

Calculation of the thermal resistance $R_{dry,mass}$ of masonry consisting of vertically perforated masonry units and internal/external plaster layers.

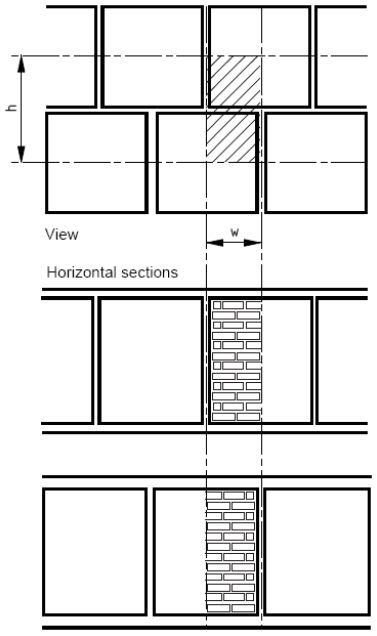
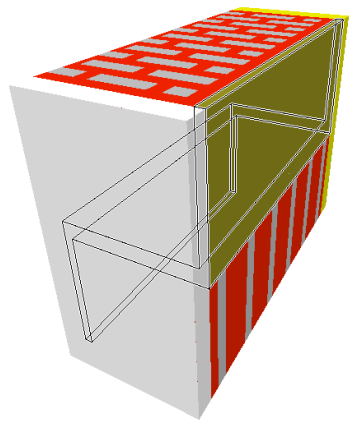


Figure 3. Test reference case 2



Col.		Type	CEN-rule	Name	Pat.	λ [W/mK]	ε [-]	θ [°C]	h [W/m²K]
23		MATERIAL		external plaster		0.450			
25		MATERIAL		internal plaster		0.100			
31		MATERIAL		mortar		0.200			
132		MATERIAL		fired clay		0.350			
170		BC_SIMPL	HE	exterior				0.0	25.00
174		BC_SIMPL	HI_NORML	interior (normal)				20.0	7.70
192		EQUIMAT	NIHIL	cavity type 1		0.074			
193		EQUIMAT	NIHIL	cavity type 2		0.082			

Figure 4. TRISCO thermal data

	n	Q [W]	Dq [K]	L [W/K]	l [m]	h [m]	S [m²]	U [W/m2K]		U [W/m2K]	difference [%]
TRISCO data EN1745_case2.trc	344448	0.3317	20.0	0.0166	0.1325	0.250	0.0331	0.501	EN 1745	0.509	1.6

Table 2

The masonry consisting of vertically perforated masonry units and an internal and external plaster layer is shown in Figure 3. The thermal data as listed in the standard and as used in the

program TRISCO are shown in Figure 4.
Some geometrical data are missing in the standard:

- The thickness of the internal and external plaster layers: 0.02 m (internally) and 0.025 m (externally) were used. These values can be justified from the indirectly given thermal resistance of both layers.
- The thickness of the mortar joint: a thickness of 0.015 m was assumed for both horizontal and vertical joints. It means that the width w (Figure 3) is 0.1325 m instead of 0.125 m (value listed in the standard, resulting in a vertical joint with zero width).

Table 2 contains the relevant thermal results and compares them with the standard results. The deviation between TRISCO and standard values is within the requested deviation of 2%.

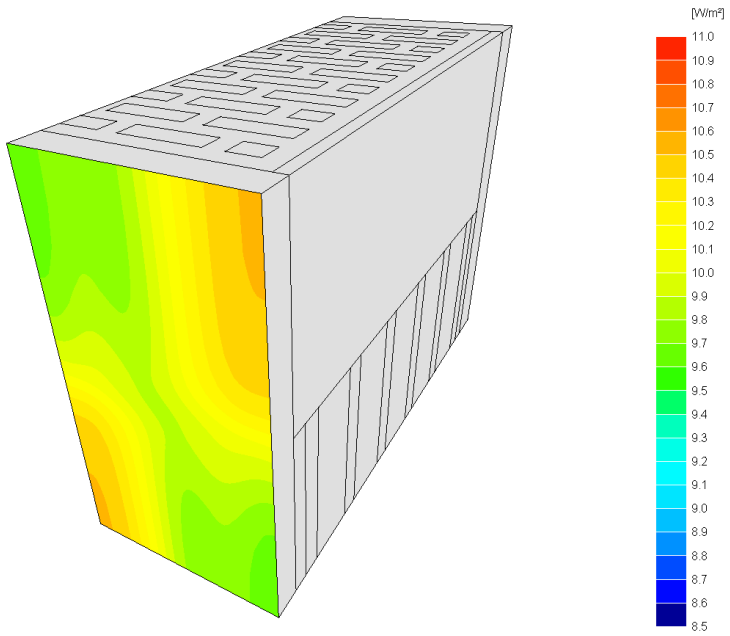


Figure 5. Heat flow density at the internal surface.

Test reference case 3

Too many data are missing in the standard to perform an unambiguous simulation.

Bibliography

EN 1745:2012 "Masonry and masonry products – Methods for determining thermal properties".

EN ISO 6946/2017 "Building components and building elements – Thermal resistance and thermal transmittance – Calculation methods.