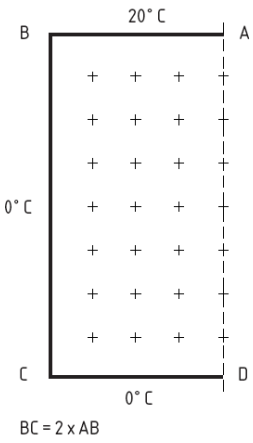
VALIDATION OF THE PROGRAMS TRISCO & SOLIDO ACCORDING TO EN ISO 10211

Introduction

Annex C of the standard ISO 10211[1] contains 4 test reference cases (2 2D and 2 3D). In order to be classified as a three-dimensional steady-state high precision method, TRISCO and SOLIDO shall give results corresponding with those of these 4 cases. The SOLIDO data were obtained by importing the TRISCO data. In the precision range required in the standard, the SOLIDO simulation results are identical to the TRISCO ones.

Test reference case 1

TRISCO data validation_10211_case1.trc
SOLIDO data validation_10211_case1_sld.sld



Analytical solution at grid nodes (°C)			
9,7	13,4	14,7	15,1
5,3	8,6	10,3	10,8
3,2	5,6	7,0	7,5
2,0	3,6	4,7	5,0
1,3	2,3	3,0	3,2
0,7	1,4	1,8	1,9
0,3	0,6	0,8	0,9

Figure 1. Test reference case 1 as listed in EN ISO 10211:2017

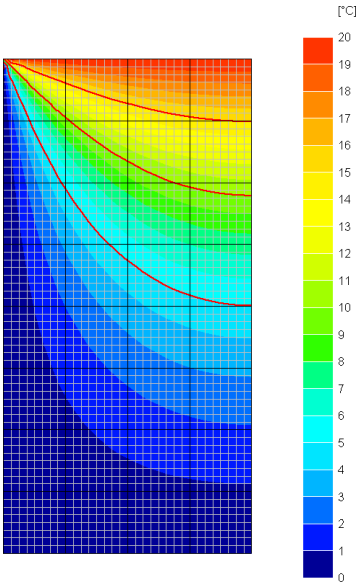


Figure 2. Results obtained by TRISCO

Using the grid as shown in Figure 2 with 4290 nodes the maximum difference between the analytical solution and the simulated one is less than 0.0034 °C. This is lower than the maximum of 0.1 °C required by the standard. The grid temperatures obtained by TRISCO rounded to 1 decimal are identical to the ones listed in the standard.
Table 1 compares the difference between the simulated and the analytical solution as a function of the number of nodes. More details can be found in validation_10211_case1.xlsx.

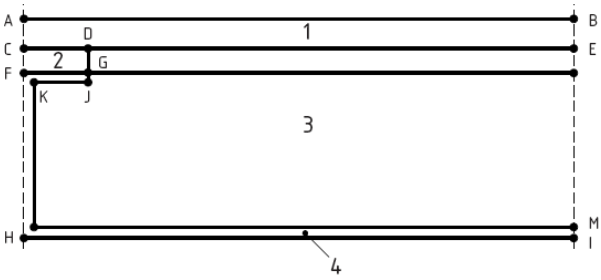
[1] ISO 10211:2017 *Thermal bridges in building construction — Heat flows and surface temperatures - Detailed calculations*

Table 1. Simulated and analytical solution of case 1

number of nodes	simulated temperature – real temperature [°C]	
	minimum	maximum
90	-0.234442	0.209684
306	-0.052136	0.046134
1122	-0.013477	0.011988
4290	-0.003398	0.003026
16770	-0.000851	0.000758
66306	-0.000213	0.000189
263682	-0.000057	0.000076
1051650	-0.000015	0.000016

Test reference case 2

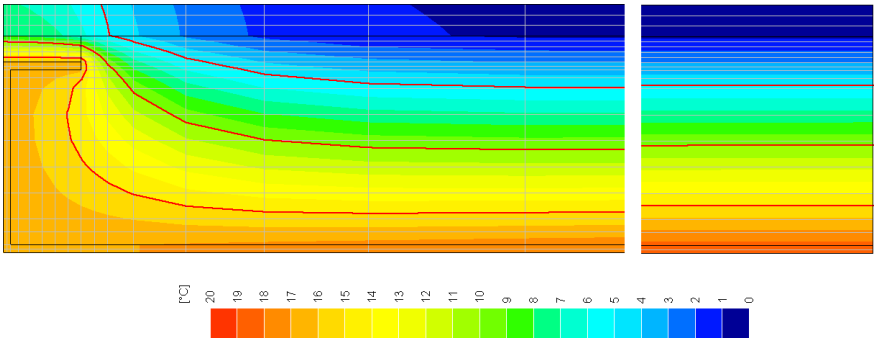
TRISCO data validation_10211_case2.trc
SOLIDO data validation_10211_case2_sld.sld



Dimensions mm	Thermal conductivity W/(m·K)	Boundary conditions
AB = 500	1: 1,15	AB: 0 °C with R_{se} = 0,06 m²·K/W
AC = 6	2: 0,12	HI: 20 °C with R_{si} = 0,11 m²·K/W
CD = 15	3: 0,029	
CF = 5	4: 230	
EM = 40		
GJ = 1,5		
IM = 1,5		
FG - KJ = 1,5		

Temperatures in °C:		
A: 7,1		B: 0,8
C: 7,9	D: 6,3	E: 0,8
F: 16,4	G: 16,3	
H: 16,8		I: 18,3
Total heat flow rate: 9,5 W/m		

Figure 3. Test reference case 2 as listed in ISO 10211:2017(E)



Temperatures in °C		
A: 7.1		B: 0.8
C: 7.9	D: 6.3	E: 0.8
F: 16.4	G: 16.3	
H: 16.8		I: 18.3
Total heat flow rate: 9.5 W/m		

Figure 4. Results obtained by TRISCO

Using a grid with 924 nodes the grid temperatures obtained by TRISCO rounded to 1 decimal are

identical to the ones listed in the standard. The total heat loss rounded to 1 decimal (9.5 W/m) is identical to the one listed in the standard.

Test reference case 3

TRISCO data validation_10211_case3.trc
SOLIDO data validation_10211_case3_sld.sld

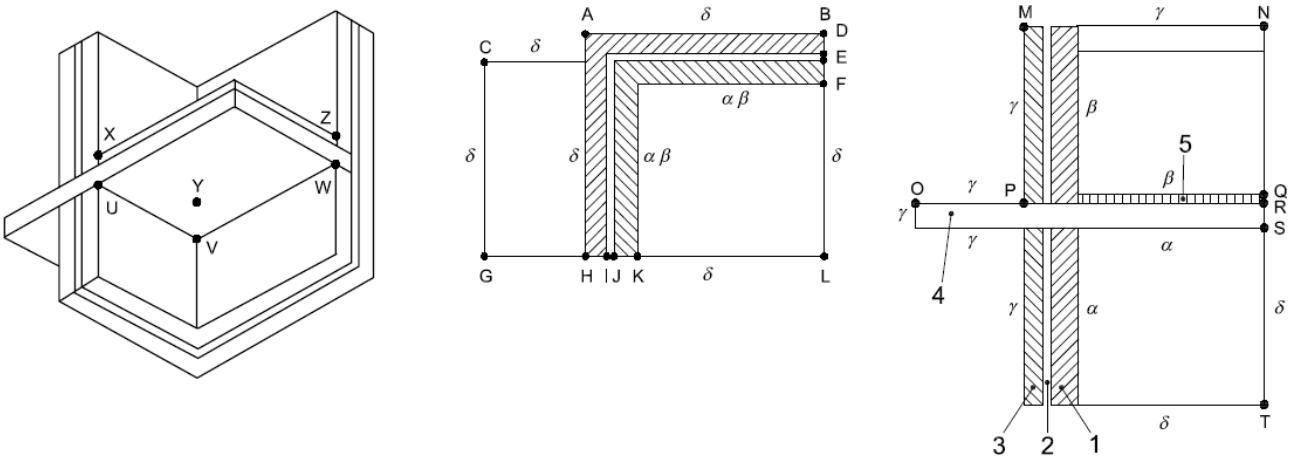
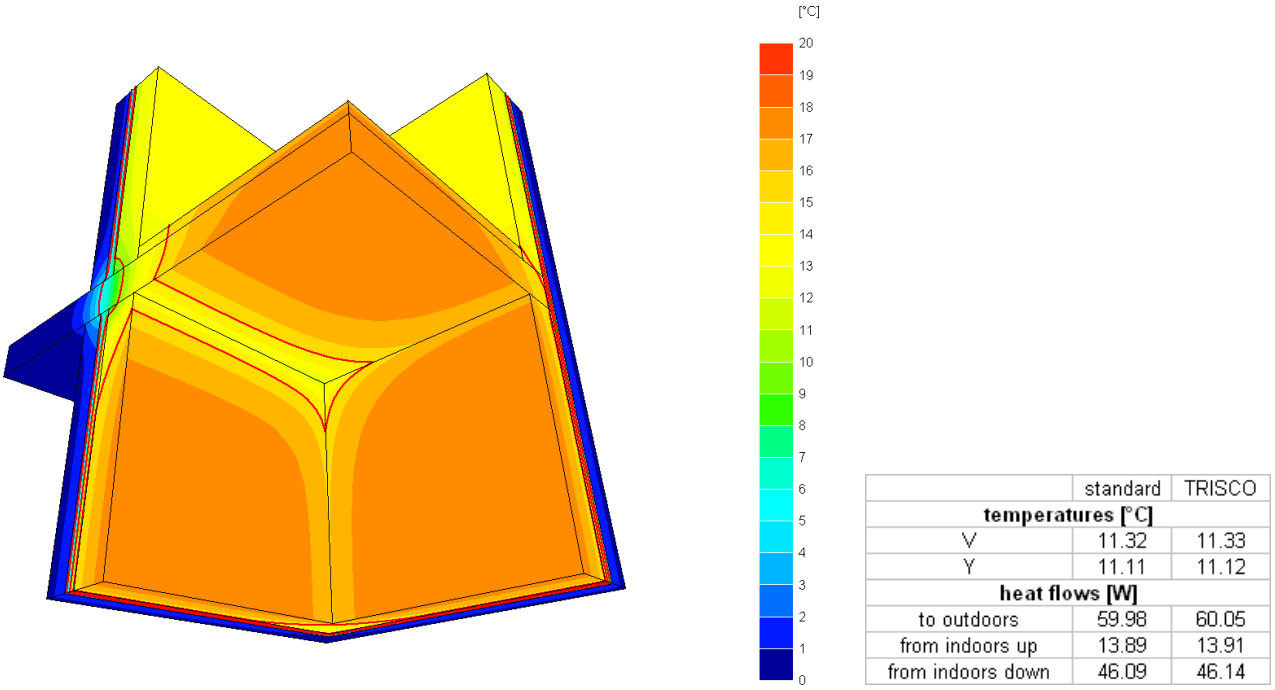


Figure 5. Test reference case 3 as listed in EN ISO 10211:2017

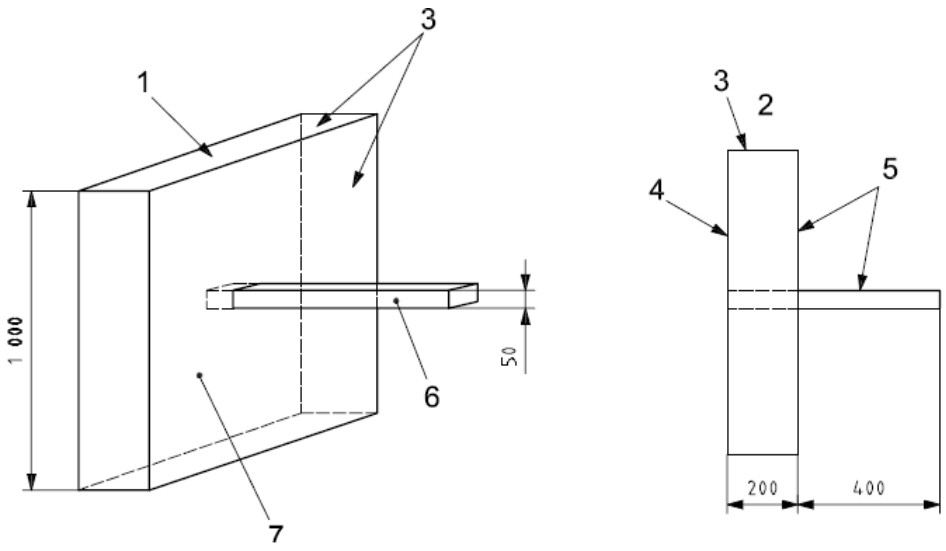


	standard	TRISCO
temperatures [°C]		
V	11.32	11.33
Y	11.11	11.12
heat flows [W]		
to outdoors	59.98	60.05
from indoors up	13.89	13.91
from indoors down	46.09	46.14

Figure 6. Results obtained by TRISCO compared to the standard results

Figure 6 shows the results obtained by TRISCO using a grid with 130926 nodes. The difference between the simulated and standard temperatures in the points V and Y is less than 0.1 °C. The difference between the simulated and standards heat flows is less than 1 %.

TRISCO data validation_10211_case4.trc
SOLIDO data validation_10211_case4_sld.sld



Heat flow	0,540 W
Lowest surface temperature on the external side	0,805 °C

Figure 7. Test reference case 4 as listed in ISO 10211:2017(E)

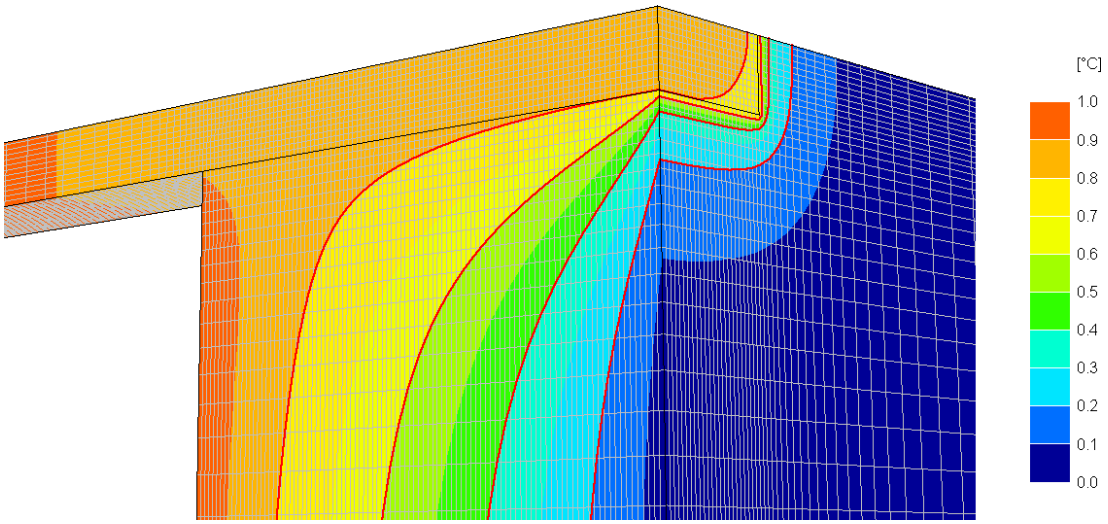


Figure 8. Results obtained by TRISCO (isotherms in part of the object)

Because of symmetry only a quarter of the object was considered in TRISCO. Figure 8 shows the results obtained using a grid with 259784 nodes. The heat flow is 0.1341 W for the quarter object or 0.540 W for the total object, which is exactly the heat flow listed in the standard.
The highest temperature on the external surface is 0.802 °C, which is within the range of 0.005 °C of the standard value (0.805 °C).

Conclusion

According to the standard ISO 10211, TRISCO (and SOLIDO) can be classified as a three-dimensional steady-state high precision method.