TPLV101 - Steady thermal with condition of exchange between walls in opposite

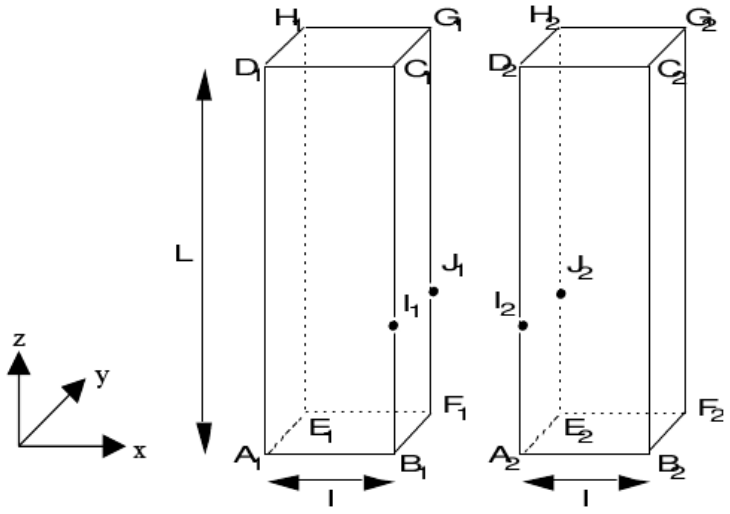
Abstract:

This elementary test makes it possible to deal with a steady problem in thermal bringing into play two fields separated by imposing a boundary condition of the type exchanges between walls.

For the modelizations presented here, the results got by *Code_Aster* are identical to the analytically calculated reference.

1 Problem of reference

1.1 Geometry



Height $L=3.m$
Width $l=1.m$

1.2 Material properties

voluminal Heat $\rho C_P=0.$
thermal Conductivity $k=1.\mathrm{W}/m°C$

1.3 Boundary conditions and loadings

outgoing Flux through the plane $B_1F_1G_1C_1$ identical to flux entering through the Temperature $A_2E_2H_2D_2$	
plane imposed in A_1	$T=0.°C$
Temperature imposed out of B_2	$T=4.5°C$
normal Flux imposed on normal $B_2F_2G_2C_2$	$\varphi=3.\mathrm{W}/m^2$
the Flux plane imposed on the planes $C_1G_1H_1D_1$ and $C_2G_2H_2D_2$	$\varphi=6.\mathrm{W}/m^2$
normal Flux imposed on the planes $E_1F_1G_1H_1$ and $E_2F_2G_2H_2$	$\varphi=2.\mathrm{W}/m^2$
Source imposed field 1	s_1
Source imposed field 2	s_2

2 Reference solution

2.1 Method of calculating used for the reference solution

One has a simple analytical solution, since it is a question of displaying a harmonic function and of adjusting the source associated in each field:

- in field 1: $T(x,y,z)=T(A_1)+x^2+y^2+z^2$, (in the reference of origin A_1),
- in field 2: $T(x,y,z)=T(A_2)+\frac{1}{2}x^2+y^2+z^2$, (in the reference of origin A_2).

One from of deduced the values from s_1 and s_2 $s_1=-6.$ $s_2=-5.\mathrm{W}/m^3$.

2.2 Results of reference

Temperatures to the points of the planes $B_1F_1G_1C_1$ and $A_2E_2H_2D_2$

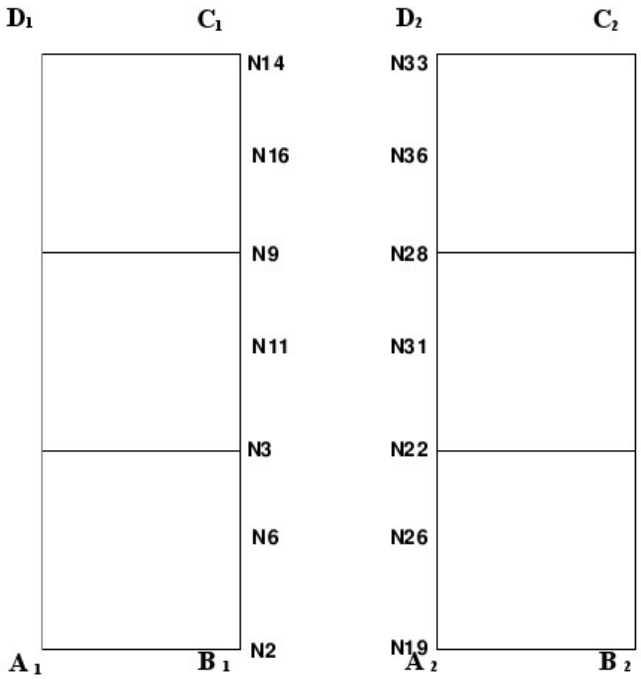
2.3 Uncertainty on the analytical

solution Solution.

3 Modelization A

3.1 Characteristic of the modelization

Modelization 2D:



3.2 Boundary conditions and loadings

outgoing Flux through the wall B_1C_1 identical to flux entering through the wall A_2D_2	
Temperature imposed in A_1	$T=0.°C$
Temperature imposed out of B_2	$T=4.5°C$
normal Flux imposed on the wall B_2C_2	$\varphi=3.\mathrm{W}/m^2$
normal Flux imposed on the planes C_1D_1 and C_2D_2	$\varphi=6.\mathrm{W}/m^2$
Source imposed field 1	s_1
Source imposed the field 2	s_2

3.3 Characteristics of the mesh

6 QUAD8
36 nodes

3.4 Values tested

Identification Temperature	Reference
node $N2$ (B_1)	1.00
node $N3$	2.00
node $N6$	1.25
node $N11$	3.25

node $N9$	5.00
node $N16$	7.25
node $N14$ (C_1)	10.00
node $N19$ (A_2)	2.00
node $N22$	3.00
node $N26$	2.25
node $N31$	4.25
node $N28$	6.00
node $N36$	8.25
node $N33$ (D_2)	11.00

3.5 Remarks

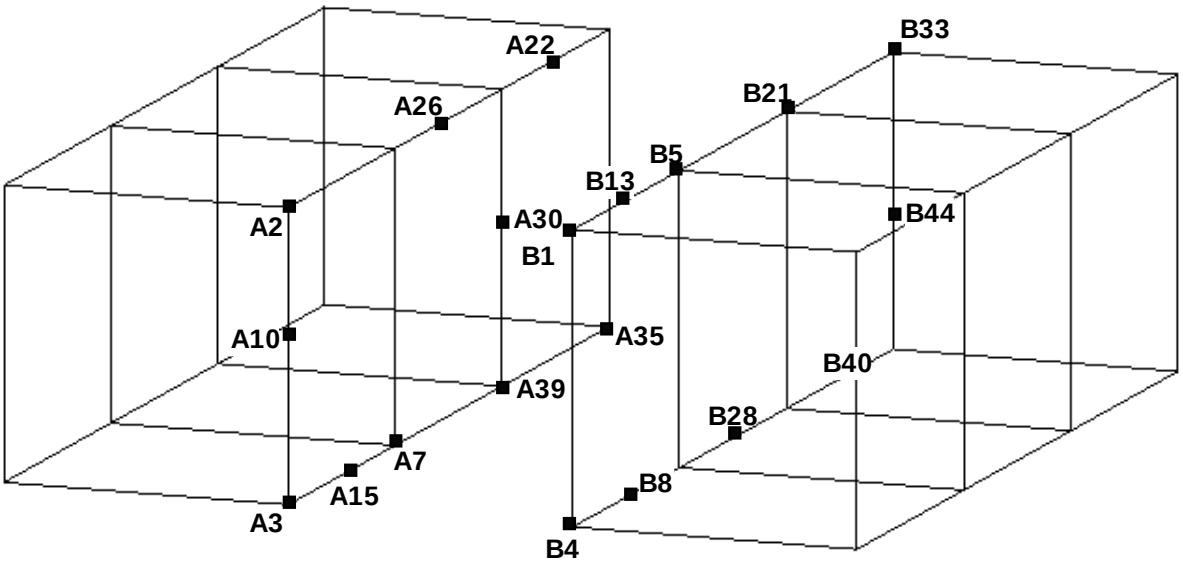
the shape functions of element QUAD8 being of order 2, it is natural to obtain the reference solution whichexpress in the form of a polynomial of order 2.

The command file deposited contains a list of times and calls command THER_LINEAIRE to carry out a transient computation which is not of interest, the coefficient of voluminal heat being taken equal to 0.

4 Modelization B

4.1 Characteristic of the modelization

Modelization 3D:



4.2 Characteristics of the mesh

6 HEXA20
88 nodes

4.3 Values tested

Identification Temperature	Reference
node $A2$ (B_1)	1.00
node $A3$ (F_1)	2.00
node $A7$	3.00
node $A10$	1.25
node $A15$	2.25
node $A22$	5.00
node $A26$	3.25
node $A30$	5.25
node $A35$ (G_1)	11.00
node $A39$	8.25
node $B1$ (A_2)	2.00
node $B4$ (E_2)	3.00
node $B5$	3.00
node $B8$	4.00

node $B13$	2.25
node $B21$	6.00
node $B28$	5.25
node $B33$ (D_2)	11.00
node $B40$	9.25
node $B44$	11.25

4.4 Remarks

the shape functions of element HEXA20 being of order 2, it are natural to obtain the reference solution which is expressed in the form of a polynomial of order 2.

The command file deposited contains a list of times and calls command THER_LINEAIRE to carry out a transient computation which is not of interest, the coefficient of voluminal heat being taken equal to 0.

5 Modelization C

5.1 Characteristic of the modelization

The modelization is the same one as that of modelization A.

5.2 Conditions aux limites and loadings

outgoing Flux through the wall B_1C_1 identical to flux entering through the wall A_2D_2	
Temperature imposed in A_1	$T=0.°C$
Temperature imposed out of B_2	$T=4.5°C$
normal Flux imposed on the wall B_2C_2	$\varphi=3.\mathrm{W}/m^2$
normal Flux imposed on the planes C_1D_1 and C_2D_2	$\varphi=6.\mathrm{W}/m^2$
Source imposed field 1	s_1
Source imposed the field 2	s_2

5.3 Characteristics of the mesh

6 QUAD8
36 nodes

5.4 Values tested

Identification	Reference
Temperature	
node N2 (B1)	1.00
node N3	2.00
N6 node	1.25
node N11	3.25
node N9	5.00
node N16	7.25
node N14 (C1)	10.00
node N19 (A2)	2.00
node N22	3.00
N26 node	2.25
node N31	4.25
N28 node	6.00
node N36	8.25
node N33 (D2)	11.00

6 Summaries of the results

the two modelizations with elements of order 2 lead in an exact way to the analytical solution and validates the establishment of the boundary conditions of the type ECHANGE_PAROI.