# TPLL100 - Anisotropic wall plan in thermics stationary

**Summary:**

The purpose of this test which relates to it thermal linear stationary and transitory is to validate the Cartesian anisotropy.

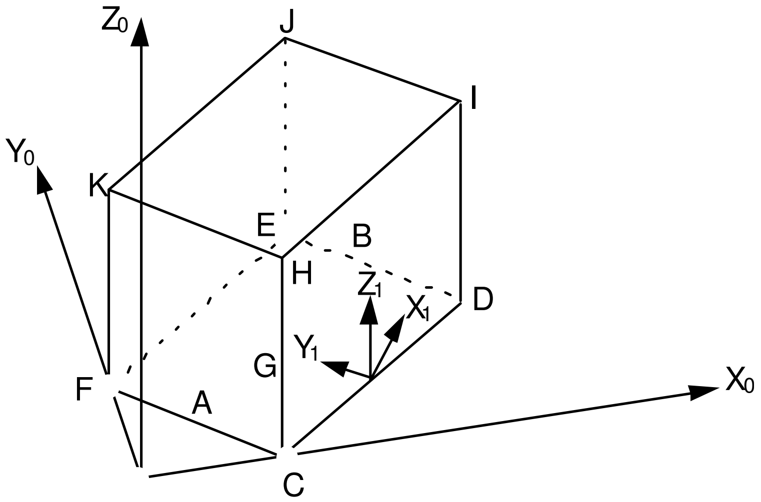
Two modelings are carried out:

- a first into voluminal,
- a second in plan.

The got results are in perfect agreement with the analytical values.

# 1 Problem of reference

## 1.1 Geometry




In the reference mark $(X_{0,} Y_{0,} Z_0)$ , the points have as coordinates:

$C(0.03;0\ ;0)$ $D(0.07;0.03;0)$ $E(0.04;0.07;0)$
$F(0\ ;0.04;0)$ $A(0.015;0.02;0)$ $B(0.055;0.05;0)$
$G(0.035;0.035;0)$

$$FK=CH=DI=EJ=0.05\,.Z_0$$

$$(CD, X_1)=\frac{\pi}{4} rad\ Z_0 // Z_1$$

## 1.2 Material properties

Anisotropic material, direction privileged along the axes of the reference mark $(X_{1,} Y_{1,} Z_1)$ :

$\lambda_X=1\,W/m°C$ $\lambda_Y=0.5\,W/m°C$ $\lambda_L=2\,W/m°C$
$\rho\,C_P=2\,J/m^3\,°C$

## 1.3 Boundary conditions and loadings

face $FEJK$ : Outgoing flow of $400\ W/m^2$ .

face $CDIH$ : Flow entering of $400\ W/m^2$ .

face $EDIJ$ : Outgoing flow of $1200\ W/m2$ .

face $FCHK$ : Imposed temperature $100\,°C$ .

Others faces: condition of Neumann.

## 1.4 Initial conditions

To do this stationary calculation, a transitory calculation is done for which the boundary conditions are constant in time. This makes it possible to test elementary calculations of mass and rigidity intervening in the first member as well as the second member.

# 2 Reference solution

## 2.1 Method of calculating used for the reference solution

Analytical solution.
Temperature varying linearly according to $CD$

Isotherms parallel with the faces $CHKF$ and $DIJE$ .

In the reference mark: $\left(\frac{CD}{\|CD\|},\frac{CH}{\|CH\|},\frac{CF}{\|CF\|},\right)$, one a:

$$\begin{bmatrix}\varphi_x\\ \varphi_y\\ \varphi_z\end{bmatrix}=\begin{bmatrix}-(\lambda_X\cos^2\alpha+\lambda_Y\sin^2\alpha)\frac{\partial T}{\partial x}\\ -(\lambda_X-\lambda_Y)\cos\alpha\sin\alpha\frac{\partial T}{\partial x}\\ 0\end{bmatrix}$$

with:

$$\varphi_x=1200\quad \varphi_y=400\quad \alpha=(X_{1,}CD)\quad T(x)=\frac{-\varphi_x}{\lambda_{X_1}\cos^2\alpha+\lambda_Y\sin^2\alpha}x+T(A)$$

that is to say: $T(x)=-1600.\mathrm{x}+20.$

If $\beta=(CD,X_0)$ : $\begin{matrix}\varphi.X_0=\cos\beta.\varphi_X-\sin\beta\,\varphi_y & \text{soit } 720\\ \varphi.Y_0=\sin\beta.\varphi_X+\cos\beta\,\varphi_L & \text{soit } 720\end{matrix}$

## 2.2 Results of reference

Temperature at the points $A, B, G$ .

Flow following the directions $X_0$ and $Y_0$ .

$$T(A)=100\quad T(B)=20\quad T(G)=60\quad \Phi.X_0=720\quad \Phi.Y_0=1040$$

## 2.3 Bibliographical references

1) NR. RICHARD: Technical note HM-18/94/0011, "Development of the thermal anisotropy in the software *Aster*".

# 3 Modeling A

## 3.1 Characteristics of modeling

$\theta$ diagram in time, forced on 1 to test the calculation of the second member.
4 elements 3D, HEXA8.

## 3.2 Characteristics of the grid

4 Hexa 8.

## 3.3 Values tested

| Identification | Reference |
|---|---|
| $T(A)$ $N7$ * | 100° |
| $T(B)$ $N2$ | 20°C |
| $T(G)$ $N13$ | 60°C |
| $\varphi . X_0$ | 720 |
| $\varphi . Y_0$ | 1040 |

*: imposed temperature

## 3.4 Remarks

The analytical solution being of order 1 and the field represented by the discretization, the code finds, with the errors rounding close, this solution.

# 4 Modeling B

## 4.1 Characteristics of modeling

Similar to the modeling A, but solved in 2D in the plan $CDEF$ .

## 4.2 Characteristics of the grid

4 QUAD 4.

## 4.3 Values tested

| Identification | Reference |
|---|---|
| $T(A)$ $N5$ * | 100° |
| $T(B)$ $N2$ | 20°C |
| $T(G)$ $N8$ | 60°C |
| $\varphi.X_0$ | 720 |
| $\varphi.Y_0$ | 1040 |

*: imposed temperature

## 4.4 Remarks

The analytical solution being of order 1 and the field represented by the discretization, the code finds, with the errors rounding close, this solution.

# 5 Summary of the results

The keyword ANGL_REP introduced into the order AFFE_CARA_ELEM is thus tested in 3D and 2D plan on an anisotropic problem of thermics.