TPLV103 - Infinite cylinder in stationary thermics anisotropic

Summary:

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

Two modelings are carried out:

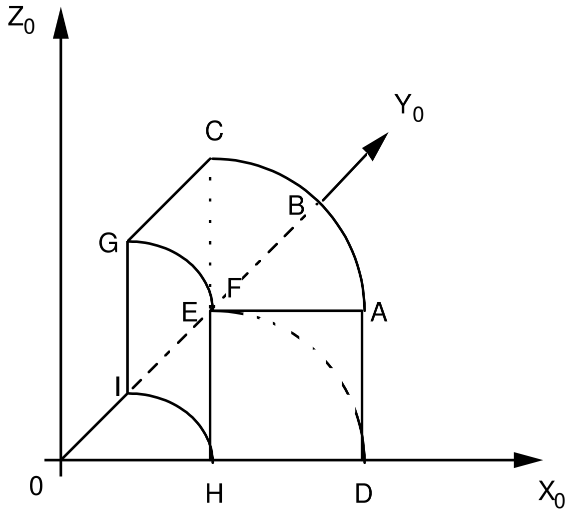
- a first into voluminal,
- a second in 2D plan.

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

1 Problem of reference

1.1 Geometry

1/4 de cylindre



In the reference mark (X_0, Y_0, Z_0), the points have as coordinates:

$C(0;2;1)$	$D(2;0;0)$	$E(0;2;0)$	$F(1;0;1)$	$O(0;0;0)$
$A(2;0;1)$	$B(\sqrt{2};\sqrt{2};1)$	$G(0;1;1)$	$H(1;0;0)$	$I(0;1;0)$

1.2 Material properties

Anisotropic material, direction privileged along the axes of the cylindrical reference mark (u_r, u_θ, u_z)

$$\lambda_r=1. \quad \lambda_\theta=0.5 \quad \lambda_z=3. W/m\,°C \quad \rho C_P=2 J/m^3\,°C$$

1.3 Boundary conditions and loadings

face $AFHD$:	Temperature imposed on $100\,°C$
face $CGIE$:	Temperature with $0\,°C$
others faces:	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 1er member as well as the 2ème.

2 Reference solution

2.1 Method of calculating used for the reference solution

Analytical solution.

Temperature varying linearly in θ.

in (r,θ,z)

$$T(\theta)=[T(C)-T(A)].\frac{2}{\pi}.\theta+T(A)$$

$$\phi(A).Y=-\lambda_{¿}\theta.\frac{1}{r}.\frac{\partial T}{\partial\theta}=-\lambda_{\theta}.\frac{1}{r(A)}[T(C)-T(A)].\frac{2}{\pi}$$

2.2 Results of reference

Temperatures at the points A and B, following flow Y at the point A.

$$T(A)=100.\quad T(B)=50.\quad \phi(A).Y=\frac{100.}{2\pi}\approx 15.915$$

2.3 Uncertainty on the solution

Analytical solution.

2.4 Bibliographical references

- NR. RICHARD: “Development of the thermal anisotropy in the software *Aster*“, Technical HM-18/94/0011 Notes.

3 Modeling A

3.1 Characteristics of modeling

θ diagram in time imposed on 1 to test the calculation of the second member in transient.

3.2 Characteristics of the grid

Regulated in 250 HEXA8 (5 elements on the edges HD and DM, 10 elements on DF) by IDEAS.

3.3 Values tested

Identification	Reference
T (A) * N1	100
T (B) N133	50
$\phi(A).Y$	15.9155

*: imposed temperature

3.4 Remarks

The symmetry of the grid makes that the solution T with the nodes of the grid is exact, but in the elements, the extrapolated solution is not exact.

Flow is calculated by *Aster* at the points of integration of the elements then deferred to the nodes by extrapolation. As flow is not uniform, this extrapolation involves a difference between calculation and reference.

4 Modeling B

4.1 Characteristics of modeling

Similar to the modeling A, but solved in the plan $HIED$.

4.2 Characteristics of the grid

Grid IDEAS with 50 QUAD4 and 66 nodes.

4.3 Values tested

Identification	Reference
$T(A)$ * $N6$	100
$T(B)$ $N36$	50
$\phi(A).Y$	15.9155

*: imposed temperature

4.4 Remarks

The symmetry of the grid makes that the solution T with the nodes of the grid is exact. But in the elements, the extrapolated solution is not exact.

Flow is calculated by *Aster* at the points of integration of the elements then deferred to the nodes by extrapolation. As flow is not uniform, this extrapolation involves a difference between calculation and reference.

5 Summary of the results

Keywords ANGL_AXE and ORIG_AXE introduced into the order AFFE_CARA_ELEM are tested in 3D and 2D plan for an anisotropic problem of thermics.