TPLV103 - Infinite cylinder in anisotropic steady thermal

Summarized:

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

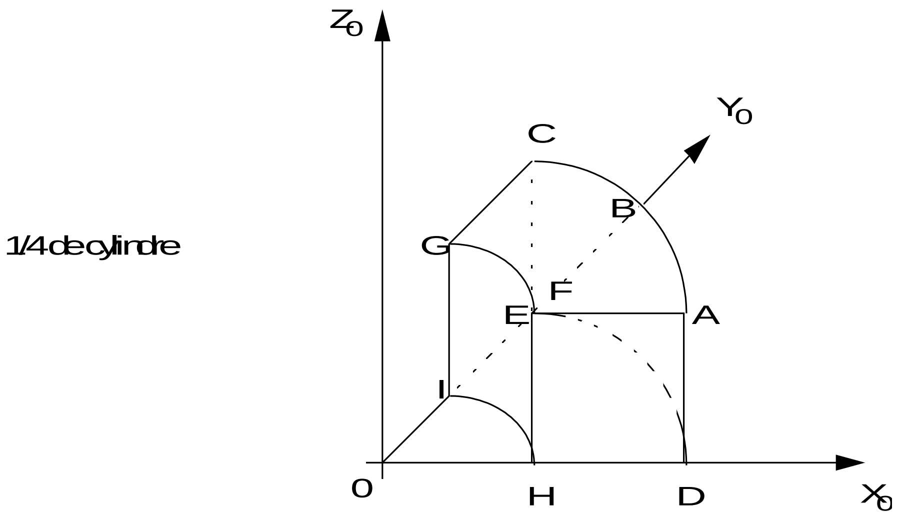
Two modelizations are carried out:

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

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

1 Problem of reference

1.1 Geometry



In the reference (X0, Y0, Z0), 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 coordinate system (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 $0\,°C$
other sides:	Neumann

1.4 Initial conditions

to do this steady calculation, one does a transient computation for which the boundary conditions are constant in time. This makes it possible to test elementary computations of mass and stiffness intervening in the 1st member as well as 2nd.

2 Reference solution

2.1 Method of calculating used for the analytical reference solution

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 to the points A and B , flux following Y to 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 analytical

solution Solution.

2.4 Bibliographical references

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

3 Modelization A

3.1 Characteristic of the modelization

θ of the time scheme forced on 1 to test the computation of the second member out of transient.

3.2 Characteristics of the structured mesh

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 mesh makes that the solution T with the nodes of the network is exact, but in the elements, the extrapolated solution is not exact.

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

4 Modelization B

4.1 Characteristic of the modelization

Similar to the modelization A, but solved in the plane $HIED$.

4.2 Characteristics of the mesh

Mesh 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 mesh makes that the solution T with the nodes of the network is exact. But in the elements, the extrapolated solution is not exact.

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

5 Summary of the results

key words ANGL_AXE and ORIG_AXE introduced into the command AFFE_CARA_ELEM are tested in 3D and 2D plane for an anisotropic problem of thermal.