TPLA01 - Infinite hollow roll in Summarized thermal

equilibrium:

Linear steady thermal.

Model axisymmetric; 3 modelizations.

Analytical solution.

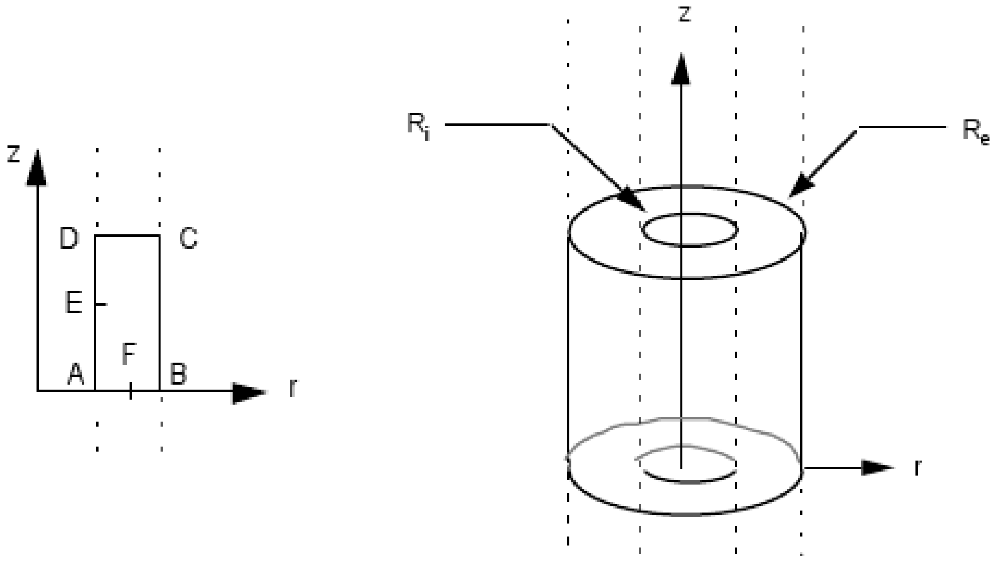
Interest of the test:

all axisymmetric elements: triangles and quadrangles, degrees 1 and 2,
varied boundary conditions: exchange, imposed temperature, imposed flux,
validation partial of the matrix of thermal “mass” because one makes “a false” transient.

The results are not affected by the distortion of meshes $h/l=40$.

1 Problem of reference

1.1 Geometry



interior Radius	$R_i=0.30\,m$
external Radius	$R_e=0.35\,m$
Point F	$r=0.32\,m$

1.2 Material properties

$\lambda=1\,W/m\,°C$

$\rho\,C_P=2\mathrm{J}/m^3\,°C$ (voluminal heat)

1.3 Boundary conditions and loadings

$[DC]\cup[AB]$:	$\Phi=0\,W/m^2$
$[EA]$:	$T=T_i=100\,°C$
$[ED]$:	$\Phi=\Phi_i=1729.9091\,W/m^2$ (returning flux)
$[CD]$: : exchange	$h=h_e=500\,W/m^2\,°C$
	$T=T_e=17.03444\,°C$

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 intervening in the first member as well as the second member.

2 Reference solution

2.1 Method of calculating used for the reference solution

$$T(r) = T_i + \Phi \log\left(\frac{r}{R_i}\right)$$

with:
$$\begin{cases} \Phi = \dfrac{T_e - Ti}{\log\left(\dfrac{R_e}{R_i}\right)} \\ \text{les flux } radiaux \left(\lambda \dfrac{\partial T}{\partial r}\right) \text{sur les parois du cylindre sont :} \\ \Phi_i = +\lambda . \dfrac{\Phi}{R_i} \\ \Phi_e = +\lambda . \dfrac{\Phi}{R_e} \end{cases}$$

T_i: Temperature in skin “interns”
T_e: Temperature in “external” skin

2.2 Results of reference

Temperatures and flux with the points $A \quad B \quad D \quad F$.

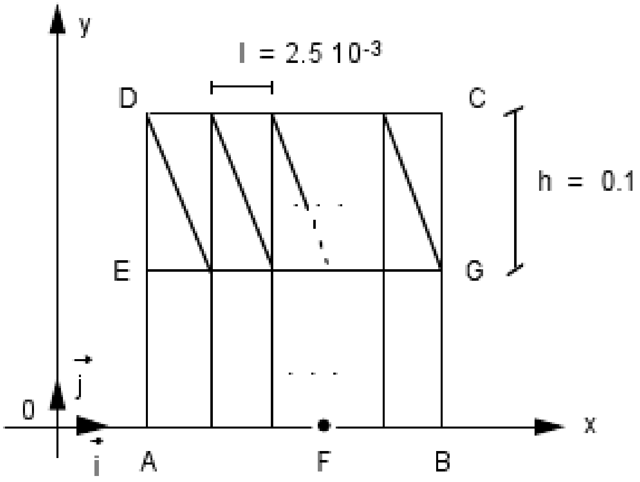
2.3 Uncertainty on the analytical

solution Solution.

3 Modelization A

3.1 Characteristic of the modelization

axis (TRIA3, QUAD4)



	x	y	
A	0.30	0.00	$N1$
B	0.35	0.00	$N41$
D	0.30	0.10	$N43$
E	0.30	0.05	$N2$
F	0.32	0.00	$N17$

3.2 Characteristics of the mesh

Many nodes: 63.

Number of meshes and types: 40 TRIA3, 20 QUAD4

3.3 Values tested

Identification	Reference
$T(A)$	100
$T(B)$	20
$T(F)$	66.506
$T(D)$	100
$\Phi(A)$	1729.91
$\Phi(B)$	1482.78
$\Phi(D)$	1729.91
$\Phi(F)$	1621.79

4 Modelization B

4.1 Characteristic of the modelization

axis (TRIA6, QUAD8)

	x	y	
A	0.30	0.00	$N180$
B	0.35	0.00	$N10$
D	0.30	0.10	$N178$
E	0.30	0.05	$N183$
F	0.32	0.00	$N112$

4.2 Characteristics of the mesh

Many nodes: 185.

Number of meshes and types: 40 TRIA6, 20 QUAD8

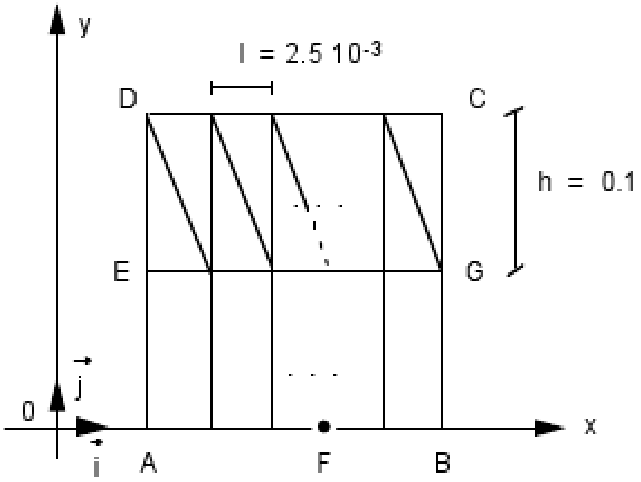
4.3 Values tested

Identification	Reference
$T(A)$	100
$T(B)$	20
$T(F)$	66.506
$T(D)$	100
$\Phi(A)$	1729.91
$\Phi(B)$	1482.78
$\Phi(D)$	1729.91
$\Phi(F)$	1621.79

5 Modelization C

5.1 Characteristic of the modelization

axis (TRIA6, QUAD9)



	x	y	
A	0.30	0.00	$N199$
B	0.35	0.00	$N10$
D	0.30	0.10	$N197$
E	0.30	0.05	$N203$
F	0.32	0.00	$N124$

5.2 Characteristics of the mesh

Many nodes: 205.

Number of meshes and types: 40 TRIA6, 20 QUAD9

5.3 Values tested

Identification	Reference
$T(A)$	100
$T(B)$	20
$T(F)$	66.506
$T(D)$	100
$\Phi(A)$	1729.91
$\Phi(B)$	1482.78
$\Phi(D)$	1729.91
$\Phi(F)$	1621.79

6 Summary of the results

This problem is correctly solved:

with different element types whatever the degree from interpolation,
is not affected by the shape of the elements $h/l=40$.