TPLA300 - Plate circular subjected to a voluminal heat source

Abstract:

This test is resulting from the validation independent of version 3 in linear steady thermal.

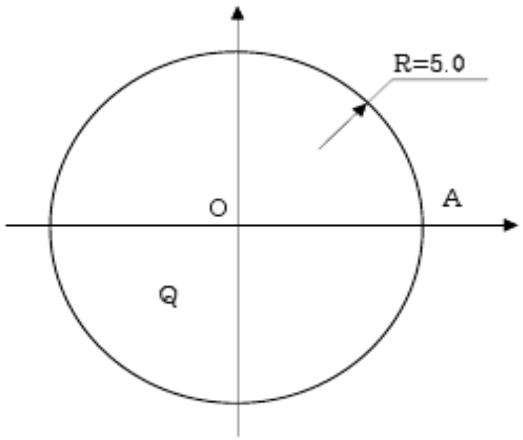
The interest of this case test 2D plane is to validate a thermal element under various boundary conditions (heat source, imposed temperature).

This case test understands two modelizations, one 2D axisymmetric, the other planes.

The results are compared with an analytical solution.

1 Problem of reference

1.1 Geometry



1.2 Properties of the thermal

$\lambda = 0.04\, W/m°C$ material Conductivity

1.3 Boundary conditions and loadings

- voluminal heat source $Q = 1\mathrm{W}/m^3$,
- temperature imposed on surface outside $(R=5)$: $T = 0°C$.

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the analytical reference solution

Solution:

$$T(r)=6.25(25-r^2)$$

2.2 Results of reference

Temperature for $r=0.,0.625,1.25,1.875,2.5,3.125,3.75,4.375,5.$

2.3 Uncertainty on the analytical

solution Solution.

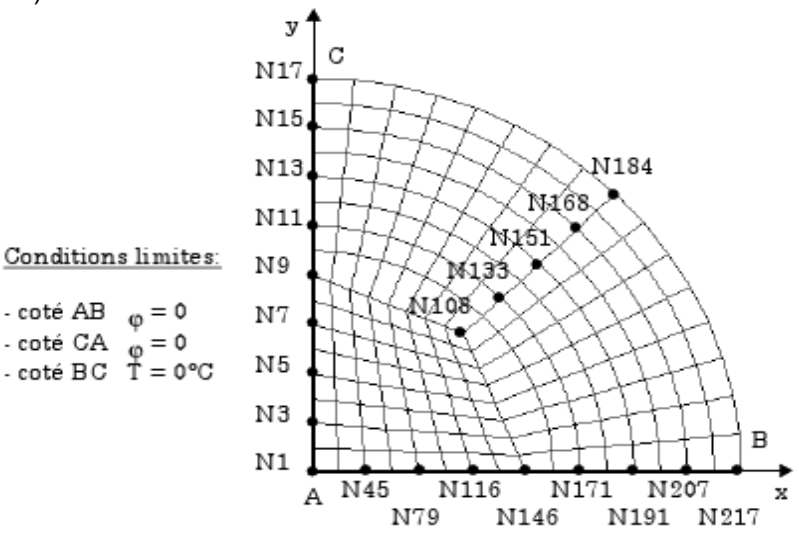
2.4 Bibliographical references

[1] W.K. Liu, T. Belytschko, “Efficient linear and nonlinear heat conduction with has quadrilateral element”, Int. J. num. Meth. Engng, flight 20, n°5, pp 931-948, 1984.

3 Modelization A

3.1 Characteristic of the modelization

PLANE (QUAD4)



3.2 Characteristic of the mesh

Many nodes: 217
Number of meshes and types: 192 QUAD4

3.3 Quantities tested and results

Identification	Reference	*Aster*	% difference	tolerance
temperatures $(°C)$				
R = 0.000 (N1)	156.25	156.07	-0.114	1%
R = 0.625 (N3)	153.81	153.63	-0.116	1%
R = 0.625 (N45)	153.81	153.63	-0.116	1%
R = 1.250 (N5)	146.48	146.31	-0.117	1%
R = 1.250 (N79)	146.48	146.31	-0.117	1%
R = 1.875 (N7)	134.28	134.10	-0.131	1%
R = 1.875 (N116)	134.28	134.10	-0.131	1%
R = 2.500 (N9)	117.19	116.98	-0.182	1%
R = 2.500 (N108)	117.19	116.82	-0.313	1%
R = 2.500 (N146)	117.19	116.98	-0.182	1%
R = 3.125 (N11)	95.21	95.04	-0.178	1%
R = 3.125 (N133)	95.21	95.00	-0.216	1%
R = 3.125 (N171)	95.21	95.04	-0.178	1%
R = 3.750 (N13)	68.36	68.23	-0.191	1%
R = 3.750 (N151)	68.36	68.21	-0.214	1%
R = 3.750 (N191)	68.36	68.23	-0.191	1%
R = 4.375 (N15)	36.62	36.55	-0.194	1%
R = 4.375 (N168)	36.62	36.54	-0.211	1%
R = 4.375 (N207)	36.62	36.55	-0.194	1%
R = 5.000 (N17)	0.00*	0.00	0.00	1%
R = 5.000 (N217)	0.00*	0.00	0.00	1%
R = 5.000 (N184)	0.00*	0.00	0.00	1%

* Condition limits

4 Summary of the results

Them got results are very satisfactory, the maximum change is of 0.313% .

Among the points of observation, the most important variation is noted with the N108 node which belongs to the element more deformed mesh.

The mesh used is that proposed in the reference. A radial mesh with the same cutting and the same ones meshes should give better results.

This test made it possible meshes to test the taking into account of a source term within the QUAD9 with a modelization AXIS (AFFE_CHAR_THER associated with key word SOURCE).