TPLP301 - Square plate with imposed temperature distributed sinusoïdalement

Summarized:

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

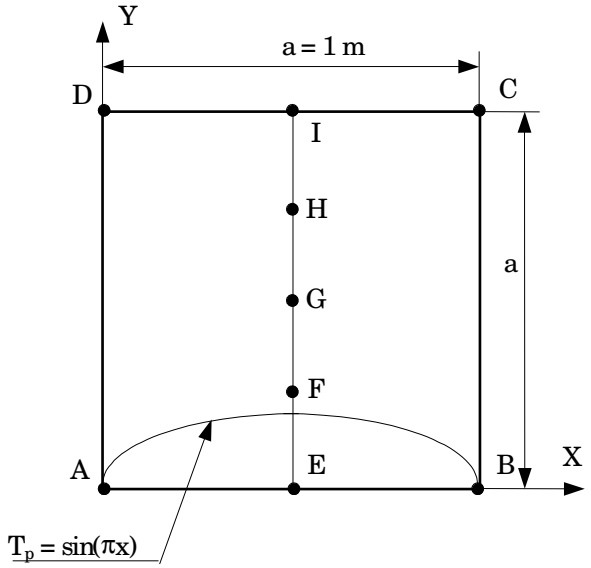
It is about a plane 2D problem represented by two modelizations, one planes, the second shell.

The features tested are the following ones:
- plane thermal element,
- thermal element shell,
- limiting conditions: sinusoidal distribution of the imposed temperature

the results are compared with an analytical solution.

1 Problem of reference

1.1 Geometry



Points	X	Y
E	0.5	0.00
F	0.5	0.25
G	0.5	0.50
H	0.5	0.75
I	0.5	1.00

1.2 Properties of the thermal

$\lambda = 1.\ W/m.\ °C$ material Conductivity

1.3 Boundary conditions and loadings

- side $[AB]$ imposed temperature $T_p = \sin(\pi x)$,
- side $[BC]$ imposed temperature $T_0 = 0°$,
- side $[CD]$ imposed temperature $T_0 = 0°$,
- side $[BA]$ imposed temperature $T_0 = 0°$.

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the analytical reference solution

Solution:

$$T(x, y) = \sinh[\pi(1.0 - y)]\sin(pix)/\sinh(\pi)$$

2.2 Results of reference

Temperature to the points E, F, G, H, I

2.3 Uncertainty on the analytical

solution Solution.

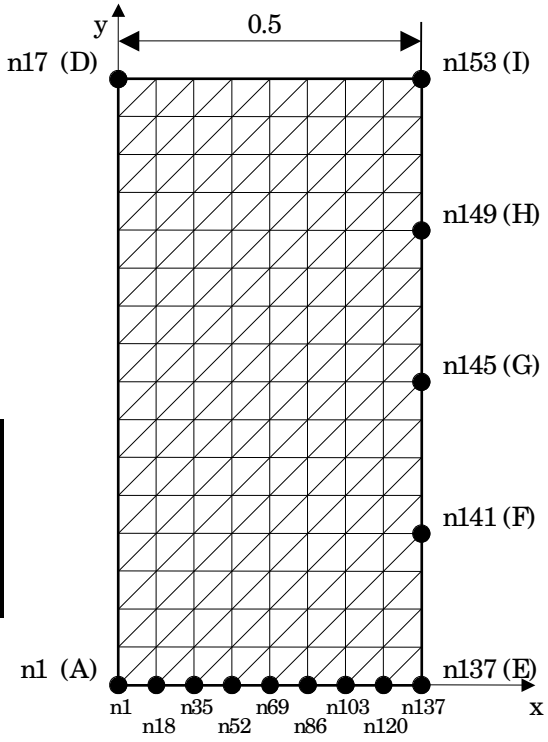
2.4 References

[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 modelization

COQUE (TRIA3)



Conditions limites:

- coté AE T= sin(πx)
- coté JD, DA T= 0°C
- coté EJ: φ= 0

Point	x	y	Noeud
E	0.5	0.	n137
F	0.5	0.25	n141
G	0.5	0.5	n145
H	0.5	0.75	n149
I	0.5	1.	n153

3.2 Characteristic of the mesh

Many nodes: 153
Number of meshes and types: 256 TRIA3

3.3 Remarks

the imposed temperature, distributed sinusoïdalement on AE , entered node by node.

The data of voluminal heat C_P is compulsory for *Code_Aster* (although without influence in this simulation). One takes $C_P = 1.J/m^3 °C$.

The limiting condition $\varphi = 0.$ is implicit on free edges.

3.4 Quantities tested and Standard

Identification				results of reference	Reference	tolerance
Temperature $(°C)$						
E	Node	$n137$	lower skin	ANALYTIQUE	1.0	1%
E	Node	$n137$	average skin	ANALYTIQUE	1.0	1%
E	Node	$n137$	higher skin	ANALYTIQUE	1.0	1%
F	Node	$n141$	lower skin	ANALYTIQUE	0.45269	1%

F	Node n141 average skin	ANALYTIQUE	0.45269	1%
F	Node n141 higher skin	ANALYTIQUE	0.45269	1%
G	Node n145 lower skin	ANALYTIQUE	0.19927	1%
G	The node is outside the field of definition with a right profile of the EXCLU type node: n145 average skin	ANALYTIQUE	0.19927	1%
G	The node is outside the field of definition with a right profile of the EXCLU type node: n145 higher skin	ANALYTIQUE	0.19927	1%
H	The node is outside the field of definition with a right profile of the EXCLU type node: n149 lower skin	ANALYTIQUE	0.07522	1%
H	The node is outside the field of definition with a right profile of the EXCLU type node: n149 average skin	ANALYTIQUE	0.07522	1%
H	The node is outside the field of definition with a right profile of the EXCLU type node: n149 higher skin	ANALYTIQUE	0.07522	1%
I	The node is outside the field of definition with a right profile of the EXCLU type node: n153 lower skin	ANALYTIQUE	0.0	1.E-4
I	The node is outside the field of definition with a right profile of the EXCLU type node: n153 average skin	ANALYTIQUE	0.0	1.E-4
I	The node is outside the field of definition with a right profile of the EXCLU type node: n153 higher skin	ANALYTIQUE	0.0	1.E-4

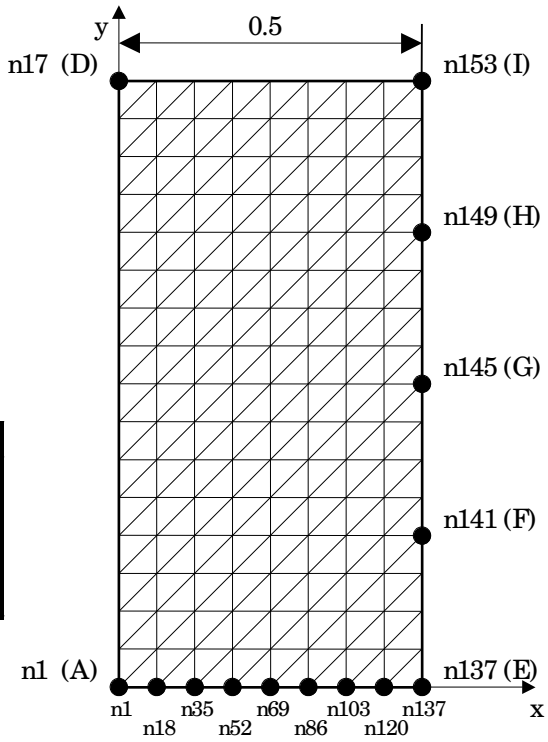
4 Modelization B

4.1 Characteristic of the modelization

PLANE (TRIA3)

Conditions limites:

- coté AE T= sin(πx)
- coté JD, DA T= 0°C
- coté EJ : φ = 0



Point	x	y	Noeud
E	0.5	0.	n137
F	0.5	0.25	n141
G	0.5	0.5	n145
H	0.5	0.75	n149
I	0.5	1.	n153

4.2 Characteristic of the mesh

Many nodes: 153
Number of meshes and types: 256 TRIA3

4.3 Remarks

the data of voluminal heat C_P is compulsory for *Code_Aster* (although without influence in this simulation). One takes $C_P = 1. J/m^3 °C$.

The limiting condition $\varphi = 0.$ is implicit on free edges.

4.4 Quantities tested and Standard

Identification	results of Reference	Reference	tolerance
Temperature $(°C)$			
E : Node $n137$	ANALYTIQUE	1.0	1%
F : Node $n141$	ANALYTIQUE	0.45269	1%
G : Node $n145$	ANALYTIQUE	0.19927	1%
H : Node $n149$	ANALYTIQUE	0.07522	1%
I : Node $n153$	ANALYTIQUE	0.0	1.E-4

5 Summary of the results

the 2 modelizations carried out, COQUE and PLANE with meshes TRIA3 give satisfactory results, the maximum change obtained is of 0.63% . The results found for the two modelizations are identical. The interest of this test is to compare the results got with an analytical solution.