TPLP301 - Square plate with imposed temperature distributed sinusoïdalement

Summary:

This test is resulting from the validation independent of version 3 in linear stationary thermics.

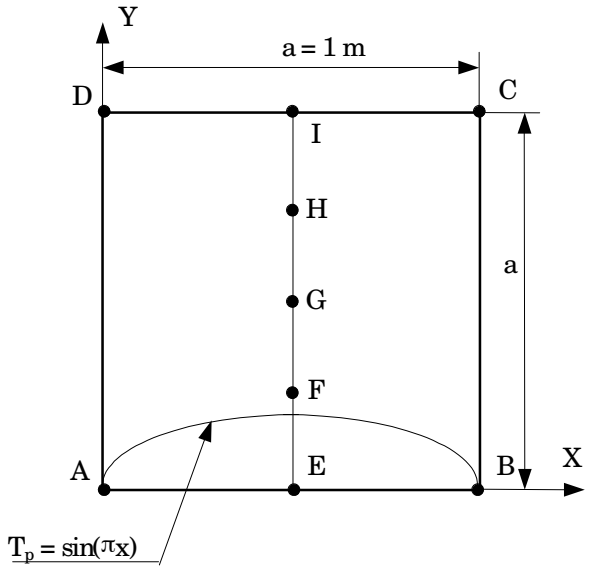
It is about a problem $2D$ plan represented by two modelings, one planes, the second hull.

The features tested are the following ones:
- thermal element plan,
- thermal element hull,
- 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 material

$\lambda = 1.\ W/m.°C$ Thermal 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 reference solution

Analytical solution:

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

2.2 Results of reference

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

2.3 Uncertainty on the solution

Analytical solution.

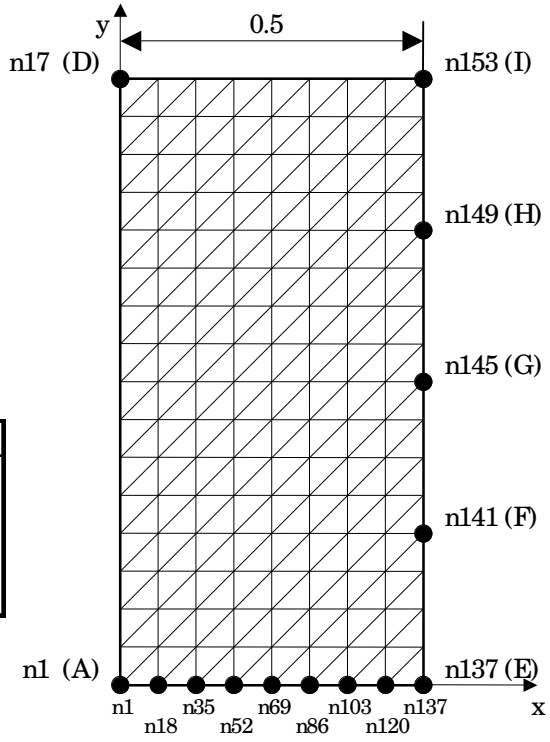
2.4 References

[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 Modeling A

3.1 Characteristics of modeling

HULL (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 Characteristics of the grid

Many nodes: 153
Many meshs and types: 256 TRIA3

3.3 Remarks

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

The data of voluminal heat C_P is obligatory 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 the free edges.

3.4 Sizes tested and results

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

F	Node	n141	average skin	ANALYTICAL	0.45269	1%
F	Node	n141	higher skin	ANALYTICAL	0.45269	1%
G	Node	n145	lower skin	ANALYTICAL	0.19927	1%
G	Node	n145	: average skin	ANALYTICAL	0.19927	1%
G	Node	n145	: higher skin	ANALYTICAL	0.19927	1%
H	Node	n149	: skin lower	ANALYTICAL	0.07522	1%
H	Node	n149	: average skin	ANALYTICAL	0.07522	1%
H	Node	n149	: higher skin	ANALYTICAL	0.07522	1%
I	Node	n153	: skin lower	ANALYTICAL	0.0	1.E-4
I	Node	n153	: average skin	ANALYTICAL	0.0	1.E-4
I	Node	n153	: higher skin	ANALYTICAL	0.0	1.E-4

4 Modeling B

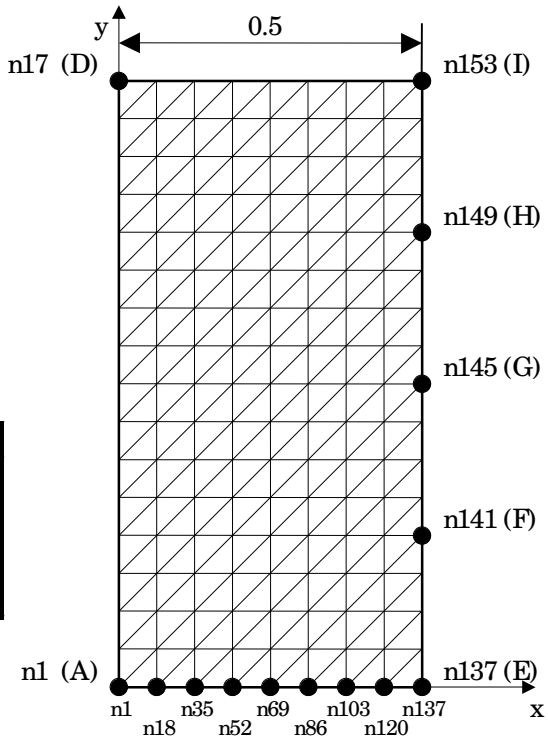
4.1 Characteristics of modeling

PLAN (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 Characteristics of the grid

Many nodes: 153
Many meshs and types: 256 TRIA3

4.3 Remarks

The data of voluminal heat C_P is obligatory 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 the free edges.

4.4 Sizes tested and results

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

5 Summary of the results

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