

TPLP301 - Square plate with imposed temperature distributed sinusoidalement

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.

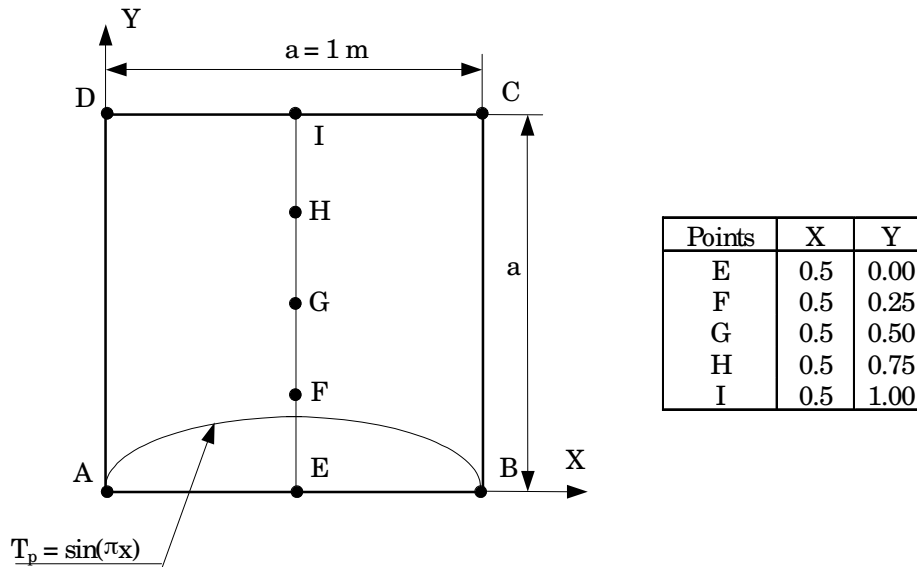
The features tested are the following ones:

- 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



1.2 Properties of material

$\lambda = 1. W / m . ^\circ C$ Thermal conductivity

1.3 Boundary conditions and loadings

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

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the reference solution

Analytical solution:

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

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

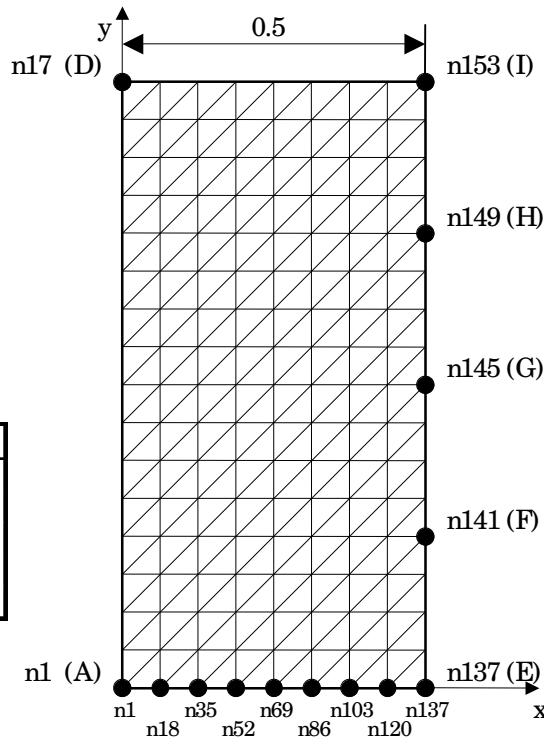
3.1 Characteristics of modeling

HULL (TRIA3)

Conditions limites:

- coté AE $T = \sin(\pi x)$
- coté JD, DA $T = 0^\circ\text{C}$
- coté EJ: $\phi = 0$

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 meshes and types: 256 TRIA3

3.3 Remarks

The imposed temperature, distributed sinusoidalement 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 $C_p = 1. J/m^3 \cdot ^\circ C$.

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

3.4 Sizes tested and results

	Identification	Type of reference	Reference	tolerance
Temperature	($^\circ C$)			
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%

Code_Aster

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

4 Modeling B

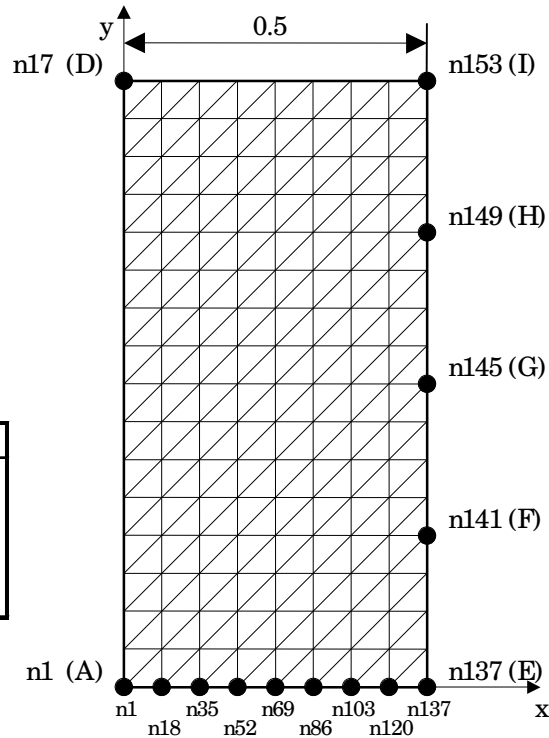
4.1 Characteristics of modeling

PLAN (TRIA3)

Conditions limites:

- coté AE $T = \sin(\pi x)$
- coté JD, DA $T = 0^\circ\text{C}$
- coté EJ: $\phi = 0$

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 meshes 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 $C_p = 1. J/m^3 \cdot ^\circ C$.

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

4.4 Sizes tested and results

Identification	Type of Reference	Reference	tolerance
Temperature ($^\circ C$)			
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

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5 Summary of the results

2 modelings carried out, HULL and PLAN with meshes 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.