

TPLS101 - Infinite plate subjected to a symmetric heat exchange with Summarized

outside:

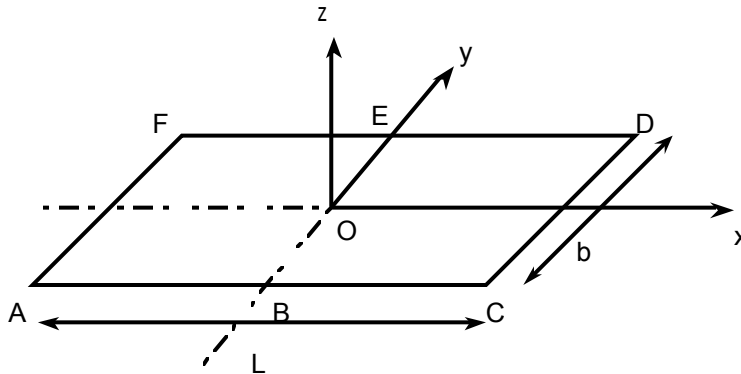
The purpose of this test is the model testing linear thermal shell at three fields per comparison with the analytical solution, for an infinite plate subjected to a couple of conditions of heat exchange with outside, symmetric compared to the average average. The equation of heat is solved in hover, with a linear, isotropic, homogeneous conduction.

The results are presented for the finite elements available of thermal surface shell triangles and quadrangles.

Compared to test TPLS100 [V4.03.100], this one makes it possible to check the contribution of the coefficients of heat exchange to the thermal stiffness, like various methods of assignment of the boundary conditions. Moreover, the solution is such as the temperature is uniform in the thickness.

1 Problem of reference

1.1 Geometry



Length: $L = 20\text{mm}$

Width: $b = 2\text{mm}$

Thickness: $h = 4\text{mm}$

1.2 Material properties

Conductivity $\lambda = 1000\text{ W/mm/}^\circ\text{C}$

1.3 Boundary conditions and loadings

- Temperature null at the point O , on all the thickness.
- On upper faces $(ABEF)^+$ and lower $(ABEF)^-$:
coefficient of heat exchange: $h = 10\text{ W/mm}^2/\text{ }^\circ\text{C}$
outside temperature: $T_{ext} = 50^\circ\text{C}$
- On the sides higher $(BCDE)^+$ and lower $(BCDE)^-$:
coefficient of heat exchange: $h = 10\text{ W/mm}^2/\text{ }^\circ\text{C}$
outside temperature: $T_{ext} = -50^\circ\text{C}$

2 Reference solution

2.1 Method of calculating used for the Analytical reference solution

For more details to refer to the document [R3.11.01] and the note [bib1].

2.2 Results of reference

Temperature in higher, lower skin and average average.

2.3 Uncertainty on the analytical

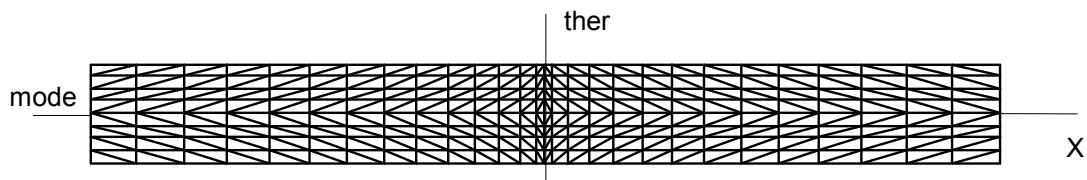
solution Solution.

2.4 Bibliographical references

- S. ANDRIEUX, F. VOLDOIRE HI-71/7131 - Formulation of a model of thermal for the thin shells (12/7/90).

3 Modelization A

3.1 Characteristic of the N201



Cutting: 28 elements in length,
8 elements in width.

Boundary conditions - loading (three computations for three choices):

- computation a: scalar loadings and dualisation of the condition of Dirichlet:

```
TEMP_IMPO (NOEUD= "N1", TEMP_SUP= 0. , TEMP_MIL= 0. , TEMP_INF= 0.)
ECHANGE (GROUP_MA = ' GRSD1', COEF_H_SUP: 10. , COEF_H_INF = 10. ,
          TEMP_EXT_SUP = -50. , TEMP_EXT_INF = -50.)
          (GROUP_MA = ' GRSD2', COEF_H_SUP = 10. , COEF_H_INF = 10. ,
          TEMP_EXT_SUP = 50. , TEMP_EXT_INF = 50.)
```

- computation b: loadings constant functions and dualisation of the condition of Dirichlet:
as above, but with constant functions having same values.
- computation C: scalar loadings and "kinematical" loading:

```
THER_IMPO (NOEUD= "N1", TEMP_SUP= 0. , TEMP_MIL= 0. , TEMP_INF= 0.)
```

3.2 Characteristics of the mesh

Many nodes: 969

Number of meshes and types: 448 meshes TRIA6

3.3 Values tested

	Identification	Reference
Node N201 (-10.,0.)	Temp_sup	49.999
	Temp_mil	49.999
	Temp_inf	49.999
Node N176 (-5.15,0.)	Temp_sup	49.9658
	Temp_mil	49.9658
	Temp_inf	49.9658
Node N171 (-4.32,0.)	Temp_sup	49.8888
	Temp_mil	49.8888
	Temp_inf	49.8888
Node N166 (-3.53,0.)	Temp_sup	49.6631
	Temp_mil	49.6631
	Temp_inf	49.6631
Node N161	Temp_sup	49.0542

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

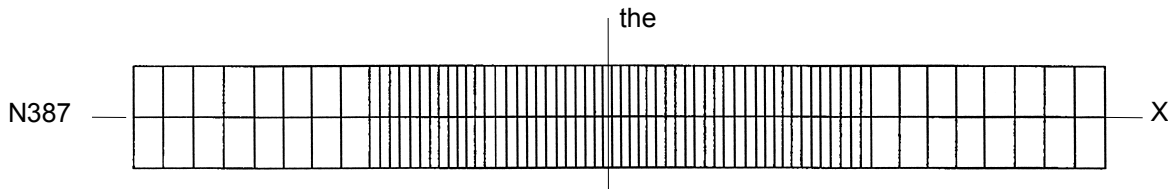
(-2.8,0.)	Temp_mil	49.0542
	Temp_inf	49.0542
Node N156	Temp_sup	47.556
(-2.13,0.)	Temp_mil	47.556
	Temp_inf	47.556
Node N141	Temp_sup	26.700
(-0.54,0.)	Temp_mil	26.700
	Temp_inf	26.700
Node N136	Temp_sup	11.830
(-0.19,0.)	Temp_mil	11.830
	Temp_inf	11.830
Temp_sup N11	Node	- 26.700
(0.54,0.)	Temp_mil	- 26.700
	Temp_inf	- 26.700
Temp_sup N26	Node	- 47.556
(2.13,0.)	Temp_mil	- 47.556
	Temp_inf	- 47.556

Contents of the file Temperatures

- results to the nodes of computation have,
- heat flux on the average average (computation a),
- values tested deferred above (computations has, B, c).

4 Modelization B

4.1 Characteristic of the modelization



Cutting: 68 elements in length,
2 elements in width.

Boundary conditions - loading (three computations for three choices):

- scalar loadings and dualisation of the condition of Dirichlet:

```
TEMP_IMPO (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT
PROFILE OF THE EXCLU TYPE NODE: N1,  TEMP_SUP: 0. , TEMP_MIL: 0. , TEMP_INF: 0.)
ECHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
          TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
          (GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
          TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)
```

- loadings constant functions and dualisation of the condition of Dirichlet:

as above, but with constant functions having same values.

- scalar loadings and "kinematical" loading:

```
THER_IMPO: (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT
PROFILE OF THE EXCLU TYPE NODE: N1,  TEMP_SUP: 0. , TEMP_MIL: 0. , TEMP_INF: 0.)
```

4.2 Characteristics of the mesh

Many nodes: 456

Number of meshes and types: 136 meshes QUAD4

4.3 Values tested

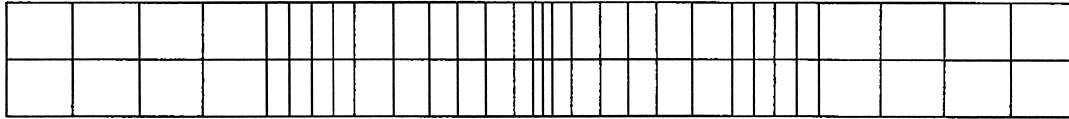
Identification		Reference
Node <i>N387</i> (-10.,0.)	Temp_sup	49.999
	Temp_mil	49.999
	Temp_inf	49.999
Node <i>N397</i> (-5.15,0.)	Temp_sup	49.9658
	Temp_mil	49.9658
	Temp_inf	49.9658
Node <i>N401</i> (-4.32,0.)	Temp_sup	49.8888
	Temp_mil	49.8888
	Temp_inf	49.8888
Node <i>N405</i> (-3.53,0.)	Temp_sup	49.6631
	Temp_mil	49.6631
	Temp_inf	49.6631
Node <i>N409</i>	Temp_sup	49.0542

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(-2.8,0.)	Temp_mil	49.0542
	Temp_inf	49.0542
Node N412	Temp_sup	47.556
(-2.13,0.)	Temp_mil	47.556
	Temp_inf	47.556
Node N420	Temp_sup	26.700
(-0.54,0.)	Temp_mil	26.700
	Temp_inf	26.700
Node N422	Temp_sup	11.830
(-0.19,0.)	Temp_mil	11.830
	Temp_inf	11.830
Temp_sup N426	Node	- 26.700
(0.54,0.)	Temp_mil	- 26.700
	Temp_inf	- 26.700
Temp_sup N434	Node	- 47.556
(2.13,0.)	Temp_mil	- 47.556
	Temp_inf	- 47.556

5 Modelization C

5.1 Characteristic of the modelization



Cutting: 30 elements in length,
2 elements in width.

Boundary conditions - loading (three computations for three choices):

- scalar loadings and dualisation of the condition of Dirichlet:

TEMP_IMPO (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT PROFILE OF THE EXCLU TYPE NODE: N1, TEMP_SUP: 0. , TEMP_MIL: 0. , TEMP_INF: 0.)
ECHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
(GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)

- loadings constant functions and dualisation of the condition of Dirichlet:

as above, but with constant functions having same values.

- scalar loadings and "kinematical" loading:

THER_IMPO: (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT PROFILE OF THE EXCLU TYPE NODE: N1, TEMP_SUP: 0. , TEMP_MIL: 0. , TEMP_INF: 0.)

5.2 Characteristics of the mesh

Many nodes: 410

Number of meshes and types: 60 meshes QUAD8

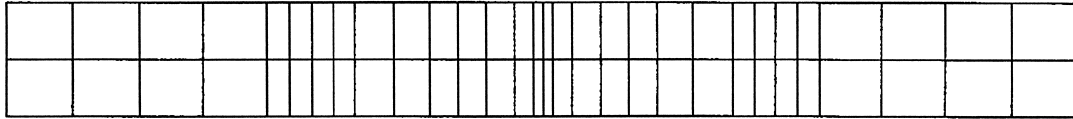
5.3 Values tested

	Identification	Reference
Node N227 (-10.,0.)	Temp_sup	49.999
	Temp_mil	49.999
	Temp_inf	49.999
Node N233 (-5.15,0.)	Temp_sup	49.9658
	Temp_mil	49.9658
	Temp_inf	49.9658
Node N235 (-4.32,0.)	Temp_sup	49.8888
	Temp_mil	49.8888
	Temp_inf	49.8888
Node N237 (-3.53,0.)	Temp_sup	49.6631
	Temp_mil	49.6631
	Temp_inf	49.6631

Node N238	Temp_sup	49.0542
(-2.8,0.)	Temp_mil	49.0542
	Temp_inf	49.0542
Node N239	Temp_sup	47.556
(-2.13,0.)	Temp_mil	47.556
	Temp_inf	47.556
Node N242	Temp_sup	26.700
(-0.54,0.)	Temp_mil	26.700
	Temp_inf	26.700
Node N243	Temp_sup	11.830
(-0.19,0.)	Temp_mil	11.830
	Temp_inf	11.830
Temp_sup N246	Node	-26.700
(0.54,0.)	Temp_mil	-26.700
	Temp_inf	-26.700
Temp_sup N249	Node	-47.556
(2.13,0.)	Temp_mil	-47.556
	Temp_inf	-47.556

6 Modelization D

6.1 Characteristic of the modelization



Cutting: 30 elements in length,
2 elements in width.

Boundary conditions - loading (three computations for three choices):

- scalar loadings and dualisation of the condition of Dirichlet:

TEMP_IMPO (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT PROFILE OF THE EXCLU TYPE NODE: N1, TEMP_SUP: 0. , TEMP_MIL: 0. , TEMP_INF: 0.)
ECHANGE: (GROUP_MA: GRSD1, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: -50. , TEMP_EXT_INF: -50.)
(GROUP_MA: GRSD2, COEF_H_SUP: 10. , COEF_H_INF: 10. ,
TEMP_EXT_SUP: 50. , TEMP_EXT_INF: 50.)

- loadings constant functions and dualisation of the condition of Dirichlet:

as above, but with constant functions having same values.

- scalar loadings and "kinematical" loading:

THER_IMPO: (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT PROFILE OF THE EXCLU TYPE NODE: N1, TEMP_SUP: 0. , TEMP_MIL: 0. , TEMP_INF: 0.)

6.2 Characteristics of the mesh

Many nodes: 470

Number of meshes and types: 60 meshes QUAD9

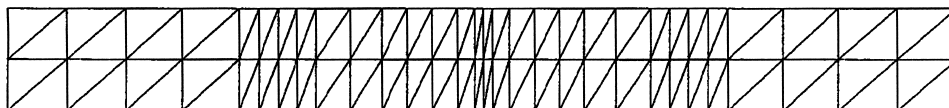
6.3 Values tested

Identification		Reference
Node N227 (- 10. , 0.)	Temp_sup	49.999
	Temp_mil	49.999
	Temp_inf	49.999
Node N233 (-5.15,0.)	Temp_sup	49.9658
	Temp_mil	49.9658
	Temp_inf	49.9658
Node N235 (-4.32,0.)	Temp_sup	49.8888
	Temp_mil	49.8888
	Temp_inf	49.8888
Node N237 (-3.53,0.)	Temp_sup	49.6631
	Temp_mil	49.6631
	Temp_inf	49.6631

Node N238	Temp_sup	49.0542
(-2.8,0.)	Temp_mil	49.0542
	Temp_inf	49.0542
Node N239	Temp_sup	47.556
(-2.13,0.)	Temp_mil	47.556
	Temp_inf	47.556
Node N242	Temp_sup	26.700
(-0.54,0.)	Temp_mil	26.700
	Temp_inf	26.700
Node N243	Temp_sup	11.830
(-0.19,0.)	Temp_mil	11.830
	Temp_inf	11.830
Temp_sup N246	Node	-26.700
(0.54,0.)	Temp_mil	-26.700
	Temp_inf	-26.700
Temp_sup N249	Node	-47.556
(2.13,0.)	Temp_mil	-47.556
	Temp_inf	-47.556

7 Modelization E

7.1 Characteristic of the modelization



Cutting: 30 elements in length,
2 elements in width.

Boundary conditions - loading (three computations for three choices):

- scalar loadings and dualisation of the condition of Dirichlet:

```
TEMP_IMPO (NOEUD = N1, TEMP_SUP = 0. , TEMP_MIL = 0. , TEMP_INF = 0.)
ECHANGE (GROUP_MA =GRSD1, COEF_H_SUP = 10. , COEF_H_INF = 10. ,
        TEMP_EXT_SUP = -50. , TEMP_EXT_INF = -50.)
        (GROUP_MA =GRSD2, COEF_H_SUP = 10. , COEF_H_INF = 10. ,
        TEMP_EXT_SUP = 50. , TEMP_EXT_INF = 50.)
```
- loadings constant functions and dualisation of the condition of Dirichlet:
as above, but with constant functions having same values.
- scalar loadings and "kinematical" loading:

OTHER_IMPO: (THE NODE IS OUTSIDE THE FIELD OF DEFINITION WITH A RIGHT
PROFILE OF THE EXCLU TYPE NODE: N1, TEMP_SUP: 0. , TEMP_MIL: 0. , TEMP_INF: 0.)

7.2 Characteristics of the mesh

Many nodes: 590

Number of meshes and types: 120 meshes TRIA7

7.3 Values tested

Identification	Reference
Node N227	Temp_sup 49.999
(-10.,0.)	Temp_mil 49.999
	Temp_inf 49.999
Node N233	Temp_sup 49.9658
(-5.15,0.)	Temp_mil 49.9658
	Temp_inf 49.9658
Node N235	Temp_sup 49.8888
(-4.32,0.)	Temp_mil 49.8888
	Temp_inf 49.8888
Node N237	Temp_sup 49.6631
(-3.53,0.)	Temp_mil 49.6631
	Temp_inf 49.6631
Node N238	Temp_sup 49.0542

(-2.8,0.)	Temp_mil	49.0542
	Temp_inf	49.0542
Node N239	Temp_sup	47.556
(-2.13,0.)	Temp_mil	47.556
	Temp_inf	47.556
Node N242	Temp_sup	26.700
(-0.54,0.)	Temp_mil	26.700
	Temp_inf	26.700
Node N243	Temp_sup	11.830
(-0.19,0.)	Temp_mil	11.830
	Temp_inf	11.830
Temp_sup N246	Node	- 26.700
(0.54,0.)	Temp_mil	- 26.700
	Temp_inf	- 26.700
Temp_sup N249	Node	- 47.556
(2.13,0.)	Temp_mil	- 47.556
	Temp_inf	- 47.556

8 Summary of the results

One note that the variations on the temperature are weak compared to the reference solution (lower than 0.41%).

Meshes the QUAD8 and QUAD9 give the same results.