TTLP300 - Heat transfer in a metal bar orthotropic

Abstract:

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

It is about a problem 2D plane represented by only one modelization (plane).

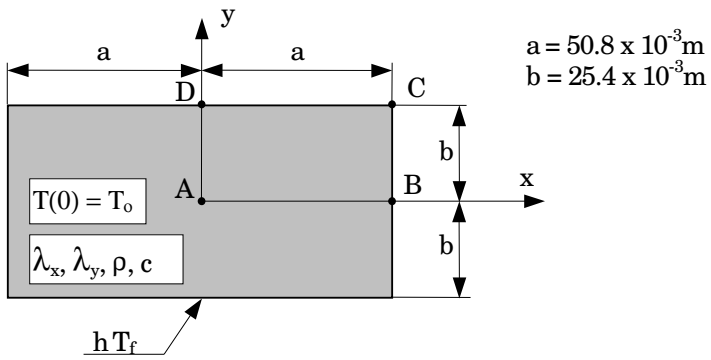
The features tested are the following ones:
- plane thermal element,
- orthotropic material,
- algorithm of transient thermal,
- limiting condition: convection.

The interest of the test lies in the taking into account of an orthotropic material.

The results are compared with a solution based on a graphic estimate.

1 Problem of reference

1.1 Geometry



1.2 Properties of the thermal

$\lambda_x = 34.614\, W/m°C$	material conductivity along the thermal x
$\lambda_y = 6.237\, W/m°C$	axis conductivity along the axis y
$C_P = 37.719\, J/kg.°C$	specific heat
$\rho = 6407.38\, kg/m^3$	density

1.3 Boundary conditions and loadings

Convection:

- $h = 1362.71\, W/m^2°C$
- $T_f = 37.78°C$.

1.4 Initial conditions

$T(x, y, t=0) = 260°C$

2 Reference solution

2.1 Method of calculating used for the reference solution

the original reference solution given in the book [bib1] is based on a graphic estimate. This reference is quoted in the handbook of checking of ANSYS [bib2]

2.2 Results of reference

Temperature to the points $A\,B\,C\,D$ at time $t=3\text{s}$

2.3 Uncertainty on the Unknown

solution, it was not possible to get the original reference (delivers old, more published).

2.4 Bibliographical references

- Schneider, P.J., “Conduction Heat Transfer”, Addison-Wesley Publishing Co., Inc. Reading, Farmhouse., 2nd Printing, 1957.
- ANSYS: “Checking manual”, 1 St edition, June 1,1976

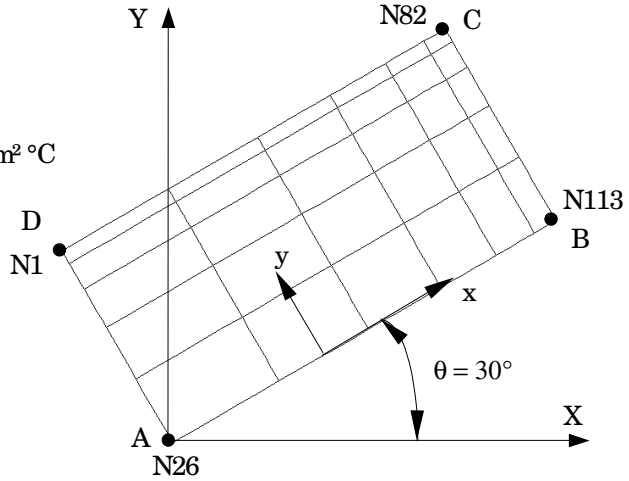
3 Modelization A

3.1 Characteristic of the modelization

PLANE (QUAD8)

Conditions limites:

- cotés AB et DA: $\varphi = 0$
- cotés BC et CD: $T_{ext} = 37.78$ °C
  $h = 1362.71$ w/m² °C



3.2 Characteristic of the mesh

Many nodes:	113
Number of meshes and types:	30 QUAD8

3.3 Remarks

the discretization in time step are the following one:

10 steps	for $[0., 1.D-4]$	either $\Delta t = 1.D-5$
9 steps	for $[1.D-4, 1.D-3]$	or $\Delta t = 1.D-4$
9 steps	for $[1.D-3, 1.D-2]$	or $\Delta t = 1.D-3$
9 steps	for $[1.D-2, 1.D-1]$	or $\Delta t = 1.D-2$
9 steps	for $[1.D-1, 1.D0]$	or $\Delta t = 1.D-1$
20 steps	for $[1.D0, 3.D0]$	or $\Delta t = 1.D-1$

4 Results of the modelization A

4.1 Values tested

Identification	Reference	*Aster*	% difference	Tolerance
urgent $t=3\ s$				
Items	$T(°C)$			
$A(N26)$	237.50	238.95	0.611	5%
$B(N113)$	137.22	140.71	2.541	5%
$C(N82)$	65.98	66.19	0.318	5%
$D(N1)$	94.44	93.30	1.206	5%

5 Summary of the results

the got results are satisfactory, the maximum change is of 2.5% lower than the tolerance fixed initially (5%) (the reference solution is obtained graphically).

This test made it possible to test out of linear transient, modelization PLANE, the commands:

- DEFI_MATERIAU associated with key word THER_ORTH, allowing to define the characteristics of an orthotropic material,
- AFFE_CARA_ELEM associated with key word MASSIF, allowing to define the axes of orthotropy.