# TTLP300 - Heat transfer in an orthotropic metal bar

**Summary:**

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

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

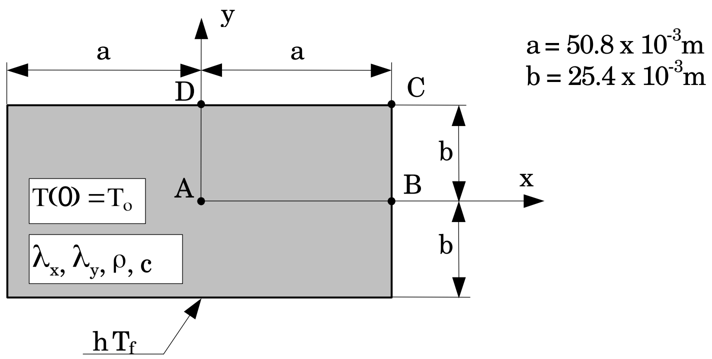
The features tested are the following ones:
- thermal element plan,
- orthotropic material,
- transitory algorithm of thermics,
- limiting condition: convection.

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 material

| | |
|---|---|
| $\lambda_x = 34.614\ W/m\,°C$ | thermal conductivity along the axis $x$ |
| $\lambda_y = 6.237\ W/m\,°C$ | thermal 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 at the points $A\,B\,C\,D$ at the moment $t=3\mathrm{s}$

## 2.3 Uncertainty on the solution

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

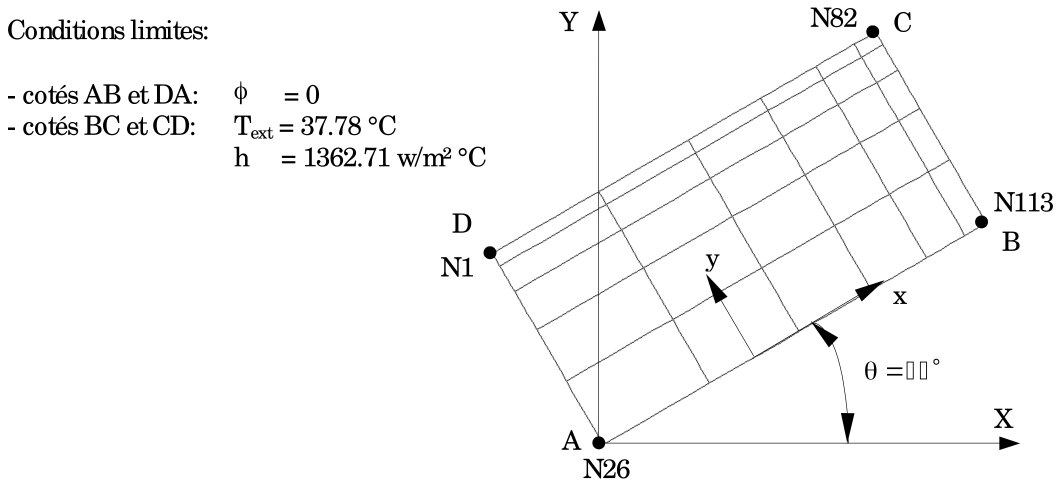
## 2.4 Bibliographical references


- 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 Modeling A

## 3.1 Characteristics of modeling

PLAN (QUAD8)




## 3.2 Characteristics of the grid

| | |
|---|---|
| Many nodes: | 113 |
| Many meshs and types: | 30 QUAD8 |

## 3.3 Remarks

The discretization in step of time is the following one:

| | | |
|---|---|---|
| 10 pas | for $[0., 1.D-4]$ | that is to say $\Delta t = 1.D-5$ |
| 9 pas | for $[1.D-4, 1.D-3]$ | that is to say $\Delta t = 1.D-4$ |
| 9 pas | for $[1.D-3, 1.D-2]$ | that is to say $\Delta t = 1.D-3$ |
| 9 pas | for $[1.D-2, 1.D-1]$ | that is to say $\Delta t = 1.D-2$ |
| 9 pas | for $[1.D-1, 1.D0]$ | that is to say $\Delta t = 1.D-1$ |
| 20 pas | for $[1.D0, 3.D0]$ | that is to say $\Delta t = 1.D-1$ |

# 4 Results of modeling A

## 4.1 Values tested

| Identification | Reference | *Aster* | % difference | Tolerance |
|---|---|---|---|---|
| moment $t=3\,s$ | | | | |
| | | | | |
| Points | $T(°C)$ | | | |
| $A(N26)$ | 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 in linear transient, modeling PLAN, the orders:

- DEFI_MATERIAU associated with the keyword THER_ORTH, allowing to define the characteristics of an orthotropic material,
- AFFE_CARA_ELEM associated with the keyword SOLID MASS, allowing to define the axes of orthotropism.