TPLP01 - Field in L with geometrical singularity

Abstract:

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

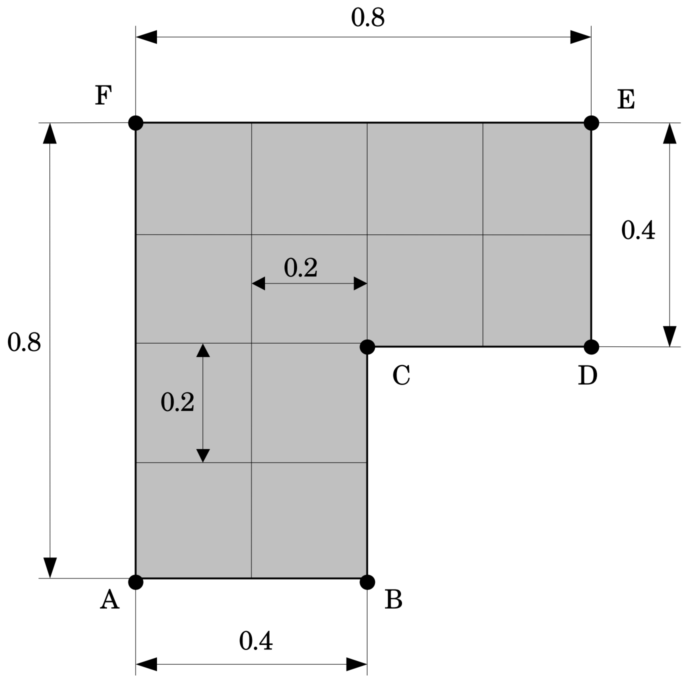
It is about a problem 2D plane presenting two modelizations, one planes, the second voluminal one.

The purpose is to validate, in the presence of a geometrical singularity, the plane thermal elements and 3D with for boundary condition an imposed temperature.

The results are compared with those provided by VPCS.

1 Problem of reference

1.1 Geometry



Dimensions in meters

1.2 Properties of the thermal

$\lambda=1.\,W/m.\,°C$ material conductivity

1.3 Boundary conditions and loadings

- side $[AF]$ imposed Temperature $T_p=10\,°C$,
- side $[DE]$ imposed Temperature $T_p=0\,°C$,
- side $[AB],[BC],[CD],[EF]$, $flux=0.$

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is that given in file TPLP01/89 of guide VPCS.

2.2 Results of reference

Temperature to the points of a squaring of with dimensions $0.2\mathrm{m} \times 0.2\mathrm{m}$.

2.3 Uncertainty on the analytical

solution Solution.

2.4 References

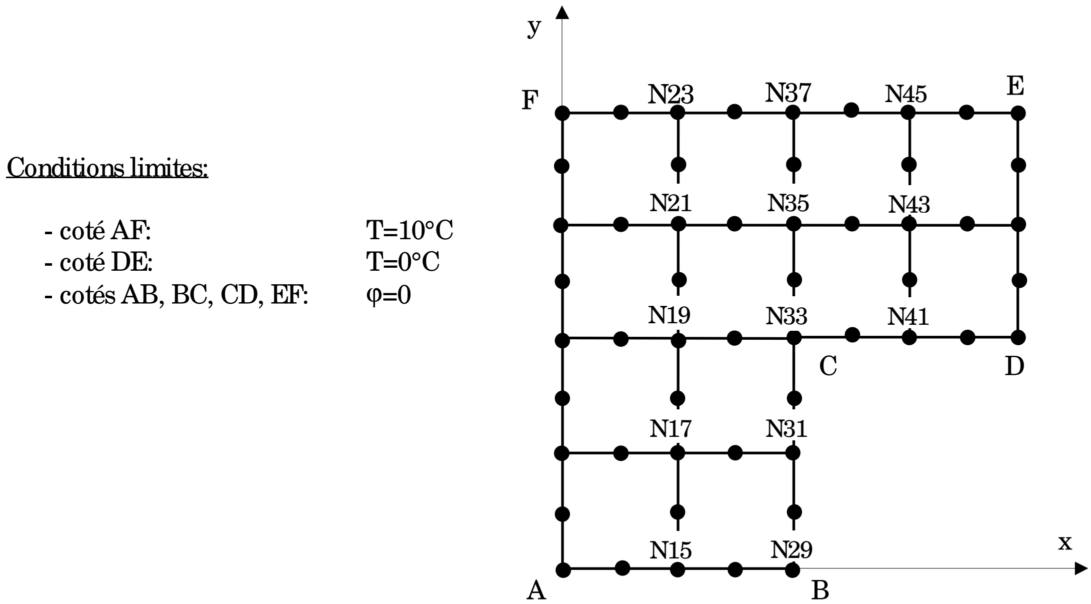
[1] Guides validation of the software packages of structural analysis. French company of the Mechanics, AFNOR 1990 ISBN 2-12-486611-7

[2] G.T. Symm-, National Physical Laboratory Division of Numerical Analysis and Computing, treatment of singularities in solution of Laplace' S equation by integral year equation method, NPL Carryforward NAC 31, January 1973.

3 Modelization A

3.1 Characteristic of the modelization

PLANE (QUAD8)



3.2 Characteristic of the mesh

Many nodes:	53
Number of meshes and types:	12 QUAD8

3.3 Quantities tested and results

Identification	Reference	tolerance
Temperature $(°C)$		
$x=0.2\ y=0.0(N15)$	9.316	1%
$y=0.2(N17)$	9.001	1%
$y=0.4(N19)$	8.514	1%
$y=0.6(N21)$	8.018	1%
$y=0.8(N23)$	7.869	1%
$x=0.4\ y=0.0(N29)$	9.009	1%
$y=0.2(N31)$	8.640	1%
$y=0.4(N33)$	6.667	1%
$y=0.6(N35)$	5.680	1%
$y=0.8(N37)$	5.495	1%
$x=0.6\ y=0.4(N41)$	2.972	1%
$y=0.6(N43)$	2.881	1%
$y=0.8(N45)$	2.816	1%

4 Modelization B

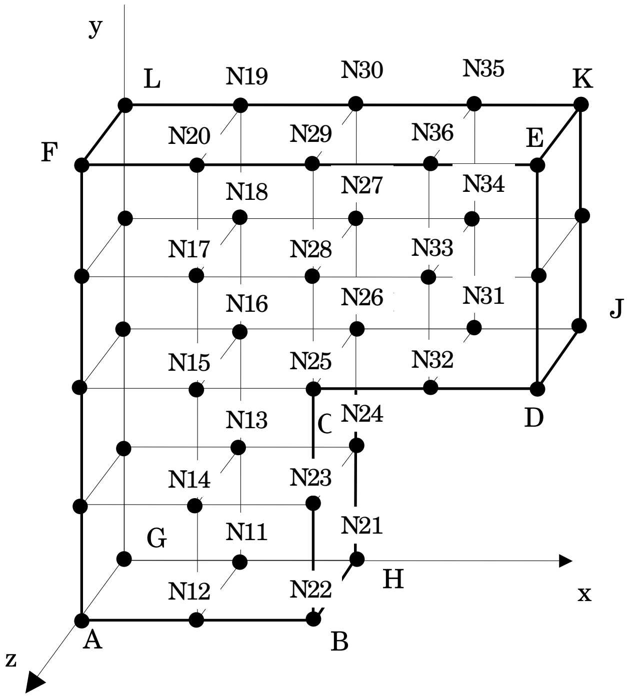
4.1 Characteristic of the modelization

3D (HEXA8)

Conditions limites:

- face AGLF: T=10°C
- face DJKE: T=0°C
- faces ABHG, BHIC: φ=0
- faces CDJI, FEKL: φ=0

Epaisseur = 0.2 m



4.2 Characteristic of the mesh

Many nodes: 42
Number of meshes and types: 12 HEXA8

4.3 Quantities tested and results

Identification	Reference	tolerance
Temperature $(°C)$		
$x=0.2\ y=0.0(N11)$	9.316	1%
$(N12)$	9.316	1%
$y=0.2(N13)$	9.001	1%
$(N14)$	9.001	1%
$y=0.4(N15)$	8.514	1%
$(N16)$	8.514	1%
$y=0.6(N17)$	8.018	1%
$(N18)$	8.018	1%
$y=0.8(N19)$	7.869	1%
$(N20)$	7.869	1%
$x=0.4\ y=0.0(N21)$	9.009	1%
$(N22)$	9.009	1%
$y=0.2(N23)$	8.640	1%
$(N24)$	8.640	1%

$y=0.4(N25)$	6.667	1%
$(N26)$	6.667	1%
$y=0.6(N27)$	5.680	1%
$(N28)$	5.680	1%
$y=0.8(N29)$	5.495	1%
$(N30)$	5.495	1%
$x=0.6\ y=0.4(N31)$	2.972	1%
$(N32)$	2.972	1%
$y=0.6(N33)$	2.881	1%
$(N34)$	2.881	1%
$y=0.8(N35)$	2.816	1%
$(N36)$	2.816	1%

5 Summary of the results

the two modelizations give results whose certain values exceed the tolerance fixed initially (1%):

- for the modelization A (PLANE with meshes QUAD8), the maximum change is of 1.19% (going beyond for only one value out of the 13 tested),
- for the modelization B (3D with meshes HEXA8), the maximum change is of 2.7% (going beyond for two values out of 26 tested).

The modelization of the geometrical singularity (presence of an important heat gradient close to the singularity) is represented better with quadratic elements (modelization A).

For the two modelizations, the accuracy should be improved by means of a finer mesh (more important refinement in the zone of the geometrical singularity).

The results are regarded as acceptable taking into account the modelizations carried out.