

ZZZZ185 - Validation of the order MODI_MAILLAGE associated with SYMMETRY and of the order PROJ_CHAMP associated with DISTANCE_MAX

Summary:

The objective of this case test is to validate the order MODI_MAILLAGE with the keyword SYMMETRY and orders it PROJ_CHAMP with the keyword DISTANCE_MAX.

- the order MODI_MAILLAGE, with the keyword SYMMETRY allows to take the symmetrical one of a grid 2D or 3D ,
- the order PROJ_CHAMP with the keyword DISTANCE_MAX allows not to project the field on the nodes which do not answer the 2 following criteria:
 - 1) the nodes are not in an element of the 1^{er} grid,
 - 2) the nodes are beyond DISTANCE_MAX.

The case test consists in realizing:

- a thermal study on 1/8^{ème} of structure,
- the construction of the thermal field on 1/4 of structure by projection of the results got on the 1/8^{ème} of structure, with the taking into account of a symmetry plane,
- a thermal study on 1/4 of structure,
- the comparison of the field of temperature obtained by projection and a study on 1/4 of structure.

1 Problem of reference

1.1 Geometry

The structure is obtained by rotation around axis Z, of the section represented with [the Figure 1.1-a].

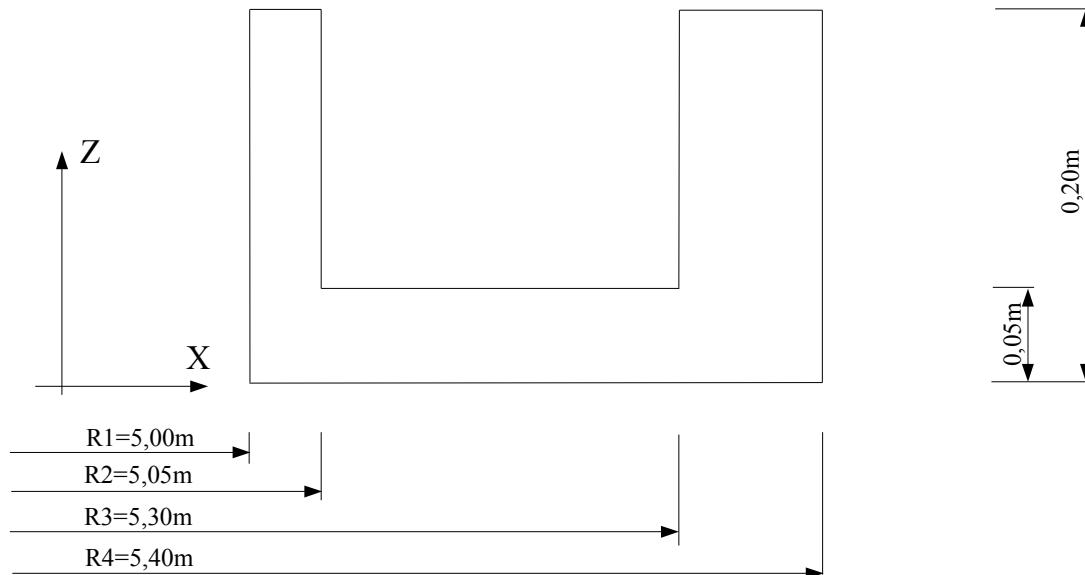


Figure 1.1-a : Cut of the structure

1.2 Properties of material

The study is carried out in linear thermics, only the thermal characteristics are necessary to the definition of materials.

Isotropic thermal conductivity: $\lambda = 15.0 \text{ W/m.k}$

1.3 Boundary conditions and loadings

The study is carried out in linear thermics, the conditions on the imposed temperatures are represented with [the Figure 1.3-a], the conditions of flow and heat exchange are indicated to [the Figure 1.3-b].

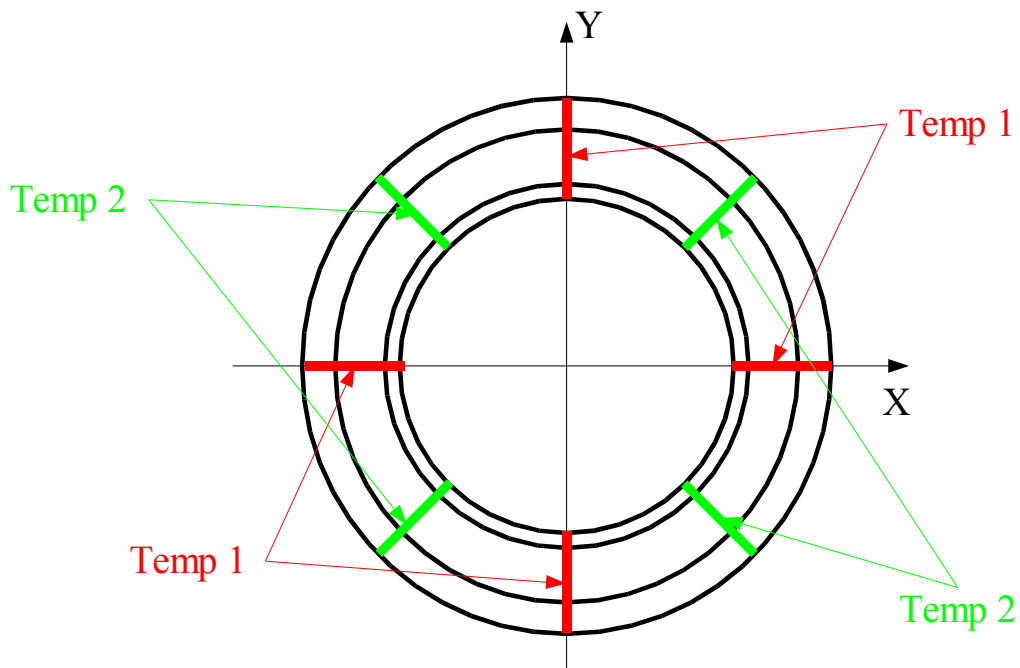


Figure 1.3-a : Sight of top, with the conditions in imposed temperature.

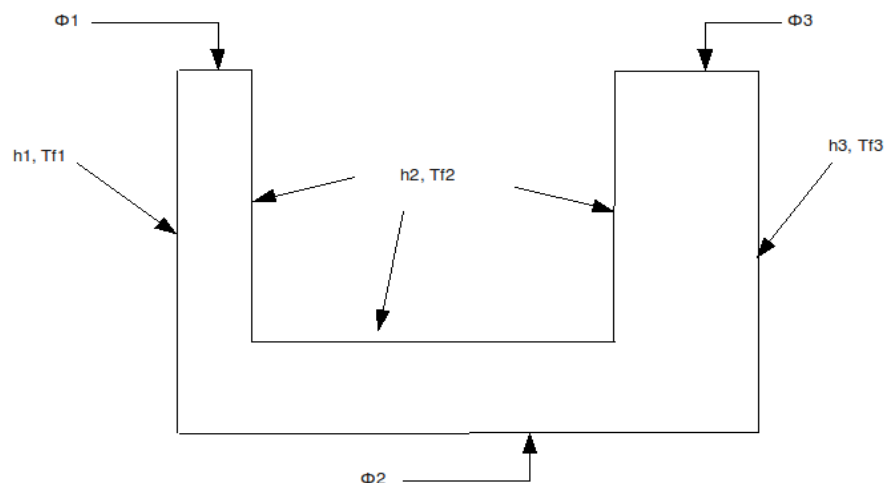


Figure 1.3-b : Cross-section, with the conditions of flow and heat exchange.

Conditions of flow:

$$\phi_1 = 10.0 \text{ W/m}^2$$

$$\phi_2 = 0.0 \text{ W/m}^2$$

$$\phi_3 = 30.0 \text{ W/m}^2$$

Conditions of exchange by convection:

$$h_1 = 350.0 \text{ W/m}^2 \text{ K} \quad tf_1 = 300.0 \text{ }^\circ\text{C}$$

$$h_2 = 400.0 \text{ W/m}^2 \text{ K} \quad tf_2 = 275.0 \text{ }^\circ\text{C}$$

$$h_3 = 600.0 \text{ W/m}^2 \text{ K} \quad tf_3 = 310.0 \text{ }^\circ\text{C}$$

Conditions of imposed temperature:

$$Temp_1 = 250.0 \text{ }^\circ\text{C}$$

$$Temp_2 = 160.0 \text{ }^\circ\text{C}$$

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating

For this case test, 2 studies are carried out.

- The first study is carried out on 1/8^{ème} of structure. Calculation is a linear thermal analysis, with the boundary conditions described with [§1.2].
- The second study is carried out on 1/4 of structure. Calculation is a linear thermal analysis, with the boundary conditions described with [§1.2].

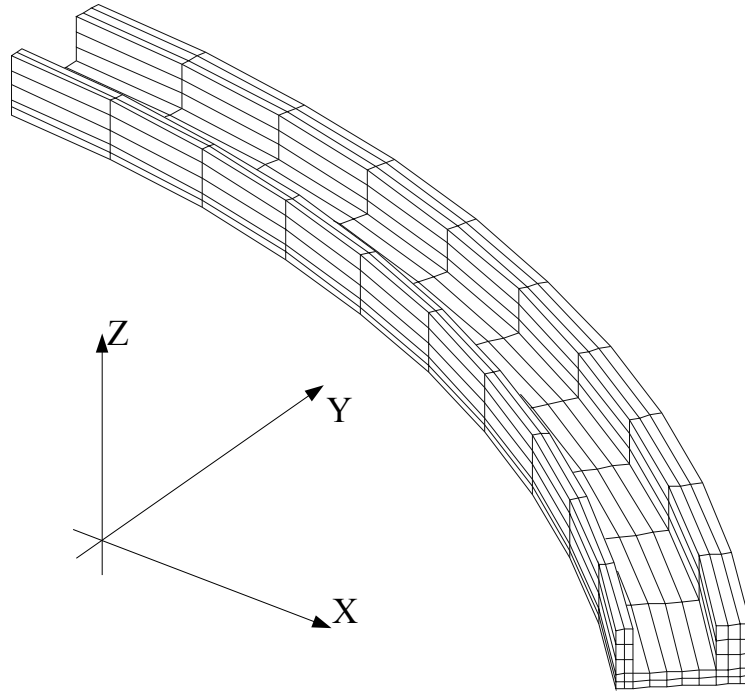


Figure 2.1-a : Grid of 1/8^{ème} of structure.

2.2 Sizes and results of reference

The result of reference is the field of temperature.

The result of the study on 1/8^{ème} of structure and its grid is saved in a file with format "MED". The projected fields will be then compared with those obtained by the study carried out on 1/4 of structure.

[the Figure 2.2-a] the field of temperature gives obtained on 1/8^{ème} of structure.

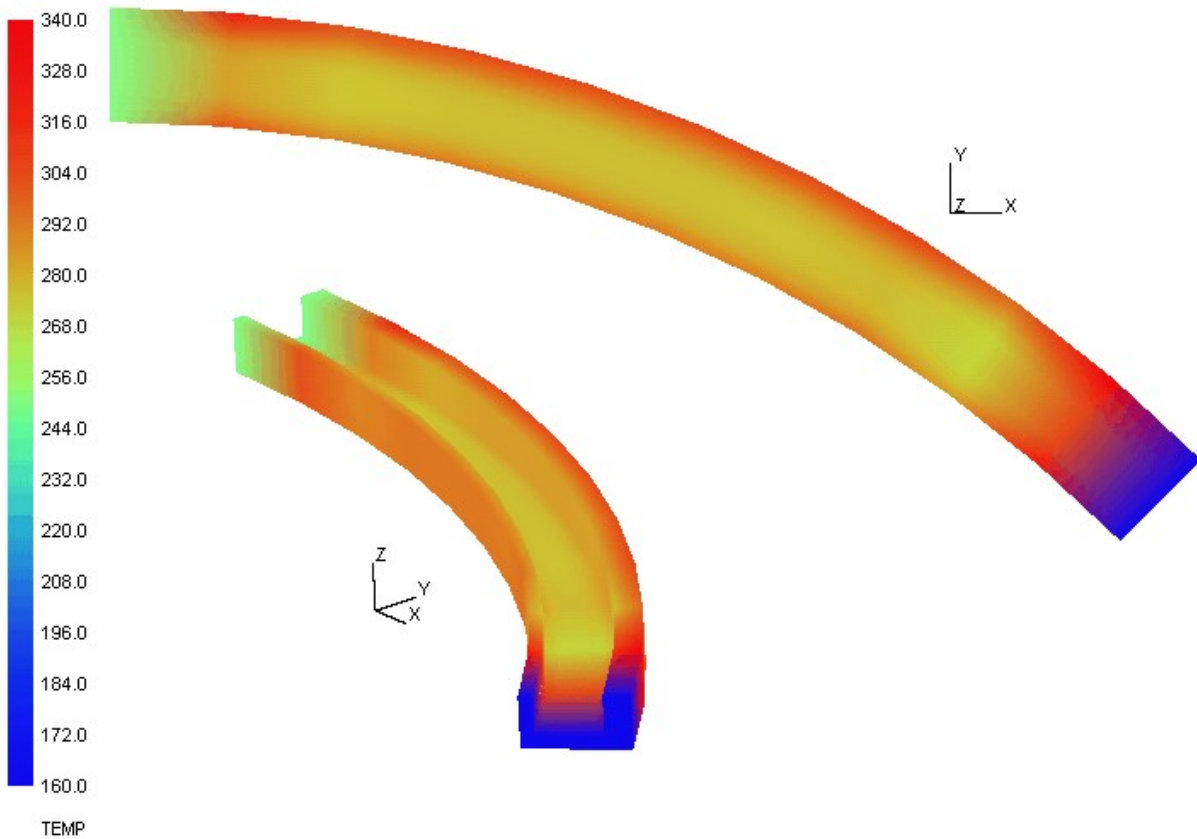


Figure 2.2-a : Field of temperature calculated on 1/8^{ème} structure.

2.3 Uncertainties on the solution

Pas de signification in this case.

The goal of the case test is to check that the symmetry of the grid and that projections of the field of temperature are correctly made.

2.4 Bibliographical references

Without use.

3 Modeling A

3.1 Characteristics of modeling

The goal of this modeling is to obtain the solution with the thermal problem starting from the calculation carried out on 1/8^{ème} structure.

The case test proceeds the following way:

- reading from the grid, 1/8^{ème} of structure, starting from the file with format "MED", orders LIRE_MAILLAGE.
- reading of the field of temperature starting from the file with format "MED", orders LIRE_CHAMP.
- creation of a result starting from the field previously read, order CREA_RESU.
- creation of a model starting from the grid previously read, order AFFE_MODELE.
- creation of a model for the groups of meshes which belong to the symmetry plane, order AFFE_MODELE (Cf notices n°1).
- reading from the grid, 1/8^{ème} of structure, starting from the file with the format "MED" and modification of the grid by symmetry compared to the plan (π_{sym}) defined by:
- AXE_1 = (1.0, 1.0, 0.0), AXE_2 = (0.0, 0.0, -1.0), NOT = (0.0, 0.0, 0.0)

orders LIRE_MAILLAGE and MODI_MAILLAGE.

- reading of the field of temperature starting from the file with format "MED", orders LIRE_CHAMP.
- creation of a result starting from the field previously read, order CREA_RESU.
- creation of a model starting from the symmetrical grid, orders AFFE_MODELE.
- reading of the grid accounting for 1/4 of the structure, orders LIRE_MAILLAGE.
- creation of a model starting from the grid previously read, order AFFE_MODELE.
- projection of the 3 results created starting from the solution calculated on 1/8^{ème} of structure, order PROJ_CHAMP with the keyword DISTANCE_MAX.
- extraction of the fields of temperature of the 3 results resulting from projection, orders CREA_CHAMP.
- creation of a null field on the model built on 1/4 of the structure, orders CREA_CHAMP (Cf notices n°2).
- combination of all the fields, orders CREA_CHAMP/OPERATION='ASSE'.
- creation of a result starting from the combination of the fields, CREA_RESU.

Notice n°1:

In this case test, nodes of the grid, [Figure 3.2-a], belong to the symmetry plane π_{sym} . For these nodes, the projection of the field of temperature will thus be entered 2 times. To avoid once cumulating the field of temperature of too, a solution is to create a model containing only these nodes and to carry out projection on the complete grid. This field project will be then withdrawn using the order CREA_CHAMP/OPERATION='ASSE'.

Notice n°2:

The projection of the fields using the order PROJ_CHAMP and of the keyword DISTANCE_MAX allows not to create a field on the nodes which are not contained in one of the elements of the initial grid and which are at a distance higher than DISTANCE_MAX element nearest. When one combines fields using the order CREA_CHAMP/OPERATION='ASSE', it is the first field with the nodes which is taken as reference. If the field is incomplete, as in our case, the combination will not give the anticipated result. The solution is thus to create a null field on all the model and to make use of it like reference field.

3.2 Characteristics of the grid

The projection of the field of temperature calculated on 1/8^{ème} of structure (grid of [Figure 1.1-a]) is project on the model built starting from the grid of the 1/4 of structure [Figure 3.2-a)].

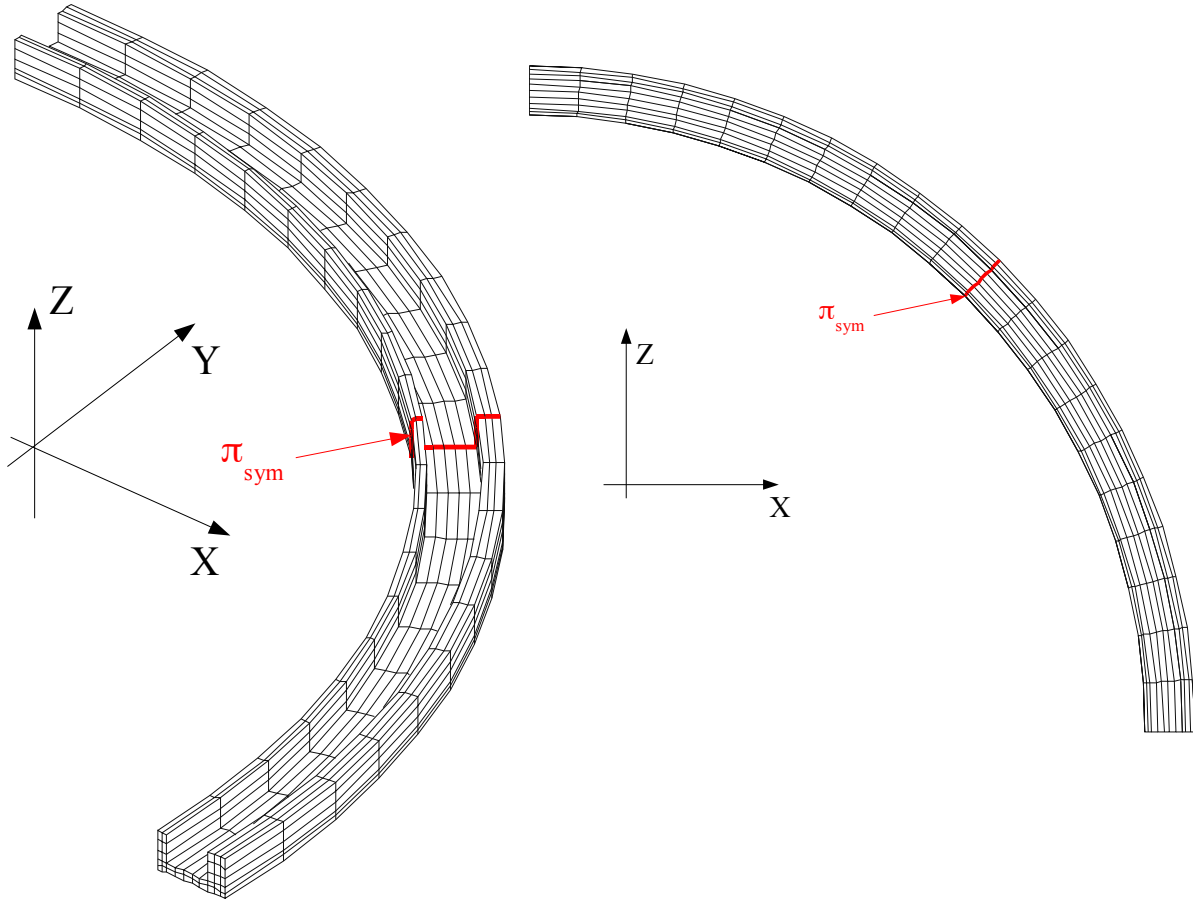


Figure 3.2-a : Grid of the 1/4 of the structure.

3.3 Sizes tested and results

The test is carried out on the field of temperature.

Result got by projection and combination on 1/4 of structure is extracted the field from temperature TEMP1. Result calculated on 1/4 of structure is extracted the 2nd field of temperature TEMP2. These 2 fields are withdrawn using the order CREA_CHAMP/OPERATION=' ASSE', and the test is carried out on the maximum and minimal value resulting field. In all points of the structure, one must have TEMP1 = TEMP2, the field resulting from the order CREA_CHAMP/OPERATION=' ASSE' must thus be null in all points.

Values tested	Reference	Code_Aster	Precision
Maximum	0.0	2.694E-05	1.0E-4
Minimum	0.0	-1.808E-05	1.0E-4

[the Figure 3.3-a] gives the map of the differences between the two fields of temperature obtained at the time of this case test.

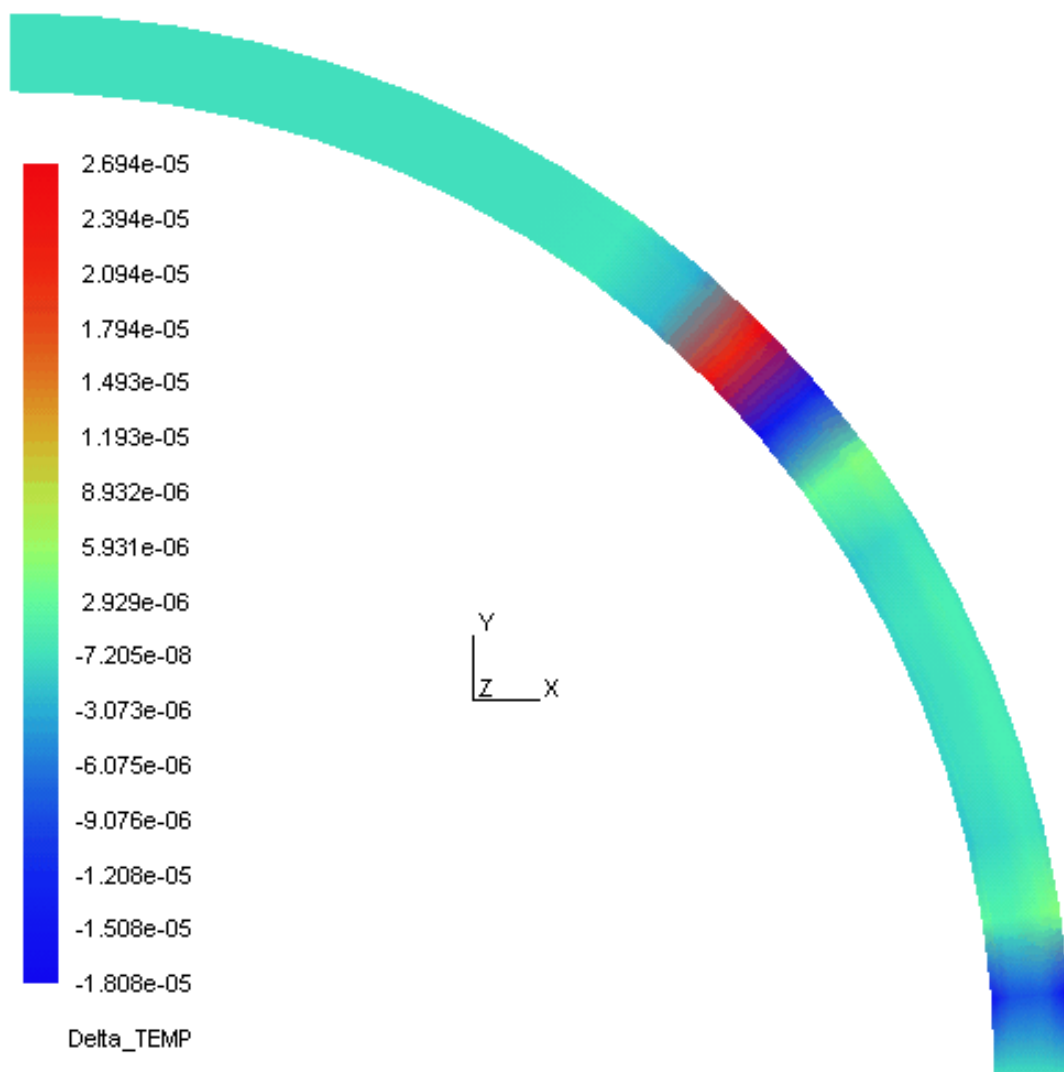


Figure 3.3-a : Map of the differences in temperature.

4 Summary of the results

This case test makes it possible to validate:

- the order MODI_MAILLAGE associated with the keyword SYMMETRY,
- the order PROJ_CHAMP associated with the keyword DISTANCE_MAX.

The validation is done on all the field of temperature and not only on some points.

When the 2 orders are associated, it should be taken account owing to the fact that the fields supported by nodes which belong to the symmetry plane can be entered 2 times.

During the combination of the fields using the order CREA_CHAMP/OPERATION='ADZE', it is the structure of the first CHAM_NO who is used as structure of reference. If the structure is incomplete, one thus should be created CHAM_NO of reference.