ZZZZ340 – Validation of key word TEMP_CONTINUE for AFFE_CHAR_THER

Summarized

This test factor key word validates key word TEMP_CONTINUE of the ECHANGE_PAROI of operators AFFE_CHAR_THER and AFFE_CHAR_THER_F [U4.44.02]. This key word relates to only the models X-FEM, and resulted in cancelling all the degrees of freedom nouveau riches (“Heaviside” and “ace-tip”) corresponding to the presence of cracks given by the user under the key word FISSURES. The zero setting of these degrees of freedom amounts solving the equation of heat on a field not comprising these cracks.

One validates this functionality on a simple problem of steady linear thermal in dimension 2. One considers a square plate with imposed temperature, comprising an emerging right crack laid out in the direction orthogonal to gradient of temperature. The use of the key word TEMP_CONTINUE makes it possible not to take into account the discontinuity of the field of temperature through this crack and to be reduced to the resolution of the “healthy” problem, this last admitting an analytical solution.

Only one modelization is considered:
•modelization A : X-FEM 2D (crack in the middle of the elements)

1 Problem of reference

1.1 Geometry

the structure $2d$ is a unit square: $LX=1\,m$ and $LY=1\,m$ (Figure 1.1-1).

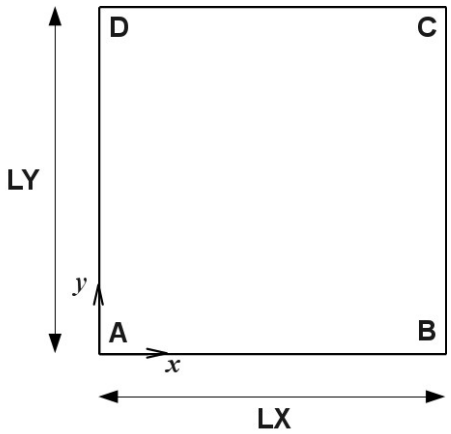

Figure 1.1-1: Geometry of the operational plate

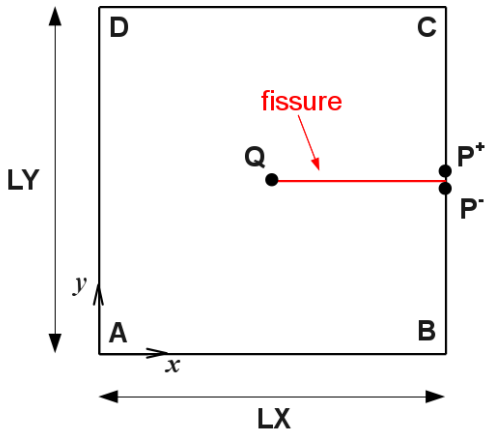

Figure 1.1-2: Geometry of the plate with fictitious crack

For the need for the benchmark, one also considers the same field in the presence of a crack fictitious, right and emerging on the right, located at middle height (Figure 1.1-2). One notes P^+ to it not coordinates $(LX\,,LY^+/2)$ (located on the upper lip), P^- it not of coordinates $(LX\,,LY^-/2)$ (located on the lower lip), and Q the point of coordinates $(LX/2,LY/2)$ (located at a peak of crack).

Note:

This crack is described as fictitious because it does not constitute part of the border of the field, and thus does not affect any the solution of the problem of reference. Its presence is only due to the data-processing validation of the functionality tested.

1.2 Properties of the thermal

material Conductivity: $\lambda=1\,W.m^{-1}.K^{-1}$
Voluminal heat capacity: $\rho C_p=2\,J.m-3.\mathrm{K}^{-1}$

1.3 Boundary conditions and loadings

One imposes a temperature $\bar{T}^{\inf}=10\,°C$ on the nodes of the segment AB and $\bar{T}^{\sup}=20\,°C$ on the nodes of the segment CD (see Figure 1.1-1).

1.4 Initial conditions

Nothing (the problem is steady)

2 Reference solution

2.1 Method of calculating

It acts of an analytical solution. In this configuration the problem is unidimensional and the equation of heat is reduced to the following differential equation:

$\frac{d^2T}{dy^2}=0$ with the conditions $T(y=0)=\bar{T}^{\inf}$ and $T(y=LY)=\bar{T}^{\sup}$

This equation admits the following solution:

$T(y)=(\bar{T}^{\sup}-\bar{T}^{\inf})\frac{y}{LY}+\bar{T}^{\inf}$

2.2 Quantities and results of reference

One tests the temperature at the points P^+, P^- and Q (see Figure 1.1-2). What corresponds to:

$T(\frac{LY}{2})=\frac{(\bar{T}^{\sup}+\bar{T}^{\inf})}{2}$, numerical application: $T(\frac{LY}{2})=15\,°C$

Standard	Identification of reference	Value of reference
Points P^+, P^- and Q - $TEMP$	"ANALYTIQUE"	$15\,°C$

3 Modelization a: fissures NON-with a grid in dimension 2

crack not being with a grid, the condition of exchange between the lips of crack is applied using the key word FISSURES factor key word ECHANGE_PAROI of operator AFFE_CHAR_THER [U4.44.02].

3.1 Characteristics of the modelization

One uses the modelization PLANE of the THERMAL phenomenon. The wide finite element method (X-FEM) is used.

3.2 Characteristics of the mesh

the structure is modelled by a regular mesh composed of 101×101 QUAD4, respectively along the axes x y. The crack is not with a grid.

3.3 Quantities tested and results

the quantities below are initially tested if the loading making it possible to impose the continuity of the field temperature (key word TEMP_CONTINUE) results from operator AFFE_CHAR_THER, they are then tested when it results operator AFFE_CHAR_THER_F.

One tests the temperature at the points P^+, P^- and Q (see Figure 1.1-2). For that one tests the field of temperature after call to operators POST_MAIL_XFEM and POST_CHAM_XFEM.

Standard	identification of reference	Value of reference	Tolerance
Points P^+, P^- and Q $TEMP$	"ANALYTIQUE"	15	0.1%

4 Summaries of the results

the purpose of this test is reached: factor key word to validate for the models X-FEM key word TEMP_CONTINUE of the ECHANGE_PAROI of operators AFFE_CHAR_THER and AFFE_CHAR_THER_F.