ZZZZ268 - Validation of POST_BORDET in 2D and 3D

Summary:

This test validates calculation of the constraint and the probability of Bordet, in two dimensions and three dimensions, with thermal evolution, on cases in which the mechanical fields are uniform (what allows an analytical calculation of these sizes); the purpose of this case test is well to test the digital developments and not to carry out a study of a realistic case.

1 Problem of reference

1.1 Geometry of modeling A

One considers an axisymmetric bar of ray 1mm and height 10mm subjected to a simple tensile test (in imposed displacement). This test is selected because it makes it possible to obtain uniform mechanical fields.

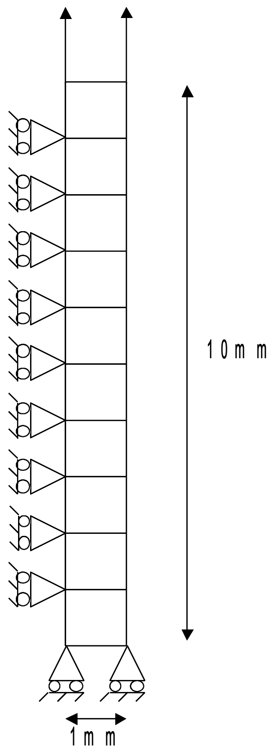

Figure 1.1: Axisymmetric bar.

1.2 Geometry of modeling B

A cube on side here is considered 1mm subjected to traction.

The front face is blocked according to the direction X, the face of left according to the direction Y, the face of bottom according to the axis Z and an incremental traction of $0{,}001\,\text{mm}$ is applied to the higher face.

1.3 Properties of material

The material is elastoplastic perfect with a Young modulus of $300\,000\,\text{MPa}$, a Poisson's ratio of 0 and one yield stress of $300\,\text{MPa}$.

1.4 Boundary conditions and loadings

For modeling A, one carries out 5 increments of traction of $0{,}01\,\mathrm{mm}$, so that the increment of total deflection is of $1.0\,\mathrm{E}\text{-}3$ and that the yield stress is reached with the first step.
For modeling B, the front face is blocked according to the direction X, the face of left according to the direction Y, the face of bottom according to the axis Z and an incremental traction of $0{,}001\,\mathrm{mm}$ is applied to the higher face.

The temperature varies linearly in the bar of $\mathrm{O°C}$ with $5\mathrm{O°C}$ on 5 pas de time.

In order to test the various opportunities given share the macro-order `CALC_BORDET`, one uses, when that is possible, of the parameters function of the temperature and the speed of plastic deformation. The list of the parameters used is presented in the table below.

Parameter	Type	Value
`M`	Scalar	22
`SIG_CRIT`	Scalar	250
`VOLU_REFE`	Scalar	1
`SIGM_REFE`	Function	$200+\mathrm{T}$
`SEUIL_CALC`	Tablecloth	$\begin{cases} 10\,T & \text{si } \dot{\varepsilon}^p=0{,}0005 \\ 5\,T & \text{si } \dot{\varepsilon}^p=0{,}001 \end{cases}$
`DEF_PLAS_REFE`	Scalar	0

Table 1.1 : Parameters of Bordet used

2 Reference solution

2.1 Method of calculating

In both cases, because of the uniform character of the mechanical fields, one can carry out analytical calculation at the same time constraints of Bordet and probabilities. One uses for that the equations of the model of Bordet presented in documentation [R7.02.06]: Models of Beremin, Bordet and Rice and Tracey.

2.2 Sizes and results of reference

One tests in both cases at the same time the constraint of Bordet and the associated probability, for the moments going from 0 to 5.
For modeling A, one gets the following results of reference:

Moment	Constraint of Bordet	Probability of Bordet
0	0	0,0000
1	0	0,0000
2	247,67	0,9999
3	252,23	0,9995
4	254,1	0,9701
5	254,7	0,7780

Table 2.1 : Analytical results for modeling A

For modeling B, one gets the following results of reference:

Moment	Constraint of Bordet	Probability of Bordet
0	0	0,0000
1	0	0,0000
2	211,75	0,3500
3	215,64	0,2150
4	217,24	0,11
5	217,75	0,0467

Table 2.2 : Analytical results for modeling B

2.3 Uncertainties on the solution

Because of the analytical character, the reference solution is exact. One thus admits only one error lower than $0,5\%$.

3 Modeling A

3.1 Characteristics of modeling

Modeling is axisymmetric.

3.2 Characteristics of the grid

The bar is cut out in 10 quadratic quadrangular meshs QUAD8.

3.3 Sizes tested and results

For this modeling, the analytical values and tolerances are indexed in the table below:

Moment	σ_{Bordet} theoretical	P_{Bordet} theoretical	Error on σ_{Bordet}	Error on P_{Bordet}
0	0	0,0000	0	0
1	0	0,0000	0	0
2	247,67	0,9999	<0,1%	<0,1%
3	252,23	0,9995	<0,1%	<0,1%
4	254,1	0,9701	<0,1%	<0,1%
5	254,7	0,7780	<0,1%	<0,1%

Table 3.1 : Results of modeling A

The difference is almost worthless.

4 Modeling B

4.1 Characteristics of modeling

Modeling is three-dimensional.

4.2 Characteristics of the grid

The grid contains 1 elementary mesh 3D of type HEXA8.

4.3 Sizes tested and results

For this modeling, the analytical values and the tolerances are indexed in the table below:

Moment	σ_{Bordet} theoretical	P_{Bordet} theoretical	Error on σ_{Bordet}	Error on P_{Bordet}
0	0	0,0000	0	0
1	0	0,0000	0	0
2	211,75	0,3500	<0,1%	<0,1%
3	215,64	0,2150	<0,1%	<0,1%
4	217,24	0,11	<0,1%	<0,1%
5	217,75	0,0467	<0,1%	<0,3%

Table 4.1 : Results of modeling B

The difference is almost worthless in all the cases.

5 Summary of the results

In two modelings and for every moment, the errors are almost worthless.
One can thus say that the order correctly calculates the constraints and probabilities of Bordet in $2D$ and $3D$: the development is validated.