ZZZZ268 - Validation of POST_BORDET in 2D and 3D

Summarized:

This test validates computation of the stress 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 computation of these quantities); the purpose of this case test is well testing the numerical developments and not to carry out a study of a realistic case.

1 Problem of reference

1.1 Geometry of the modelization A

One considers an axisymmetric bar of radius $1\,\mathrm{mm}$ and height $10\,\mathrm{mm}$ subjected to a simple traction test (in imposed displacement). This test is selected because it makes it possible to obtain uniform mechanical fields.

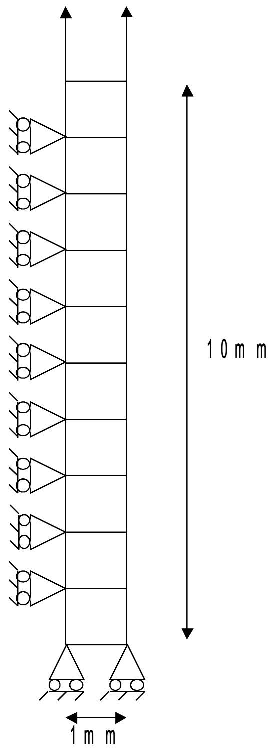

Figure 1.1: Axisymmetric bar.

1.2 Geometry of the modelization B

One considers here a cube on side $1\,\mathrm{mm}$ subjected to tension.

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 tension of $0{,}001\,\mathrm{mm}$ is applied to the upper face.

1.3 Properties of the material

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

1.4 Boundary conditions and loadings

For the modelization A, one carries out 5 increments of tension 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 the modelization 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 tension of $0{,}001\,\mathrm{mm}$ is applied to the upper face.

The temperature linearly varies in the bar deàsur $\mathrm{O°C}$ $\mathrm{5O°C}$ the 5 time step.

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

Standard	parameter	Value
`M`	Scalar	22
`Scalar`	SIG_CRIT	250
`VOLU_REFE`	Scalar	1
`SIGM_REFE`	Function	$200+\mathrm{T}$
`SEUIL_CALC`	Scalar	$\begin{cases} 10\,T & \text{si } \dot{\varepsilon}^p=0{,}0005 \\ 5\,T & \text{si } \dot{\varepsilon}^p=0{,}001 \end{cases}$
`Three-dimensions function`	DEF_PLAS_REFE	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 computation at the same time stresses 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 Quantities and results of reference

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

Time	Forced 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 the modelization A

For the modelization B, the following results of reference are got:

Time	Forced 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 the modelization 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 Modelization A

3.1 Characteristic of the modelization

The modelization is axisymmetric.

3.2 Characteristics of the mesh

the bar is cut out in 10 meshes quadrangular quadratic `QUAD8`.

3.3 Quantities tested and results

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

Theoretical	σ_{Bordet} time	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 the modelization To

the difference is almost null.

4 Modelization B

4.1 Characteristic of the modelization

The modelization is three-dimensional.

4.2 Characteristics of the mesh

The mesh contains 1 3D elementary `mesh` type `HEXA8`.

4.3 Quantities tested and results

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

Theoretical	σ_{Bordet} time	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 the modelization B

the difference is almost null in all the cases.

5 Summary of the results

In the two modelizations and for all times, the errors are almost null.
One can thus say that the command correctly calculates the stresses and probabilities of Bordet in $2D$ and $3D$: the development is validated.