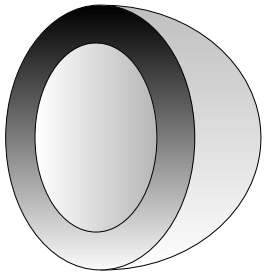
SSNP145 – Validation of control PRED_ELAS in plasticity

Summarized:

The use of lenitive models can lead to brutal snap-back which makes difficult the course of computation. To follow these instabilities, two types of control are available in Code_Aster: control by elastic prediction (PRED_ELAS), which depends on the constitutive law and control in strain (DEFORMATION) generic. In the case as of modelizations with an elastoplastic behavior undamaged, it is possible to use control by elastic prediction. What adds a possibility of control of the materials presenting a plate of hardening (perfectly plastic behavior) but also makes it possible to mix plastic materials (for example reinforcements in the concrete) with damaging materials.

1 Problem of reference

1.1 Geometry and boundary conditions



Appears 1.1-a : geometry of studied structure

the studied structure is a hollow sphere under pressure $p=1\mathrm{MPa}$. The properties of symmetry of the problem will be used.
The interior radius is worth $R_{\mathrm{int}}=100\,mm$ and the external radius is worth $R_{\mathrm{ext}}=200\,mm$).

1.2 Properties of the material

Constitutive law	Behavior elastic	Behavior plastic	Behavior damaging (weakened zone)
VMIS_ISOT_LINE	$E=200.000\,MPa$ $\nu=0,3$	$\sigma_y=300\,MPa$ $E_T=0$	$\sigma_y=5\,MPa$ $E_T=-10000\,MPa$

2 Reference solution

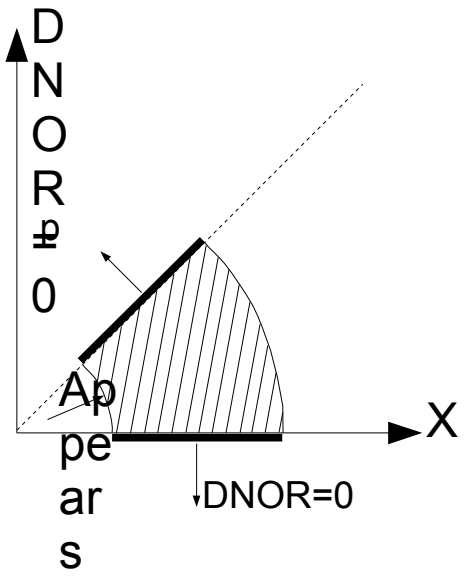
the values tested are analytical values of a purely spherical problem under perfect plasticity. The pressure varies in structure according to the radius r according to the following formula:

$$p(r)=2.\sigma_y.\log\left(\frac{r}{R_{\mathrm{int}}}\right)+\left(\frac{2}{3}\right).\sigma_y.\frac{R_{\mathrm{int}}^3-R_{\mathrm{ext}}^3}{R_{\mathrm{ext}}^3}$$

3 Modelization A

3.1 Characteristic of the modelization

One models only one eighth of the sphere into axisymmetric:



3.1-a 3.1-a : geometry of structure – models axisymmetric

One imposes DNOR=0 for symmetry and an interior pressure unit PRES_REP of $1 MPa$.

3.2 Characteristics of the mesh

The model is axisymmetric and comprises 2109 TRIA3.

3.3 Quantities tested and results

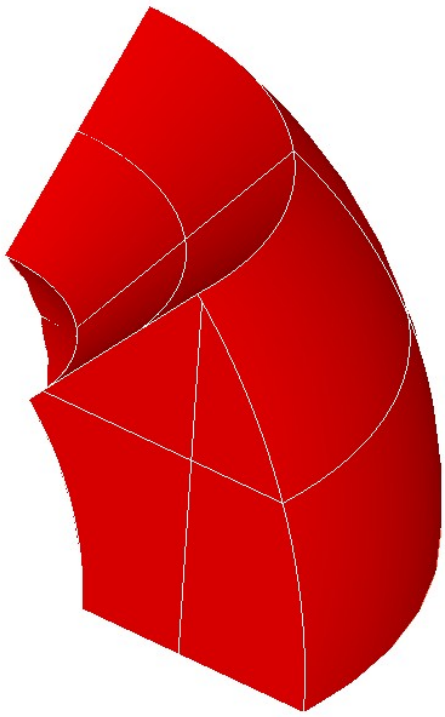
to validate the solution obtained, one tests at the last moment the parameter of control which must be worth the pressure obtained by the formula given to the §2.

Value tested	Urgent	Standard	Reference	*Variation*
Parameter of control	20,0	415,89	Analytical	0,19%
	20,0	416,45	NON-regression	$1.0\times10^{-8}\%$

4 Modelization B

4.1 Characteristic of the modelization

The modelization tested is 3D. One uses symmetries of the problem to represent only one sixteenth sphere.



Appear 4.1-a : geometry of structure – models 3D

4.2 Characteristic of the mesh

The model is 3D and comprises 4905 HEXA8.

4.3 Quantities tested and results

to validate the solution obtained, one tests at the last moment the parameter of control which must be worth the pressure obtained by the formula given to the §2.

Value tested	Urgent	Standard	Reference	*Variation*
Parameter of control	20,0	415,89	Analytical	1,6%

	20,0	422,4168347	NON-regression	1.0×10^{-8} %

5 Modelization C

5.1 Characteristic of the modelization

The modelization tested is 3D. One uses symmetries of the problem to represent only one sixteenth sphere (identical that in the modelization B).

5.2 Characteristics of the mesh

The model is 3D and comprises 4226 TETRA4.

5.3 Quantities tested and results

to validate the solution obtained, one tests at the last moment the parameter of control which must be worth the pressure obtained by the formula given to the §2.

Value tested	Urgent	Standard	Reference	*Variation*
Parameter of control	20,0	415,89	Analytical	4,8%
	20,0	435,92	NON-regression	1.0×10^{-8} %

6 Summary of the results

This benchmark makes it possible to check the good performance of control in plasticity. The got results are of excellent quality, they are slightly less less good in 3D because of a too coarse mesh.