# SSNP145 – Validation of piloting PRED_ELAS in plasticity

**Summary:**

The use of lenitive laws can lead to brutal snap-back which makes difficult the course of calculation. To follow these instabilities, two types of piloting are available in Code_Aster: piloting by elastic prediction (PRED_ELAS), which depends on the law on behavior and piloting in deformation (DEFORMATION) credits. In the case as of modelings with an elastoplastic behavior undamaged, it is possible to use piloting by elastic prediction. What adds a possibility of piloting of materials presenting a plate of work 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

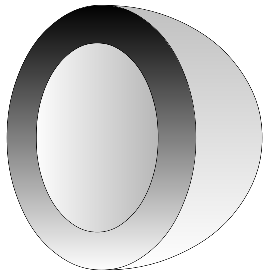

**Figure 1.1-a : geometry of the studied structure**

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 ray is worth $R_{\mathrm{int}}=100\,mm$ and the external ray is worth $R_{\mathrm{ext}}=200\,mm$ ).

## 1.2 Properties of material

| Law of behavior | Elastic behavior | Plastic behavior | Damaging behavior (weakened zone) |
|---|---|---|---|
| VMIS_ISOT_LINE | $E=200.000\,MPa$<br>$\nu=0{,}3$ | $\sigma_y=300\,MPa$<br>$E_T=0$ | $\sigma_y=5\,MPa$<br>$E_T=-10000\,MPa$ |

# 2 Reference solution

The values tested are analytical values of a purely spherical problem under perfect plasticity. The pressure varies in the structure according to the ray $r$ 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 Modeling A

## 3.1 Characteristics of modeling

One models only one eighth of the sphere into axisymmetric:

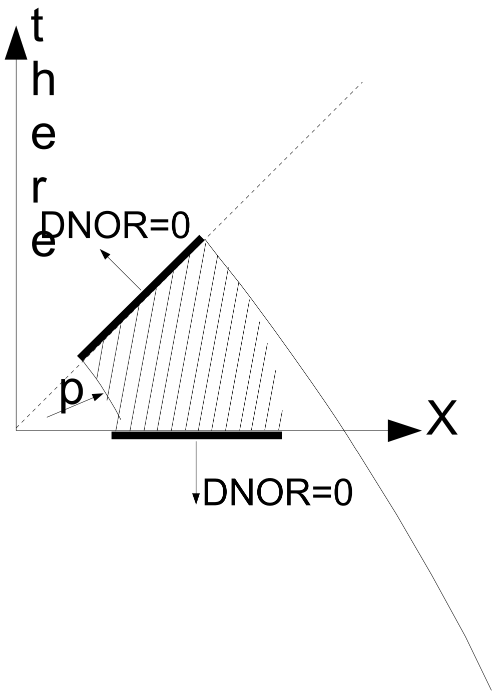


**Figure 3.1-a : geometry of the structure – model axisymmetric**

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

## 3.2 Characteristics of the grid

The model is axisymmetric and comprises 2109 TRIA3.

## 3.3 Sizes tested and results

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

| Value tested | Moment | Reference | Type | *Variation* |
|---|---|---|---|---|
| Parameter of piloting | 20.0 | 415.89 | Analytical | 0.19% |
| | 20.0 | 416.45 | Not-regression | $1.0\times 10^{-8}$ % |

# 4 Modeling B

## 4.1 Characteristics of modeling

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

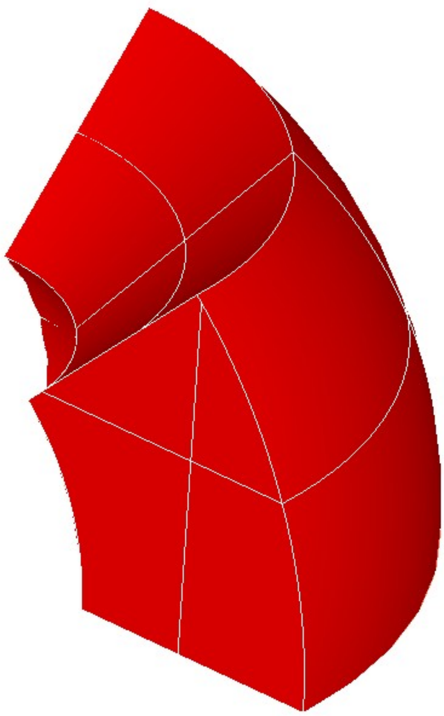

**Figure 4.1-a : geometry of the structure – model 3D**

## 4.2 Characteristics of the grid

The model is 3D and comprises 4905 HEXA8.

## 4.3 Sizes tested and results

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

| Value tested | Moment | Reference | Type | Variation |
|---|---|---|---|---|
| Parameter of piloting | 20.0 | 415.89 | Analytical | 1.6% |
| | 20.0 | 422.4168347 | Not-regression | $1.0\times10^{-8}\%$ |

# 5 Modeling C

## 5.1 Characteristics of modeling

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

## 5.2 Characteristics of the grid

The model is 3D and comprises 4226 TETRA4.

## 5.3 Sizes tested and results

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

| Value tested | Moment | Reference | Type | Variation |
|---|---|---|---|---|
| Parameter of piloting | 20.0 | 415.89 | Analytical | 4.8% |
| | 20.0 | 435.92 | Not-regression | $1.0\times10^{-8}\%$ |

# 6 Summary of the results

This CAS-test makes it possible to check the good performance of piloting in plasticity. The got results are of excellent quality, they are slightly less less good in 3D because of a too coarse grid.