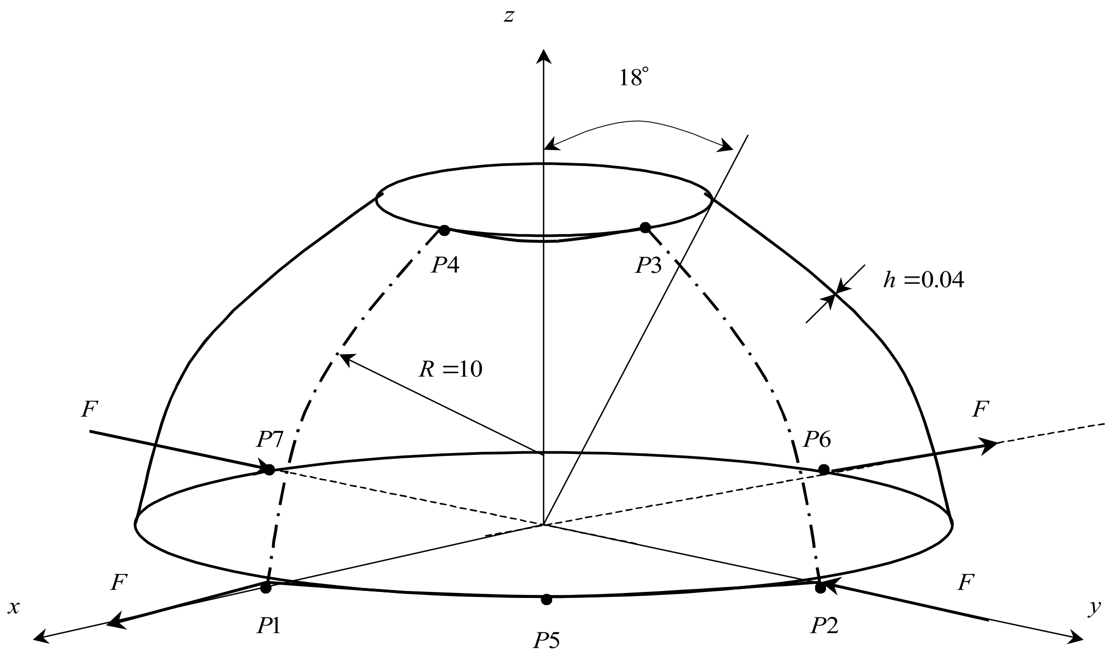
SSNV141 - Segment of a sphere pinch

Summary:

One presents in this CAS-test a geometrical nonlinear quasi static calculation of segment of a sphere pinch. It makes it possible to test modeling COQUE_3D into nonlinear geometrical and the algorithm of update of great rotations 3D (Keyword GROT_GDEP of the operator STAT_NON_LINE). This popular example in linear analysis shows the capacity of the element of hull to representing well the inflection without extension and the movements of rigid body. Moreover the thinness of the hull compared to its radius of curvature makes it possible to test the treatment of blocking in transverse shearing. Deformations obtained by *Code_Aster* different from 0.1 to 1.25% compared to those of Code the SAMCEF software, taken for reference.

1 Problem of reference

1.1 Geometry



Cap pinch:

En $P1$ $F = Fe_x$

En $P6$ $F = - Fe_x$

En $P2$ $F = - Fe_y$

En $P7$ $F = Fe_y$

With $F > 0$

1.2 Material properties

Elastic behavior:

$$E = 6.825 \times 10^7 \; ; \; \nu = 0.3$$

1.3 Boundary conditions and loadings

One seeks the successive states of balance under the loading

$$F(t)=t$$

applied in $P_1 P_6 P_2 P_7$

Because of the geometrical and physical symmetry of the problem, only the quarter $P_1 P_2 P_3 P_4$ is modelled, by taking account of the conditions of symmetry. These conditions eliminate 5 movements from rigid body. The last movement of rigid body is eliminated by blocking following displacement z. at the point P_5,

Boundary conditions: P_5 : $DZ=0$

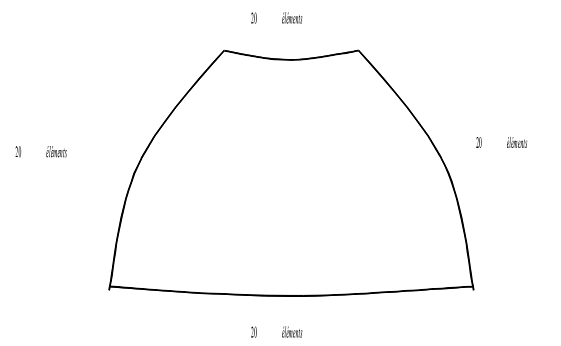
Symmetry: $P2P3$: $DY=0.$ $DRX=0.$ $DRZ=0.$

$P4P1$: $DX=0.$ $DRY=0$. $DRZ=0.$

One is interested particularly in displacements of the points P_1 and P_3 according to the directions of loading.

2 Reference solution

This solution [bib4] is that which is obtained with software the SAMCEF software [bib1]. Modeling is based on a theory of hull in resulting efforts with a Co-rotational formulation [bib3] and a discretization DSQ [bib2].



The grid considered is of 20×20 quadrilateral elements.

The strategy of Newton with level of force imposed illustrates a difficulty of convergence. One pushes calculation until $F=100$.

2.1 Bibliographical references

1) The SAMCEF software, Handbook of reference V7.1 Elements Volume, 1998

2) J-L. Batoz, G.Dhatt, “Modeling of the Structures by Finite elements: Hulls”, Hermes, Paris, 1992

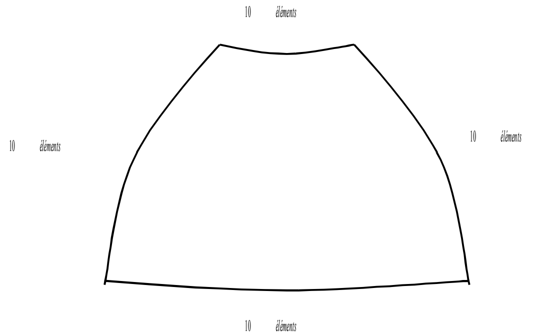
3) Crisfield M.A., “Non-linear Finite Element Analysis of Solids and Structures”, Volume 1: Essentials, John Wiley, Chichester, 1994

4) PH. JETTEUR, Kinematic Non Linéaire of the Hulls. Report SAMTECH, Contract PP/GC - 134/96, 1998

3 Modeling A

3.1 Characteristics of modeling

Element MEC3QU9H (voluminal hull)
Modeling COQUE_3D



3.2 Characteristics of the grid

Many nodes: 441

Many meshs and types: 100 QUAD9

3.3 Features tested

- Modeling COQUE_3D into nonlinear geometrical.
- The static algorithm of update of great rotations GROT_GDEP of STAT_NON_LINE .

3.4 Values tested

The incremental analysis is carried out in the interval of pseudo-time $[0:100.]$ in 10 pas de charges.

History of horizontal displacement DX at the point $P1$

Moment	Force F	Reference
020.	020.	+1.484E+00
050.	050.	+2.578E+00
100.	100.	+3.390E+00

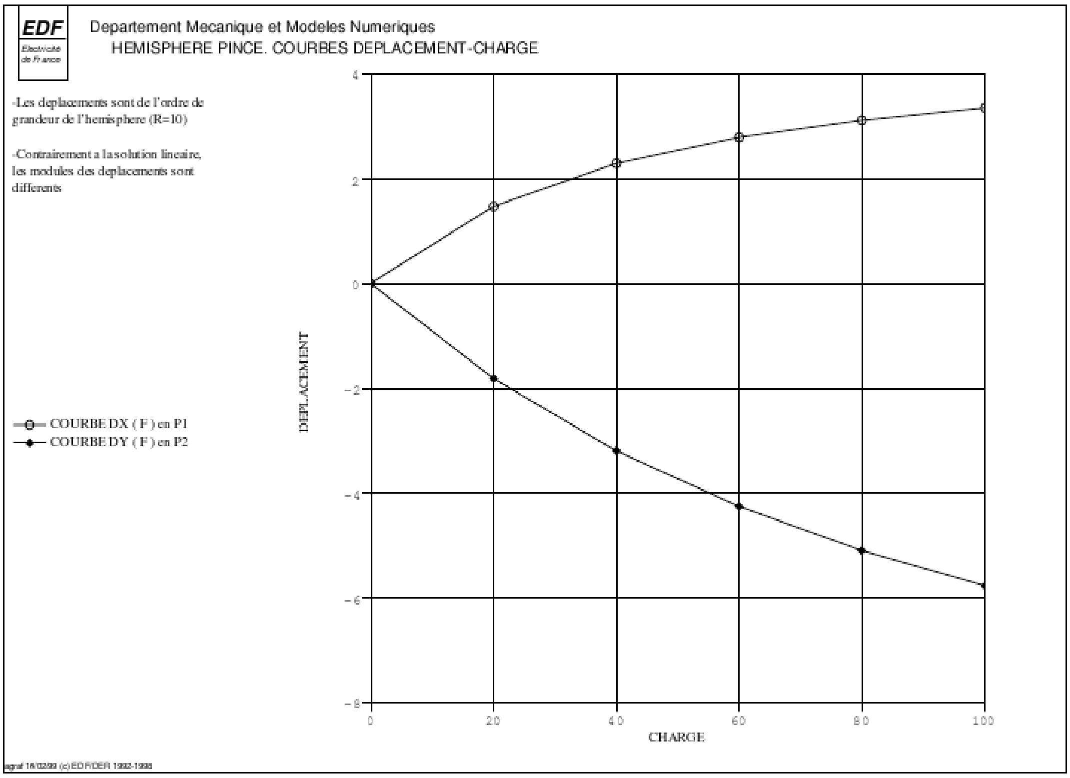
History of horizontal displacement DY at the point $P2$

Moment	Force F	Reference
020.	020.	– 1.799E+00
050.	050.	-3.759E+00
100.	100.	-5.802E+00

3.5 Remarks

One uses as value for `COEF_RIGI_DRZ: 0,001`.

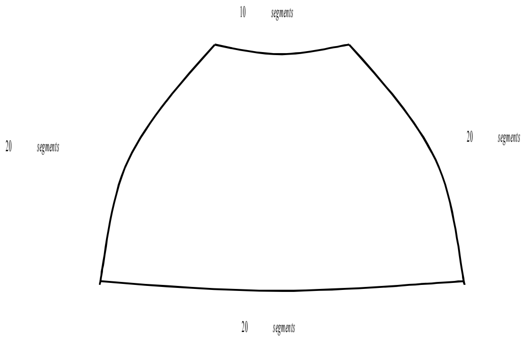
One presents curved displacement – load to the requested points.



4 Modeling B

4.1 Characteristics of modeling

Element MEC3TR7H (voluminal hull)
Modeling COQUE_3D



4.2 Characteristics of the grid

Many nodes: 1541

Number of meshs and type: 734 TRIA7

4.3 Features tested

- Modeling COQUE_3D into nonlinear geometrical.
- The static algorithm of update of great rotations GROT_GDEP of STAT_NON_LINE .

4.4 Values tested

The incremental analysis is carried out in the interval of pseudo-time $[0:100.]$ in 10 pas de charges.

History of horizontal displacement DX at the point $P1$

Moment	Force F	Reference
020.	020.	+1.479E+00
050.	050.	+2.578E+00
100.	100.	+3.390E+00

History of horizontal displacement DY at the point $P2$

Moment	Force F	Reference
020.	020.	– 1.799E+00
050.	050.	-3.759E+00
100.	100.	-5.802E+00

4.5 Remarks

One uses as value for COEF_RIGI_DRZ: 0,001.

5 Summary of the results

The facts of the case correspond to a thin hull $\frac{h}{R}=0.4\%$. It is necessary to increase the value of COEF_RIGI_DRZ who allots a rigidity around the normal of the elements of hull which is worth by default 10^{-5} the smallest rigidity of inflection around the directions in the plan of the hull in order to be able to increase the value of the swing angle which one can reach. Values of this coefficient until 10^{-3} remain licit.

The solution *Code_Aster* is close to the reference solution the SAMCEF software for two modelings.

This test thus shows the good performance of modeling COQUE_3D in great displacements and great rotations, without revealing of blocking in shearing.