SSNV140 - Embedded cylindrical panel

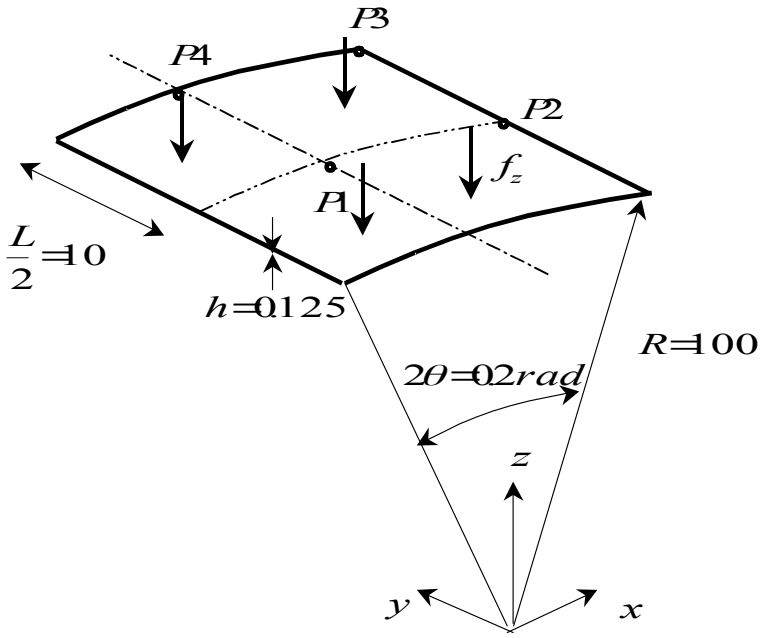
Summary:

One presents in this test a quasi static calculation of embedded elastic cylindrical panel subjected to a surface force given either in the total reference mark, or in the local reference mark. This force is constant in the first case and following in the second case. Modeling thus is tested COQUE_3D nonlinear geometrical by using the algorithm of update of great rotations 3D GROT_GDEP of STAT_NON_LINE, as well as the treatment of the following pressures for modeling COQUE_3D. The reference solution which is digital is obtained with software the SAMCEF software.

1 Problem of reference

1.1 Geometry

The lengths are expressed in meters.



The cylindrical panel is embedded along its 4 sides and subjected to a surface force.

- data in the total reference mark for modeling a:

$$\mathbf{f}=-f_z\mathbf{e}_z;\ f_z>0$$

- data in the local reference mark for modeling b:

$$\mathbf{f}=-f_z\mathbf{n};\ f_z>0$$

who leads to the membrane compression of the panel, accompanied by localised inflections. In the case of modeling B, n is the normal with the reactualized geometry of the panel.

Because of the geometrical and physical symmetry of the problem, only the quarter $P_1P_2P_3P_4$ panel is modelled, by taking account of the conditions of symmetry.

1.2 Material properties

Elastic behavior:

$$E=450000\,MPa\ ;\ \nu=0.3$$

1.3 Boundary conditions and loadings

Boundary conditions

$P2P3$:	$DX=0.$	$DY=0.$	$DZ=0.$	$DRX=0$	$DRY=0$	$DRZ=0$
$P3P4$:	$DX=0.$	$DY=0.$	$DZ=0.$	$DRX=0$	$DRY=0$	$DRZ=0$

Symmetry:

$P1P2$:		$DY=0.$	$DRX=0.$		$DRZ=0.$
$P4P1$:	$DX=0.$			$DRY=0.$	$DRZ=0.$

One seeks the successive states of balance under the loading made up of the surface force given in the total reference mark:

$$f_z(t)=t$$

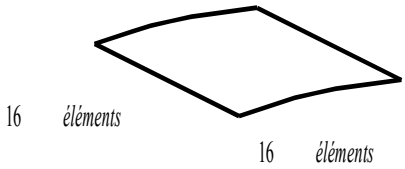
t being the pseudonym time.

One is only interested in the component vertical of displacement in P_1.

2 Reference solution

2.1 Method of calculating used for the 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 in the calculation of reference is a regular grid of 16×16 quadrilateral elements with 4 nodes each one.

2.2 Results of reference

History of vertical displacement DZ in meters with the node charged $P1$

Moment	Surface force fz (N)	DZ in $P1$ (m)
0.2	0.2	– 1.043E-01
0.4	0.4	– 3.935E-01
0.7	0.7	– 5.13E-01

2.3 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: Beams and Plates”, Hermes, Paris, 1992

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

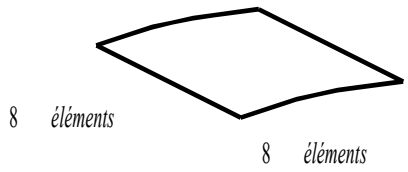
4) PH. JETTEUR, Kinematic Non Linéaire of the Hulls. Report SAMTECH, Contract PP/GC - 134/96, 1998

3 Modeling A

3.1 Characteristics of modeling

Modeling COQUE_3D

Element MEC3QU9H (voluminal hull 3D) - regular Grid



3.2 Characteristics of the grid

Many nodes: 320

Number of meshs and type: 64 QUAD9

The grid is twice less fine than that of the reference solution.

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

History of vertical displacement DZ with the node charged

Moment	Surface force fz	Reference
0.2	0.2	– 1.043E-01
0.4	0.4	– 3.935E-01

3.5 Remarks

The value by default of COEF_RIGI_DRZ = 0.00001 was selected (value generally used in linear analysis).

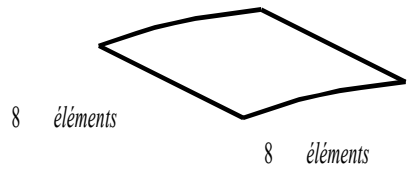
4 Modeling B

It is identical to modeling A, except for the loading which is following: it is reactualized according to the geometry. One goes until the moment 0.7 by step of time of 0.1 . There is thus 7 pas de charges.

4.1 Characteristics of modeling

Modeling COQUE_3D

Element MEC3QU9H (voluminal hull 3D) - regular Grid



4.2 Characteristics of the grid

Many nodes: 320

Number of meshs and type: 64 QUAD9

The grid is twice less fine than that of the reference solution.

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 values of reference come from software the SAMCEF software. They are given as an indication.

History of vertical displacement DZ with the node charged

Moment	Surface force fz	Reference (The SAMCEF software)
0.4	0.4	– 3.93E-01
0.7	0.7	– 5.13E-01

4.5 Remarks

Rotations not being very large, it is enough to use the value by default of COEF_RIGI_DRZ = 0.00001 (value generally used in linear analysis).

5 Summary of the results

The facts of the case correspond to a thin hull $\frac{h}{L}=0.625\%$ what is severe for the finite element triangle MEC3TR7H (not presented here because presenting a case of blocking to transverse shearing). The deformation is primarily membranous and rotations remain moderate.

The reference solution obtained by software the SAMCEF software is digital and its grid twice finer than that used here. Its model finite elements rests on an approach in resulting efforts with a rotational formulation [bib3]. Approach chosen in *Code_Aster* forced plane with a formulation Lagrangian total [R3.07.04] is 3D. The quality of the got results is good. The variation compared to this solution is lower than 0.5% for the vertical displacement of the central point.