SSNV140 - Cylindrical panel clamped

Abstract:

One presents in this test a quasi static computation of clamped elastic cylindrical panel subjected to a surface force given either in the total reference, or in the local coordinate system. This force is constant in the first case and following in the second case. One tests geometrical nonlinear `modelization` COQUE_3D thus by means of the algorithm of update of large rotations 3D `GROT_GDEP` of `STAT_NON_LINE`, as well as the processing of the following pressures for modelization `COQUE_3D`. The reference solution which is numerical is obtained with software the SAMCEF software.

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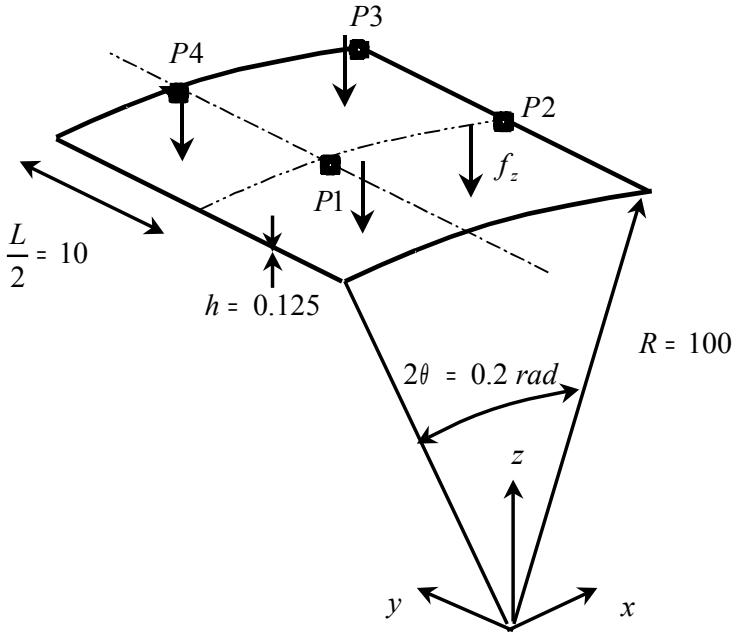
1 Problem of reference

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 for modelization a:

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

given in the local coordinate system for the modelization b:

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

which leads to the membrane compression of the panel, accompanied by localised bendings. In the case of the modelization B, n is the norm with the reactualized geometry of the panel.

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

1.2 Material properties

Behavior elastic:

$$E = 450000\,\mathrm{Pa}\ ;\ \nu = 0.3$$

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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 equilibrium under the loading made up of the surface force given in the total reference:

$$f_z(t) = t$$

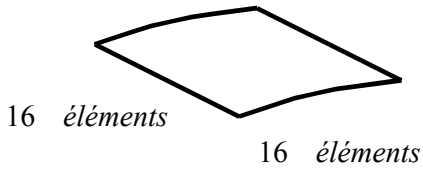
t being the pseudonym time.

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]. The modelization is based on a theory of shell in resulting forces with a CO-rotational formulation [bib3] and a discretization DSQ [bib2].



The mesh considered in the computation of reference of quadrilateral elements with 4 nodes 16×16 each one is a regular mesh.

2.2 Results of reference

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

Urgent	Forces surface 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 Volume Elements, 1998

2) J-L. Batoz, G.Dhatt, “Modelization of 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, Nonlinear Kinematics of the Shells. Ratio SAMTECH, Contract PP/GC - 134/96, 1998

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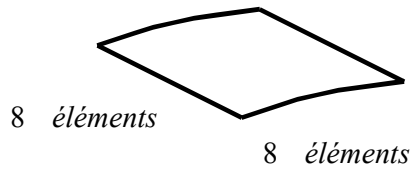
3 Modelization A

3.1 Characteristic of the modelization

Modelization COQUE_3D

Element MEC3QU9H (shell 3D voluminal) - regular Mesh



3.2 Characteristics of the mesh

Many nodes: 320

Number of meshes and type: 64 QUAD9

The mesh are twice less fine than that of the reference solution.

3.3 Functionalities tested

The modelization COQUE_3D in nonlinear geometrical.
The static algorithm of update of large rotations GROT_GDEP of STAT_NON_LINE.

3.4 Values tested

History of vertical displacement DZ to the node charged

Urgent	Forces surface fz	Reference
0.2.0.2		– 1.043E-01
0.4.0.4		– 3.935E-01

3.5 Remarks

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

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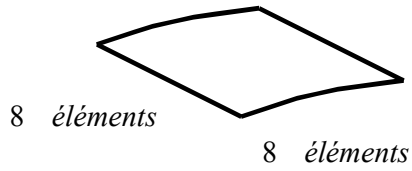
4 Modelization B

It is identical to the modelization A, except for the loading which is following: it is reactualized according to the geometry. One goes until time 0.7 by time step of 0.1. There are thus 7 steps of load.

4.1 Characteristics of the modelization

Modelization COQUE_3D

Element MEC3QU9H (shell 3D voluminal) - regular Mesh



4.2 Characteristics of the mesh

Many nodes: 320

Number of meshes and type: 64 QUAD9

The mesh are twice less fine than that of the reference solution.

4.3 Functionalities tested

The modelization COQUE_3D in nonlinear geometrical.
The static algorithm of update of large 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 to the node charged

Urgent	Forces surface 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 default value of COEF_RIGI_DRZ = 0.00001 (value generally used in linear analysis).

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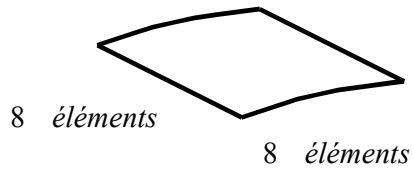
5 Modelization C

It is identical to the modelization A, except for the functionality tested, COMP_INCR instead of COMP_ELAS. As in both cases, one remains in the elastic domain, one must thus find the same results.

5.1 Characteristics of the modelization

Modelization COQUE_3D

Element MEC3QU9H (shell 3D voluminal) - regular Mesh



5.2 Characteristics of the mesh

Many nodes: 320

Number of meshes and type: 64 QUAD9

The mesh are twice less fine than that of the reference solution.

5.3 Functionalities tested

The modelization COQUE_3D in nonlinear geometrical.
The static algorithm of update of large rotations GROT_GDEP of STAT_NON_LINE.

5.4 Values tested

History of vertical displacement DZ to the node charged

Urgent	Forces surface fz	Reference
0.2.0.2		– 1.043E-01
0.4.0.4		– 3.935E-01

5.5 Remarks

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

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6 Summary of the results

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

The reference solution obtained by software the SAMCEF software is numerical and its mesh twice finer than that used here. Its model finite elements rests on an approach in resulting forces with a rotational formulation [bib3]. The approach chosen in *Code_Aster* is 3D plane stresses with a formulation Lagrangian total [R3.07.04]. 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.

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