SSNS501 - Large displacements of a cylindrical panel simply supported

Summarized:

This test represents a computation of stability of a cylindrical panel simply supported subjected to a force concentrated in its center. The behavior of the panel changes completely and clearly shows points of return in load and displacement "snap-through/snap-back". In this case a control in displacement diverges and a control in length of arc must be selected.

It makes it possible to validate the modelization finite elements `COQUE_3D` with meshes the TRIA7 and QUAD9 in the geometrical nonlinear quasi-static field in the presence of strong instabilities.

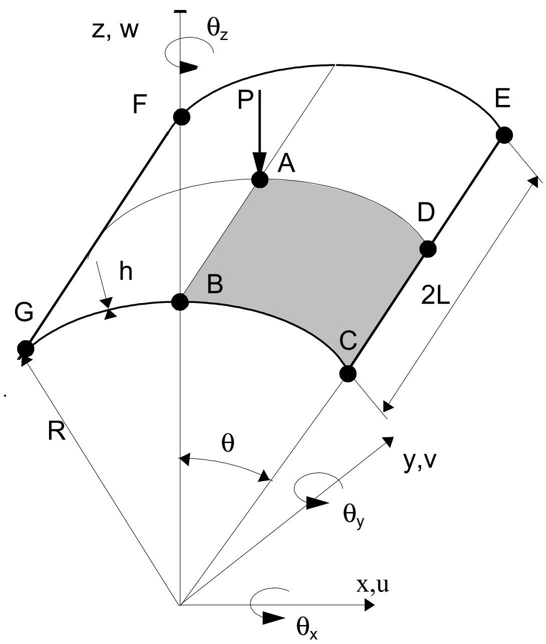
Displacements and the critical load are compared with a numerical reference solution.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

1 Problem of reference

1.1 Geometry



L = 0.254 m
R = 2.54 m
h = 0.00635 m
θ = 0.1 rd

1.2 Properties of the material

the properties of the material constituting the plate are:

$E=3.10275\times10^{9}\,Pa$	Modulus Young
$\nu=0.3$	Poisson's ratio

1.3 Boundary conditions and loadings

- Boundary conditions: panel simply supported on the sides CE and GF (null displacements, free rotations)

- One seeks the successive states of equilibrium under a load P imposed on the point A .

1.4 Initial conditions

Without Reference solution

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

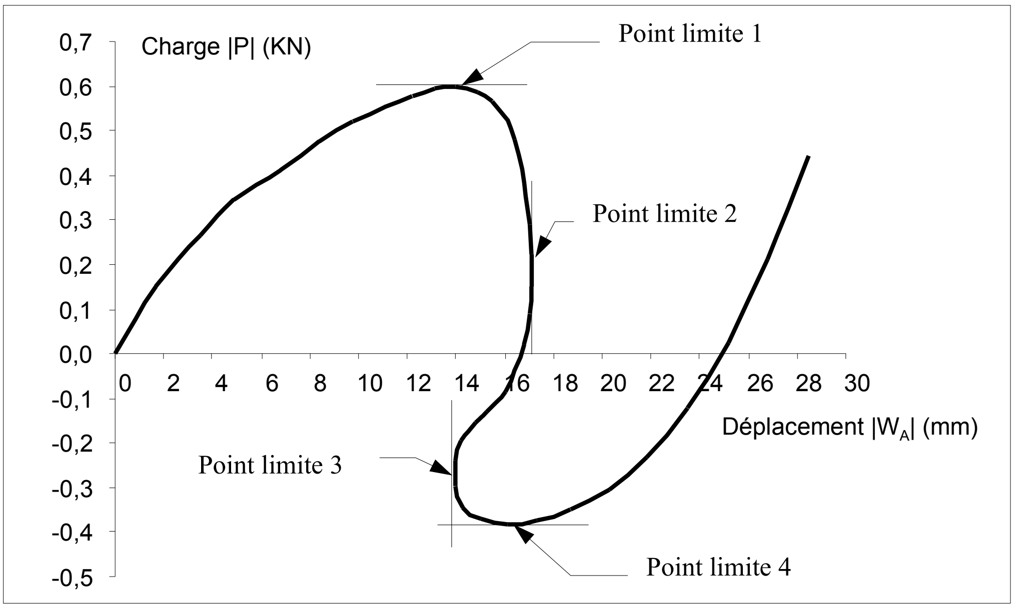
2 object

2.1 Method of calculating used for the reference solution

the reference solution was obtained with a finite element of shell DKT24 (mesh 4x6) to 4 nodes with 6 degrees of freedom per node in Total Lagrangian formulation. This solution is described in details in [bib2].

2.2 Results of reference

W_A $\times 10^{-3m}$	Charges P (KN)	Load $P/Pmax$	W_A $\times 10^{-3m}$	Charges P (KN)	Load $P/Pmax$	W_A $\times 10^{-3m}$	Charges P (KN)	Load $P/Pmax$
0.0	0.000	0.0000	– 16.4	0.480	0.8000	– 14.0	– 0.295	– 0.4916
– 1.7	0.150	0.2500	– 16.7	0.415	0.6916	– 14.3	– 0.345	– 0.5750
– 3.5	0.265	0.4416	– 16.9	0.350	0.5833	– 15.0	– 0.370	– 0.6166
– 4.9	0.345	0.5750	– 17.0	0.290	0.4833	– 16.1	– 0.380	– 0.6333
– 6.8	0.410	0.6833	– 17.1	0.225	0.3750	– 17.3	– 0.375	– 0.6250
– 8.4	0.475	0.7916	– 17.1	0.150	0.2500	– 18.7	– 0.350	– 0.5833
– 9.8	0.520	0.8666	– 17.0	0.090	0.1500	– 20.3	– 0.305	– 0.5083
– 11.1	0.555	0.9250	– 16.8	0.020	0.0333	– 21.8	– 0.230	– 0.3833
– 12.2	0.580	0.9666	– 16.4	– 0.035	– 0.0583	– 23.5	– 0.120	– 0.2000
– 13.1	0.595	0.9916	– 16.0	– 0.085	– 0.1416	– 25.2	0.025	0.0416
– 14.0	0.600	1.0000	– 15.3	– 0.130	– 0.2166	– 26.8	0.210	0.3500
– 14.9	0.585	0.9750	– 14.8	– 0.155	– 0.2583	– 28.5	0.445	0.7416
– 15.5	0.565	0.9416	– 14.2	– 0.195	– 0.3250			
– 16.1	0.525	0.8750	– 14.0	– 0.240	– 0.4000			



2.3 Uncertainties on the solution

Lower than 2%, numerical solution

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

2.4 bibliographical References

1) HAMMADI Fodil: Formulation and evaluating of finite elements with C° continuity of the geometry for the linear and nonlinear analysis of the shells.

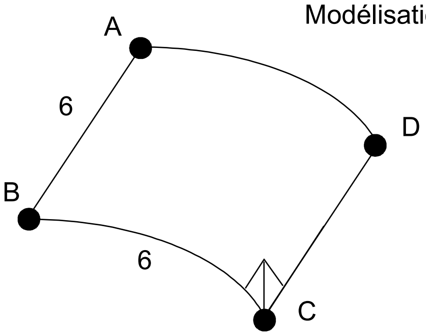
2) JAAMEI S.: Study of various Lagrangian formulations for the nonlinear analysis of plates and thin shells elastoplastic in large displacements and large rotations, Doctorate, University of Technology of Compiegne 1986.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

3 Modelization A

3.1 Characteristic of the modelization



Modélisation COQUE_3D (TRIA7)

Conditions aux limites :
- Côté CD : u = v = w = 0

Conditions de symétrie :
- Côté AB : $u = \theta_y = \theta_z = 0$
- Côté AD : $v = \theta_x = \theta_z = 0$

On modélise un quart de la plaque.

Les états successifs d'équilibre sont obtenus grâce à une méthode de pilotage par longueur d'arc.

Dans ce cas, $ETA\_PILOTAGE = \frac{p}{p_{max}}$

3.2 Characteristics of the mesh

Many nodes: 241
Number of meshes and type: 72 TRIA7

3.3 Values tested

Identification	Times	Reference	*Aster*	% difference
Not limit n°1				
`DZ`	1.03	– 0.0140	– 0.01322	– 5.573
`Eta_PILOTAGE`	1.03	1.0	0.9729	– 2.471
Point limits n°2				
`DZ`	1.78	– 0.0171	– 0.01696	– 0.847
`Eta_PILOTAGE`	1.78	0.375 0.250	0.07513	– 75.96
Point limits n°3				
`DZ`	2.3	– 0.0140	– 0.01458	4.176
`Eta_PILOTAGE`	2.3	– 0.400 – 0.492	– 0.533	19.67
Point limits n°4				
`DZ`	2.48	– 0.0161	– 0.01617	0.452
`Eta_PILOTAGE`	2.48	– 0.633	– 0.6442	1.717

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

3.4 Remarks

the strategy of computation used breaks up into two stages:

- computation in loading imposed to $P=582.\mathrm{N}$ corresponding on 97% of the critical load,
- computation in "imposed displacement": then, one imposes a displacement imposed by means of the technique of the length of arc imposed on all the structure (option LONG_ARC in STAT_NON_LINE).

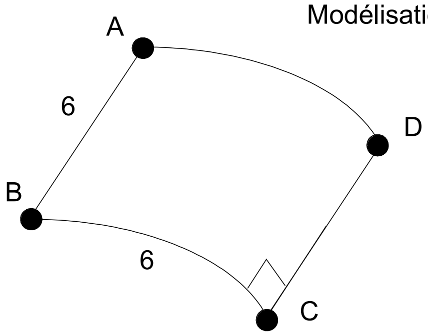
The use of the technique of length of arc makes difficult the definition of the value of reference to be introduced into command TEST_RESU, since these values cannot be imposed. To define the values of reference, we searched the values of DZ closest possible to those listed in the table of [the §2.2] and we deferred the values of the parameter of control which one was to obtain for the values of DZ in question.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

4 Modelization B

4.1 Characteristic of the modelization



Modélisation COQUE_3D (QUAD9)

Conditions aux limites :
- Côté CD : u = v = w = 0

Conditions de symétrie :
- Côté AB : u = $\theta_y = \theta_z = 0$
- Côté AD : v = $\theta_x = \theta_z = 0$

4.2 Characteristics of the mesh

Many nodes: 169
Number of meshes and type: 36 QUAD9

4.3 Values tested

Identification	Times	Reference	*Aster*	% difference
Not limit n°1				
DZ	1.03	– 0.0140	– 0.01318	– 5.886
Eta_PILOTAGE	1.03	1.0	0.9724	– 2.760
Point limits n°2				
DZ		– 0.0171	– 0.01702	– 0.462
Eta_PILOTAGE		0.375 0.250	0.101	– 67.69
Point limits n°3				
DZ		– 0.0140	– 0.01446	3.269
Eta_PILOTAGE		– 0.400 – 0.492	– 0.558	25.177
Point limits n°4				
DZ		– 0.0161	– 0.0161	– 0.007
Eta_PILOTAGE		– 0.633	– 0.640	1.120

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

4.4 Remarks

the strategy of computation used breaks up into two stages:

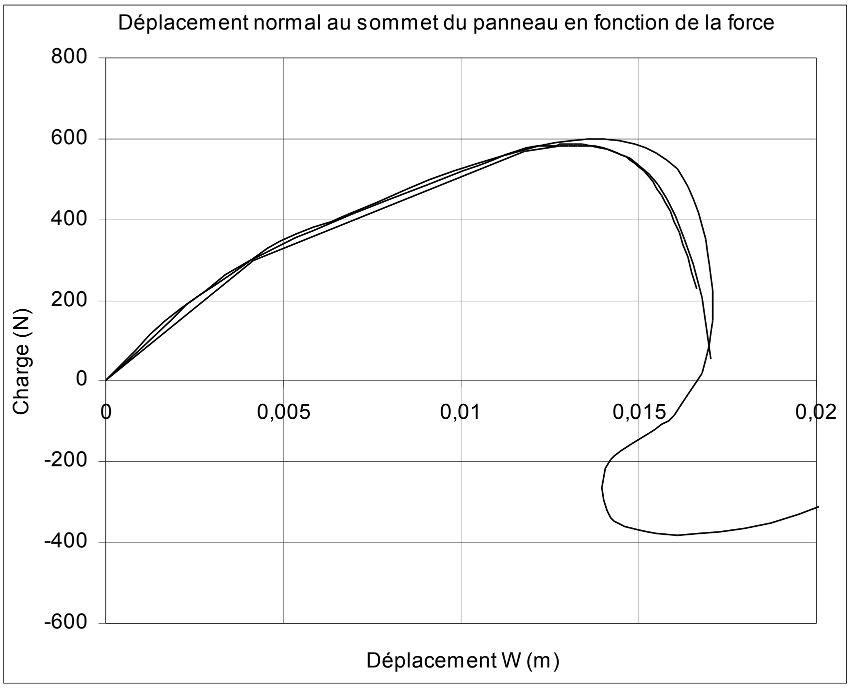
computation in loading imposed to $P=582.\mathrm{N}$ corresponding on 97% of the critical load,
computation in imposed displacement: then, one imposes a displacement imposed by means of the technique of imposed length of arc (option LONG_ARC in STAT_NON_LINE).

The use of the technique of length of arc makes difficult the definition of the value of reference to be introduced into command TEST_RESU, since these values cannot be imposed. To define the values of reference, we searched the values of DZ closest possible to those listed in the table of [the §2.2] and we deferred the values of the parameter of control which one was to obtain for the values of DZ in question.

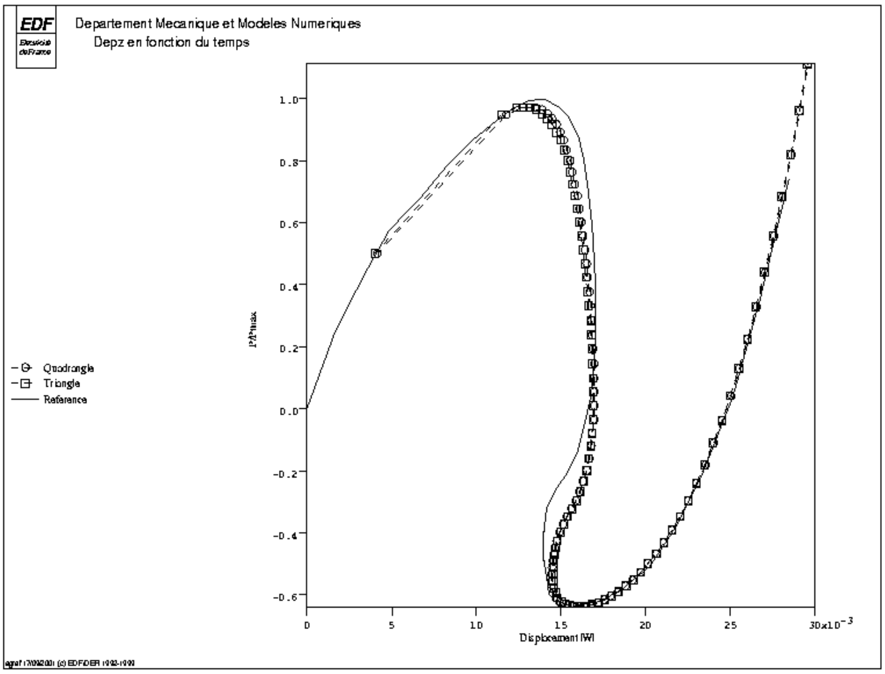
Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

5 Summary of the results



Appears 7-a: Normal displacement at the top of the panel according to the applied force. Enlarging around boundary point 1



Appears 7-b: Normal displacement at the top of the panel according to the force appliqueenormalized by its maximum value

the results for two Yield-point loads 1 and 4 are correct. The maximum error is of 2.5% for mesh TRIA3 and 2.8% for mesh QUAD9. On the other hand, the error on vertical displacement is more important. It is of 5.6% for mesh TRIA7 and 5.9% for mesh QUAD9.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)

The results between two Yield-point loads 1 and 4 are qualitatively correct. One detects well boundary points 2 and 3. Quantitatively the values of displacements for these points are good with less than 1% for boundary point 2 and with less than 5% for boundary point 3. On the level of the corresponding loads, the load as in boundary point 2 is very strongly underestimated (about 70%) and that as in boundary point 3 strongly over-estimated (about 20%).

Whatever the mesh, the pre-FLAMBEMENT behavior is correctly evaluated. The pace in post - buckling makes it possible to determine correctly displacements as in boundary points 2 and 3. The loads obtained are further away from the reference solution. From boundary point 4, one finds a good agreement between the reference and our solution.

The coefficient of correction of transverse shears A_CIS was put at 0.833 , corresponding to the thick shells. The value ($2500=10^6\times H/L$) which should have been taken into account does not make it possible to carry out computations, because of a bad conditioning of the stiffness matrixes.

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

Licensed under the terms of the GNU FDL (http://www.gnu.org/copyleft/fdl.html)