SSNS116 – Flexible membrane under actual weight

Summary:

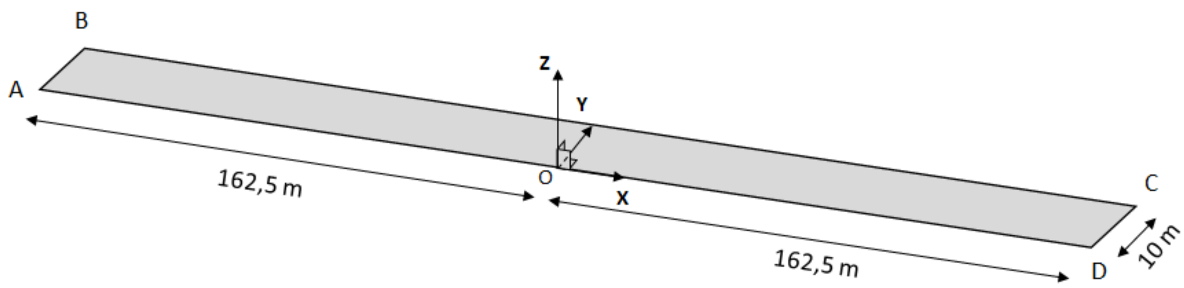
The objective of this test is to validate the operation of the element MEMBRANE into large S deformations for various types of meshs (linear, quadratic and biquadratic) E N beginning again and adapting the case test chain under actual weight (SN L 114) . It is compared S result S with one solution semi-analytical .

O N carries out also the comparison of the results of the membrane subjected to gravity (GRAVITY) with those of the membrane subjected to a nonfollowing pressure (PRES_REP with TYPE_CHARGE=' FIXE_CSTE') , of amplitude and of direction chosen such S that the resultants are identical. They thus are validated two features .

1 Problem of reference

1.1 Geometry

One is considered rectangle of length $325\,m$ and of width $10\,m$ in the plan $(0, X, Y)$.



The thickness of the membrane is indicated in `AFFE_CARA_ELEM` via the keyword `THICK` and is worth $e=2{,}2783.10^{-5}\,m$. This thickness is selected in order to obtain a mass equal to that used in the case test `SNL114`, with identical density.

1.2 Properties of material

The material is veryrubber band quasi-incompressible isotropic whose properties are:

- $E=57\,000\,MPa$
- $\nu=0.49$
- $\rho=2\,844{,}23\,kg/m^3$

One uses the law of behavior of Coming Saint Kirchhoff.

1.3 Boundary conditions and loadings

OnS edgeS AB and CD : $DX=0$, $DZ=0$.
On edge AD : $DY=0$.
Gravity is applied to the whole model, it is worth $g=9{,}81\,m/s^2$ and is directed according to (0.0, - 1) in the reference mark (X, Y, Z).
nonfollowing pressure is applied to the whole model, it is worth $p=\rho * e * g \approx 0{,}6357\,Pa$ and is directed according to $(0{,}0,-1)$ in the reference mark (X, Y, Z).

One treats the two loadings separately.

1.4 Initial conditions

One informs an initial tension of $10\,MPa$ in `AFFE_CARA_ELEM` via the keyword `N_INIT`. This tension disappears after the first increment from Newton.

2 Reference solution

2.1 Method of calculating

The calculation of the semi-analytical solution is detailed in [1] (§2.1).

2.2 Sizes and results of reference

Vertica displacement below is specifiedL calculated at the point O in LE model semi-analytical :

Size	Identification	Reference solution
Displacement	Not O - DZ	-6.352 m

2.3 Uncertainties on the solution

Semi-analytical solution: the digital resolution of the equation gives a value to 10^{-3} near.

2.4 Bibliographical references

[1] SSNL114 – Heavy cable with thermal dilation, documentation of validation of *Code_Aster*. [V6.02.114].

3 Modeling A

3.1 Characteristics of modeling

A modeling is used MEMBRANE into largeS deformationS (DEFORMATION=' GROT_GDEP') with the law of behavior of Coming Saint Kirchhoff (RELATION=' ELAS_MEMBRANE_SV'). Linear elements are used.

3.2 Characteristics of the grid

The grid contains 132 elements of the type QUAD4.

3.3 Sizes tested and results

Displacement is tested in the center of the membrane subjected to gravity, out of O, compared to the semi-analytical solution.

Identification	Type of reference	Value of reference (m)	Precision
Not O - DZ	'ANALYTICAL'	-6.352	0.05%

One compares the results got with the nonfollowing pressure with those of gravity.

Identification	Type of reference	Value of reference (m)	Precision
Not O - DZ	'AUTRE_ASTER'	-6.34942183815	0.0001%

3.4 Remarks

Linear research was used (RECH_LINEAIRE) to reach convergence.

4 Modeling B

4.1 Characteristics of modeling

A modeling is used MEMBRANE into largeS deformationS (DEFORMATION=' GROT_GDEP') with the law of behavior of Coming Saint Kirchhoff (RELATION=' ELAS_MEMBRANE_SV'). Elements are used quadratiqube.

4.2 Characteristics of the grid

The grid contains 132 elements of the type QUAD8.

4.3 Sizes tested and results

Displacement is tested in the center of the membrane subjected to gravity, out of O, compared to the semi-analytical solution.

Identification	Type of reference	Value of reference (m)	Precision
Not O - DZ	'ANALYTICAL'	-6.352	0.05%

One compares the results got with the nonfollowing pressure with those of gravity.

Identification	Type of reference	Value of reference (m)	Precision
Not O - DZ	'AUTRE_ASTER'	-6.34895127982	0.0001%

4.4 Remarks

Linear research was used (RECH_LINEAIRE) to reach convergence.

5 Modeling C

5.1 Characteristics of modeling

A modeling is used MEMBRANE into largeS deformationS (DEFORMATION=' GROT_GDEP') with the law of behavior of Coming Saint Kirchhoff (RELATION=' ELAS_MEMBRANE_SV'). Elements are used bi--quadratiqube.

5.2 Characteristics of the grid

The grid contains 132 elements of the type QUAD9.

5.3 Sizes tested and results

Displacement is tested in the center of the membrane subjected to gravity, out of O, compared to the semi-analytical solution.

Identification	Type of reference	Value of reference (m)	Precision
Not O - DZ	'ANALYTICAL'	-6.352	0.05%

One compares the results got with the nonfollowing pressure with those of gravity.

Identification	Type of reference	Value of reference (m)	Precision
Not O - DZ	'AUTRE_ASTER'	-6.34895127557	0.0001%

5.4 Remarks

Linear research was used (RECH_LINEAIRE) to reach convergence.

6 Summary of the results

This document validates the element of MEMBRANE in great deformations for Lbe linear, quadratic and biquadratic elements, as well as the options of loading GRAVITY and PRES_REP (with TYPE_CHARGE=' FIXE_CSTE') applied to the membranes. This validation is based on the comparison with an semi-analytical result and is supplemented by several tests of not-regression.

One gets results very close to the reference solution ($<0,05\%$) in all the tests, that confirms that the model approaches that of the heavy cable. Better results could undoubtedly have been obtained with a weaker membrane of width, in order to approach the assumption of the cable.

In addition, Dyears this model, the results converge much more quickly for linear elements without for as much to degrade the solution in displacement.