SSLV07 - Stretching of a parallelepiped under its own Summarized

weight:

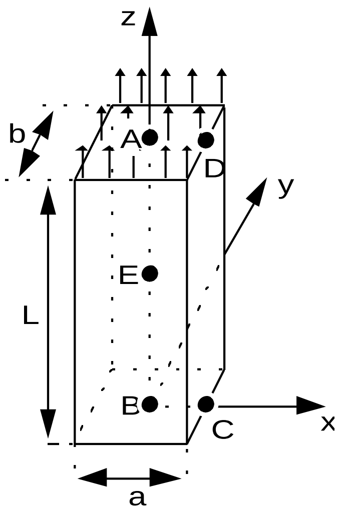
This static test 3D makes it possible to validate the following functionalities:

- loading in inertia loading (gravity or internal force) and in uniform pressure,
- computation of the potential energy of structure,
- estimator of error in residue (modelization incompressible
- B) elements (modelization D).

It understands 4 modelizations. Its interest lies in the description of the effect of the Poisson's ratio (of contraction).

1 Problem of reference

1.1 Geometry



Hauteur : $L=3\,m$
Largeur : $a=1\,m$
Epaisseur : $b=1\,m$

Coordinated of the points (in meters):

	A	B	C	D	E
x	0.	0.	0.5.0.5		0.
y	0.	0.	0.	0.	0.
z	3.	0.	0.	3.	1.5

1.2 Material properties

$E=2\,10^{11}\,MPa$

$\nu=0.3$

$\rho=7\,800\;kg/m^3$

1.3 Boundary conditions and loadings

Point: A ($u=v=w=0$, $\theta_x=\theta_y=\theta_z=0$)

Inertia loading following the uniform z

axis Forced to the tension for the upper face: $\sigma_z=\rho\,g\,L=+229\,554.\,Pa$

2 Reference solution

2.1 Method of calculating used for the reference solution

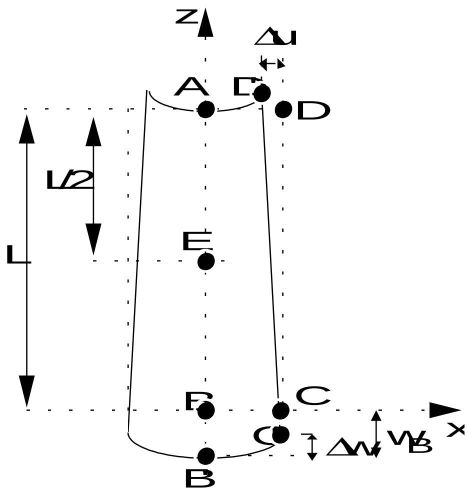
the reference solution is that given in file SSLV07/89 of the guide VPCS which presents the method of calculating in the following way:

Displacements:

$$u=-\frac{\nu\rho g x z}{E}$$
$$v=-\frac{\nu\rho g y z}{E}$$
$$w=\frac{\rho g z^2}{2E}+\frac{\nu\rho g}{2E}(x^2+y^2)-\frac{\rho g L^2}{2E}$$

Stresses:

$$\sigma_{zz}=\rho g z$$
$$\sigma_{xx}=\sigma_{yy}=\sigma_{xy}=\sigma_{yz}=\sigma_{zx}=0$$



2.2 Results of reference

Displacement of the points B C, D and E.

Stresses σ_{zz} in A and E.

2.3 Uncertainty on the analytical

solution Solution.

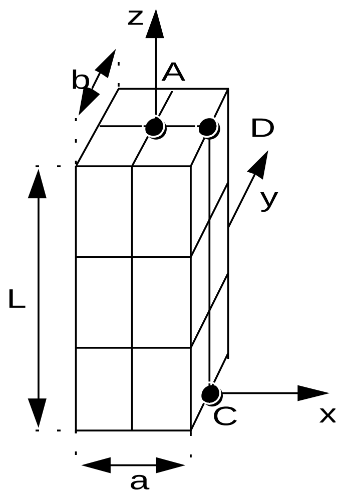
2.4 Bibliographical references

1) S.P. TIMOSHENKO. Theory of elasticity. Paris. Polytechnic library. CH. Béranger, p.279 with 282 (1961).

3 Modelization A

3.1 Characteristic of the modelization

3D



Cutting: 3 in height
2 in width and thickness
meshes hexa20

limiting Conditions: $DX=DY=0$ on $]AB]$, $DY=0$ in D, $DZ=0$ A

Names of the nodes:

$Point\ A=N59$ $Point\ B=N53$
$Point\ C=N12$ $Point\ D=N18$
$Point\ E=N56$

3.2 Characteristics of the mesh

Many nodes: 111

Number of meshes and types: 12 HEXA20

3.3 Quantities tested and Standard

Localization	results of value (m)	Reference
Point B	U_B	0.
	V_B	0.
	W_B	$-1.721655\ 10^{-6}$
Item C	U_C	0.
	V_C	0.
	W_C	$-1.707308\ 10^{-6}$
Point D	U_D	$-1.721655\ 10^{-7}$
	V_D	0.

	W_D	1.434713 10-8
Item E	U_E	0.
	V_E	0.
	W_E	– 1.291241 10-6
	(Pa)	
Point A	σ_{zz}	2.29554 105
Item E	σ_{zz}	1.14777 105

3.4 Remarks

The modelization in HEXA20 is completely acceptable for this coarse mesh. This modelization also makes it possible to test the good taking into account of the application of gravity a list of meshes or mesh groups targeted.

4 Modelization B

4.1 Characteristic of the modelization

3D

Cutting: 12 in height
8 in width and limiting
thickness meshes

HEXA8 Conditions: $DX=DY=0$ on $]AB[$, $DY=0$ in D , $DZ=0$ A

Names of the nodes: $Point\ A=N533$ $Point\ B=N521$
$Point\ C=N989$ $Point\ D=N1001$
$Point\ E=N527$

4.2 Characteristics of the mesh

Many nodes: 1053

Number of meshes and types: 768 HEXA8

4.3 Remarks

This modelization make it possible to test the estimator of error in residue in 3D.

4.4 Quantities tested and Standard

Localization	results of value (m)	Reference
Point B	U_B	0.
	V_B	0.
	W_B	$-1.721655\ 10^{-6}$
Item C	U_C	0.
	V_C	0.
	W_C	$-1.707308\ 10^{-6}$
Point D	U_D	$-1.721655\ 10^{-7}$
	V_D	0.
	W_D	1.434713 10-8
Item E	U_E	0.
	V_E	0.
	W_E	– 1.291241 10-6
	(Pa)	
Item A	σ_{zz}	2.29554 105
HEX12	relative error	1.15
HEX600	relative error	1.30

4.5 Remarks

The mesh remains insufficient for a modelization in HEXA8. The total relative error is weak (3%) but meshes exceeds 20% on some.

5 Modelization C

5.1 Characteristic of the modelization

3D

Cutting: 12 in height
8 in width and thickness
meshes hexa8

limiting Conditions: $DX=DY=0$ on $[AB]$, $DY=0$ in D, $DZ=0$ A

Names of the nodes: $Point\ A=N533$ $Point\ B=N521$
$Point\ C=N989$ $Point\ D=N1001$
$Point\ E=N527$

5.2 Characteristics of the mesh

Many nodes: 1053

Number of meshes and types: 768 HEXA8

5.3 Remarks

This modelization make it possible to test key word `FORCE_INTERNE` in `AFFE_CHAR_MECA_F`.

5.4 Quantities tested and Standard

Localization	results of value (m)	Reference
Point B	U_B	0.
	V_B	0.
	W_B	$-1.721655\ 10^{-6}$
Item C	U_C	0.
	V_C	0.
	W_C	$-1.707308\ 10^{-6}$
Point D	U_D	$-1.721655\ 10^{-7}$
	V_D	0.
	W_D	1.434713 10-8
Item E	U_E	0.
	V_E	0.
	W_E	– 1.291241 10-6
	(Pa)	
Item A	σ_{zz}	2.29554 105

5.5 Remarks

The mesh remains insufficient for a modelization in HEXA8.

6 Modelization D

6.1 Characteristic of the modelization

3D

Cutting: 3 in height
2 in width and thickness
meshes hexa20

limiting Conditions: $DX=DY=0$ on $]AB]$, $DY=0$ in D, $DZ=0$ A

Names of the nodes: $Point\ A=N59$ $Point\ B=N53$
$Point\ C=N12$ $Point\ D=N18$
$Point\ E=N56$

6.2 Characteristics of the mesh

Many nodes: 111

Number of meshes and types: 12 HEXA20

6.3 Quantities tested and Standard

Localization	results of value (m)	Reference
Point B	U_B	0.
	V_B	0.
	W_B	$-1.721655\ 10^{-6}$
Item C	U_C	0.
	V_C	0.
	W_C	$-1.707308\ 10^{-6}$
Point D	U_D	$-1.721655\ 10^{-7}$
	V_D	0.
	W_D	1.434713 10-8
Item E	U_E	0.
	V_E	0.
	W_E	– 1.291241 10-6
	(Pa)	
Item A	σ_{zz}	2.29554 105
Item E	σ_{zz}	1.14777 105

6.4 Remarks

incompressible elements HEXA20 give the same results as the standard elements.

7 Standard summary of

the results of value (m)	Reference	*Hexa20* Aster (A)	*Aster* Hexa8 (B)
U_B	0.		
V_B	0.		
W_B	$-1.721655\ 10^{-6}$	< 0.1%	< 0.1%
U_C	0.		X
V_C	0.		
W_C	$-1.707308\ 10^{-6}$	< 0.1%	0.1%
U_D	$-1.721655\ 10^{-7}$	< 0.1%	– 2.2%
V_D	0.		
W_D	$1.434713\ 10^{-8}$	– 0.2%	– 15.5%
U_E	0.		
V_E	0.		
W_E	$-1.291241\ 10^{-6}$	< 0.1%	< 0.1%
(Pa)			
$A\ \sigma_{zz}$	2.29554 105	< 0.1%	– 5.3%
$E\ \sigma_{zz}$	1.14777 105	< 0.1%	< 0.1%

Modelization: A (HEXA20 cutting: 3 in Z, 2 in X and Y)
B (HEXA8 cutting: 12 in Z, 8 in X and Y)

The modelization in HEXA8 would require a mesh much finer.