

SSLV07 - Stretching of a parallelepiped under its own weight

Summary:

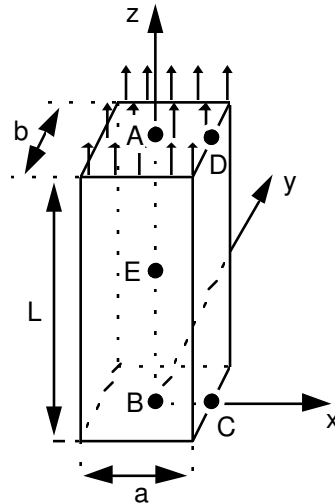
This static test 3D makes it possible to validate the following features:

- loading in actual weight (gravity or internal force) and in uniform pressure,
- calculation of the potential energy of the structure,
- estimator of error in residue (modeling B)
- incompressible elements (modeling D).
- use of `MACR_LIGN_COUP` on a concept `mult_elas` (modeling A)

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

1 Problem of reference

1.1 Geometry



Hauteur : $L = 3 \text{ m}$
 Largeur : $a = 1 \text{ m}$
 Epaisseur : $b = 1 \text{ m}$

Coordinates of the points (in meters):

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>x</i>	0.	0.	0.5	0.5	0.
<i>y</i>	0.	0.	0.	0.	0.
<i>z</i>	3.	0.	0.	3.	1.5

1.2 Material properties

$$E = 2 \cdot 10^{11} \text{ MPa}$$

$$\nu = 0.3$$

$$\rho = 7\,800 \text{ kg/m}^3$$

1.3 Boundary conditions and loadings

Not *A* : $(u=v=w=0, \theta_x=\theta_y=\theta_z=0)$

Actual weight following the axis *z*

Uniform constraint with traction for the higher face: $\sigma_z = \rho g L = +229\,554. \text{ Pa}$

2 Reference solution

2.1 Method of calculating used for the reference solution

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

Displacements:

$$u = -\frac{\nu \rho g x z}{E}$$

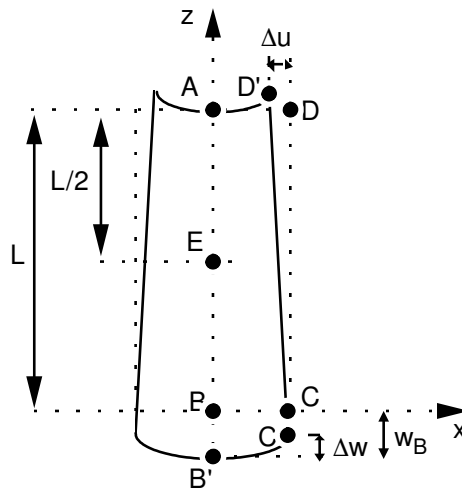
$$v = -\frac{\nu \rho g y z}{E}$$

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

Constraints:

$$\sigma_{zz} = \rho g z$$

$$\sigma_{xx} = \sigma_{yy} = \sigma_{xy} = \sigma_{yz} = \sigma_{zx} = 0$$



2.2 Results of reference

Displacement of the points B , C , D and E .

Constraints σ_{zz} in A and E .

2.3 Uncertainty on the solution

Analytical solution.

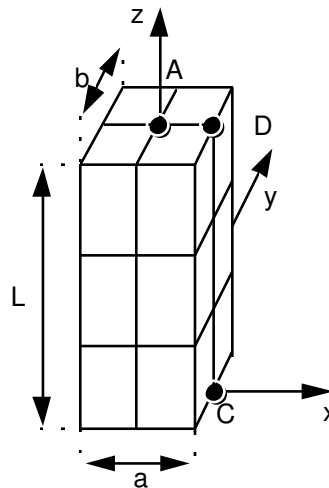
2.4 Bibliographical references

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

3 Modeling A

3.1 Characteristics of modeling

3D



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

Limiting conditions: $DX = DY = 0$ on $[AB]$, $DY = 0$ in D , $DZ = 0$ in 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 grid

Many nodes: 111

Many meshes and types: 12 HEXA20

3.3 Sizes tested and results

Localization	Type of value (m)	Reference
Not B	U_B	0.
	V_B	0.
	W_B	$-1.721655 \cdot 10^{-6}$
Not C	U_C	0.
	V_C	0.
	W_C	$-1.707308 \cdot 10^{-6}$
Not D	U_D	$-1.721655 \cdot 10^{-7}$
	V_D	0.

	W_D	1.434713 10 ⁻⁸
Not E	U_E	0.
	V_E	0.
	W_E	- 1.291241 10 ⁻⁶
	(Pa)	
Not A	σ_{zz}	2.29554 10 ⁵
Not E	σ_{zz}	1.14777 10 ⁵

Results resulting from MACR_LIGN_COUP on segment AB:

Tests of NON_REGRESSION are made on the tables resulting from MACR_LIGN_COUP applied to one CHAMP_GD . They constitute the values of reference 'AUTRE_ASTER' for the tables resulting from MACR_LIGN_COUP applied to a result of the type mult_elas .

Localization	Size	Value of Référence	Type of reference	Precision
Not E : ABSC_CURV = 1.5	Field Comp. DZ	DEPL, -	'NON_REGRESSION'	-
Not B : ABSC_CURV = 3	Field Comp. DZ	DEPL, -	'NON_REGRESSION'	-
Not E : ABSC_CURV = 1.5	Field Comp. DZ	DEPL, -1.29126028088E-06	'AUTRE_ASTER'	0.1%
Not B : ABSC_CURV = 3	Field Comp. DZ	DEPL, -1.72167375533E-06	'AUTRE_ASTER'	0.1%

3.4 Remarks

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

4 Modeling B

4.1 Characteristics of modeling

3D

Cutting: 12 in height
8 in width and thickness
meshs HEXA8

Limiting conditions: $DX = DY = 0$ on $[AB]$, $DY = 0$ in D , $DZ = 0$ in 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 grid

Many nodes: 1053
Many meshs and types: 768 HEXA8

4.3 Remarks

This modeling makes it possible to test the estimator of error in residue in 3D.

4.4 Sizes tested and results

Localization	Type of value (<i>m</i>)	Reference
Not <i>B</i>	U_B	0.
	V_B	0.
	W_B	$-1.721655 \cdot 10^{-6}$
Not <i>C</i>	U_C	0.
	V_C	0.
	W_C	$-1.707308 \cdot 10^{-6}$
Not <i>D</i>	U_D	$-1.721655 \cdot 10^{-7}$
	V_D	0.
	W_D	$1.434713 \cdot 10^{-8}$
Not <i>E</i>	U_E	0.
	V_E	0.
	W_E (<i>Pa</i>)	$-1.291241 \cdot 10^{-6}$
Not <i>A</i>	σ_{zz}	$2.29554 \cdot 10^5$
HEX12	relative error	1.15
HEX600	relative error	1.30

4.5 Remarks

The grid remains insufficient for a modeling in HEXA8. The total relative error is weak (3%) but exceeds 20% on certain meshes.

5 Modeling C

5.1 Characteristics of modeling

3D

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

Limiting conditions: $DX = DY = 0$ on AB , $DY = 0$ in D , $DZ = 0$ in 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 grid

Many nodes: 1053

Many meshes and types: 768 HEXA8

5.3 Remarks

This modeling makes it possible to test the keyword `FORCE_INTERNE` in `AFPE_CHAR_MECA_F`.

5.4 Sizes tested and results

Localization	Type of value (m)	Reference
Not <i>B</i>	U_B	0.
	V_B	0.
	W_B	$-1.721655 \cdot 10^{-6}$
Not <i>C</i>	U_C	0.
	V_C	0.
	W_C	$-1.707308 \cdot 10^{-6}$
Not <i>D</i>	U_D	$-1.721655 \cdot 10^{-7}$
	V_D	0.
	W_D	$1.434713 \cdot 10^{-8}$
Not <i>E</i>	U_E	0.
	V_E	0.
	W_E	$-1.291241 \cdot 10^{-6}$
Not <i>A</i>	(Pa)	
	σ_{zz}	$2.29554 \cdot 10^5$

5.5 Remarks

The grid remains insufficient for a modeling in HEXA8.

6 Modeling D

6.1 Characteristics of modeling

3D

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

Limiting conditions: $DX=DY=0$ on $]AB]$, $DY=0$ in D , $DZ=0$ in 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 grid

Many nodes: 111

Many meshs and types: 12 HEXA20

6.3 Sizes tested and results

Localization	Type of value (m)	Reference
Not B	U_B	0.
	V_B	0.
	W_B	$-1.721655 \cdot 10^{-6}$
Not C	U_C	0.
	V_C	0.
	W_C	$-1.707308 \cdot 10^{-6}$
Not D	U_D	$-1.721655 \cdot 10^{-7}$
	V_D	0.
	W_D	$1.434713 \cdot 10^{-8}$
Not E	U_E	0.
	V_E	0.
	W_E	$-1.291241 \cdot 10^{-6}$
	(Pa)	
Not A	σ_{zz}	$2.29554 \cdot 10^5$
Not E	σ_{zz}	$1.14777 \cdot 10^5$

6.4 Remarks

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

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7 Summary of the results

Type of value (<i>m</i>)	Reference	Aster Hexa20 (A)	Aster Hexa8 (B)
U_B	0.		
V_B	0.		
W_B	$-1.721655 \cdot 10^{-6}$	< 0.1%	< 0.1%
U_C	0.		X
V_C	0.		
W_C	$-1.707308 \cdot 10^{-6}$	< 0.1%	0.1%
U_D	$-1.721655 \cdot 10^{-7}$	< 0.1%	- 2.2%
V_D	0.		
W_D	$1.434713 \cdot 10^{-8}$	- 0.2%	- 15.5%
U_E	0.		
V_E	0.		
W_E	$-1.291241 \cdot 10^{-6}$	< 0.1%	< 0.1%
(<i>Pa</i>)			
$A \sigma_{zz}$	$2.29554 \cdot 10^5$	< 0.1%	- 5.3%
$E \sigma_{zz}$	$1.14777 \cdot 10^5$	< 0.1%	< 0.1%

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

Modeling in HEXA8 would require a grid much finer.