SSNV227 – Traction, in great displacements, of a bar made up of a material very-rubber band of the Mooney-Rivlin type

Summary:

This test Représente calculation in great displacements of a bar, made up of a material of the type Mooney-Rivlin soumhas a tractive effort.

Modeling With allows to test:

- modeling 3D with meshs HEXA20,
- a material of the type 'HYPER_ELAS'
- the loading of the following type TYPE_CHARGE=' SUIV'

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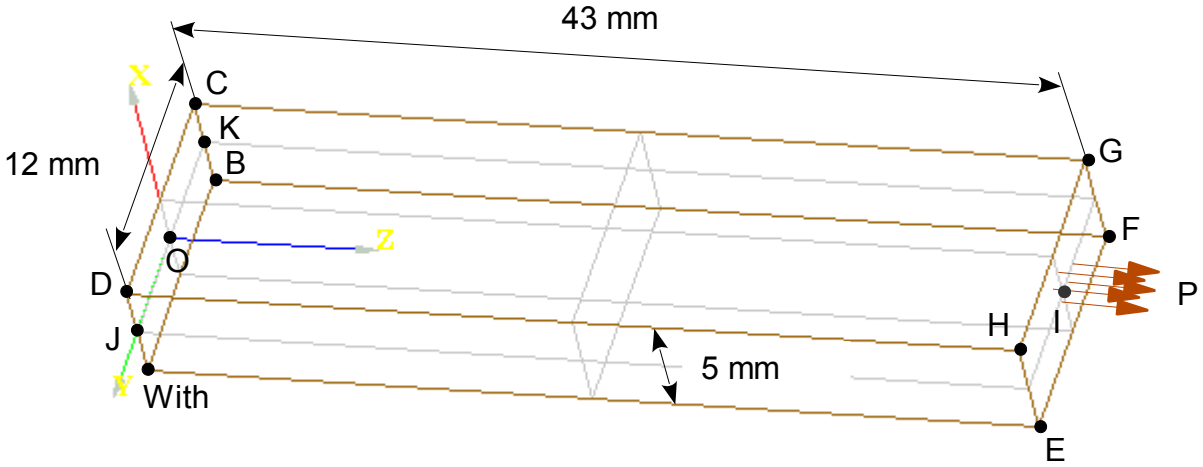
1 Problem of reference

1.1 Geometry



Not	$X(mm)$	$Y(mm)$	$Z(mm)$
A	-2.5	6.0	0.0
B	-2.5	-6.0	0.0
C	2.5	-6.0	0.0
D	2.5	6.0	0.0
E	-2.5	6.0	43.0
F	-2.5	-6.0	43.0
G	2.5	-6.0	43.0
H	2.5	6.0	43.0
I	0.0	0.0	43.0
J	0.0	6.0	0.0
K	0.0	-6.0	0.0
O	0.0	0.0	0.0

1.2 Material properties

The material is type Mooney-Rivlin, giftT them properties are the following ones:

- $C10=0.709 \quad N/mm^2$
- $C20=0. \quad N/mm^2$
- $C01=2.3456 \quad N/mm^2$
- Poisson's ratio $\nu=0,499$
- Module of compressibility $k=\frac{6(C10+C01)}{3(1-2*\nu)}=3054.6 \quad N/mm^2$

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1.3 Boundary conditions and loadings

- Boundary conditions
  - Face $ABCD$: $DZ=0$
  - Not O : $DY=0$
  - Points J, K : $DX=0$

- Pressure distributed uniformly on the face $EFGH$. Two types of calculation are carried out:

  - Calculation into small disturbance : the pressure applied is of $P=6.\times10^{-6} N/mm^2$.
  - Calculation in great displacements : the pressure applied grows linearly $P=0. N/mm^2$ until $6.0 N/mm^2$

1.4 Initial conditions

Without object

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2 Reference solution

2.1 Method of calculating used for the reference solution

Assumption of the Small Disturbances (HP)

Young modulus $E=6(C01+C10)\times(1+\nu)=18.3\,N/mm^2$
Section $A=60\text{mm}^2$

In HP, displacement DZ according to Z is such as:

$$K=\frac{DZ}{(A\times P)}$$

where:
K represent the stiffness of the bar
A represent the section of the bar ($A=60\text{mm}^2$)

Starting from balance the structure, one has $DZ\times E=Lz\times P$

where:
Lz represent the length of the following bar Z
E represent the Young Modulus $E=6(C01+C10)\times(1+\nu)=18.3154\,N/mm^2$

What gives us $DZ=\frac{Lz\times P}{E}=14{,}0865\,10^{-6}\,mm$

Great displacements: Following pressure

The loading is applied to the deformed structure (following pressure). The constraint according to Z (SIZZ) is thus identical to the pressure applied.

The other values of reference are values of not-regression obtained with modelledtion A.

2.2 Results of reference

Assumption of the Small Disturbances (HP)

Size	Component	Not	Type of Reference	Reference
DEPL	DZ	I	'ANALYTICAL'	$1.40865\times10^{-5}\,\text{mm}$

Great displacements: Following pressure

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Size	Component	Not	Type of Reference	Reference (mm)
DEPL	DX	G	'NON_REGRESSION'	-0.390384
	DY	G	'NON_REGRESSION'	0.390384
	DX	H	'NON_REGRESSION'	0.93691
	DY	H	'NON_REGRESSION'	-0.93691
	DZ	I	'NON_REGRESSION'	17.42597

Size	Component	Not	Type of Reference	Reference
EPSI_NOEU	$EPXX$	I	'NON_REGRESSION'	-0.15615
	$EPYY$		'NON_REGRESSION'	-0.15615
	$EPZZ$		'NON_REGRESSION'	0.405255
	$EPXY$		'NON_REGRESSION'	0.0
	$EPXZ$		'NON_REGRESSION'	0.0
	$EPYZ$		'NON_REGRESSION'	0.0

Size	Component	Not	Type of Reference	Reference N/mm^2
SIGM_NOEU	$SIXX$	I	'NON_REGRESSION'	0.0
	$SIYY$		'NON_REGRESSION'	0.0
	$SIZZ$		'ANALYTICAL'	6.0
	$SIXY$		'NON_REGRESSION'	0.0
	$SIXZ$		'NON_REGRESSION'	0.0
	$SIYZ$		'NON_REGRESSION'	0.0

2.3 Uncertainty on the solution

Analytical and digital solution.

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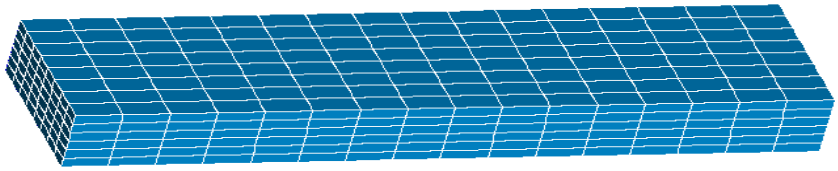
3 Modeling A

3.1 Characteristics of modeling



3.2 Characteristics of the grid

Many nodes: 3949
Number of meshs and type: 768 HEXA20

3.3 Sizes tested and results

Assumption of the Small Disturbances (HP)

Size	Component	Not	Type of Reference	Reference	Tolerance
DEPL	DX	G	'ANALYTICAL'	1.40865×10^{-5} mm	0.1%

Great displacements: Following pressure

Size	Component	Not	Type of Reference	Reference (mm)	Tolerance
DEPL	DX	G	'NON_REGRESSION'	-0.390384	0.1%
	DY	G	'NON_REGRESSION'	0.390384	0.1%
	DX	H	'NON_REGRESSION'	0.93691	0.1%
	DY	H	'NON_REGRESSION'	-0.93691	0.1%
	DZ	I	'NON_REGRESSION'	17.42597	0.1%

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Size	Component	Not	Type of Reference	Reference	Tolerance
EPSI_NOEU	*EPXX*	*I*	'NON_REGRESSION'	-0.15615	0.1%
	EPYY		'NON_REGRESSION'	-0.15615	0.1%
	EPZZ		'NON_REGRESSION'	0.405255	0.1%
	EPXY		'NON_REGRESSION'	0.0	0.001
	EPXZ		'NON_REGRESSION'	0.0	0.001
	EPYZ		'NON_REGRESSION'	0.0	0.001

Size	Component	Not	Type of Reference	Reference N/mm^2	Tolerance
SIGM_NOEU	*SIXX*	*I*	'NON_REGRESSION'	0.0	0.001
	SIYY		'NON_REGRESSION'	0.0	0.001
	SIZZ		'ANALYTICAL'	6.0	0.1%
	SIXY		'NON_REGRESSION'	0.0	0.001
	SIXZ		'NON_REGRESSION'	0.0	0.001
	SIYZ		'NON_REGRESSION'	0.0	0.001

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4 Summary of the results

The got results are satisfactory.

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