

SDLD02 - System mass-arises with 8 degrees of freedom

Summary:

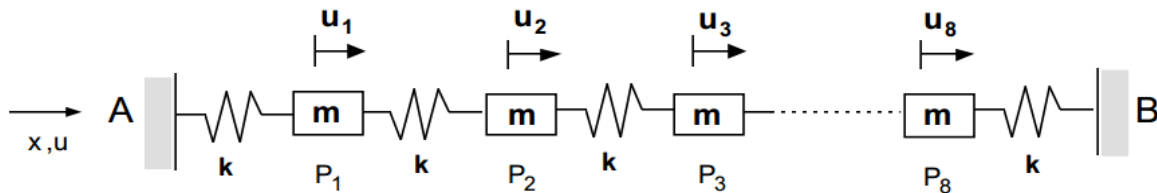
This two-dimensional problem consists in searching the frequencies and the modes of vibration of a mechanical structure made up of masses and springs. This CAS-test of Mechanics of the Structures corresponds to a dynamic analysis of a discrete model having a linear behavior.

This test allows a complete validation of the options of modeling of discrete rigidity and mass (without finite elements) offered by the order `AFFE_CARA_ELEM`. Four different modelings are proposed: two modelings for the discrete elements in translation and two others for the discrete elements in translation/rotation. In addition, various features of the orders `CALC_MODES` (calculation of values and clean vectors) and `NORME_MODE` (definition of the standard of a clean vector) are tested.

This test refers to a test `VPCS`, but it was modified. Indeed, the test `Code_Aster` direct the mechanical system towards an axis $3y=4x$, which makes it possible to validate the entry of the data in local reference mark.

1 Problem of reference

1.1 Geometry



Specific masses: $m_{P_1} = m_{P_2} = m_{P_3} = \dots = m_{P_8} = m$

Stiffnesses of connection: $k_{AP_1} = k_{P_1P_2} = k_{P_2P_3} = \dots = k_{P_8B} = k$

1.2 Material properties

Spring of elastic translation linear

$$k = 10^5 \text{ N/m}$$

Specific mass

$$m = 10 \text{ kg}$$

1.3 Boundary conditions and loadings

Points *A* and *B* : embedded ($u=0$).

1.4 Initial conditions

Without object for the modal analysis.

2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is that given in card SLD02/89 of the guide VPCS which presents the method of calculating in the following way:

The problem led to search the eigenvalues and clean vectors of:

$$(\mathbf{K} - M \omega_i) \Phi_i = 0$$
$$\mathbf{K} = \begin{bmatrix} k & -k & & & & & & & \\ -k & 2k & -k & & & & & & \\ & & & \dots & & & & & \\ & & & & -k & 2k & -k & & \\ & & & & & & & & \\ & & & & & & -k & k & \\ & & & & & & & & \end{bmatrix} \quad \mathbf{M} = \begin{bmatrix} 0 & & & & & & & & \\ & m & & & & & & & \\ & & \dots & & & & & & \\ & & & & & m & & & \\ & & & & & & & & 0 \end{bmatrix}$$

from where:

$$f_i = \frac{1}{\pi} \sqrt{\frac{k}{m}} \cos\left(\frac{n+1-i}{n+1} \frac{\pi}{2}\right)$$

$$i = 1, 2, \dots, n$$

n = many masses

Φ_i^t calculated by resolution of the linear system.

2.2 Results of reference

the first 8 Eigen frequencies and the first and eighth vectors own standards such as:

Test VPCS provides modes normalized to $\Phi^t M \Phi = 10$. Normalized modes are presented:

- with the unit generalized mass: $\Phi^t M \Phi = 1$; the components of reference are divided by $\sqrt{10}$,
- with the generalized stiffness what amounts dividing the preceding components by ω_i ,
- with the largest component of displacement.

2.3 Uncertainty on the solution

Analytical solution.

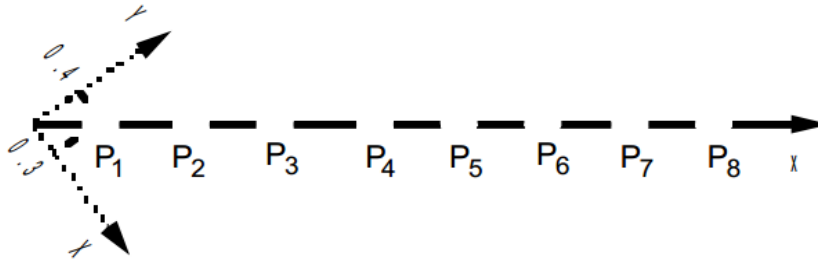
2.4 Bibliographical references

- [1] MR. LALANNE, P. BERTHIER, J. DERHAGOPIAN. Mechanics of the linear vibrations. Paris: MASSON, 2° edition, chapter 3, p. 100-101 (1986)

3 Modeling A

3.1 Characteristics of modeling

Discrete element of rigidity in translation DIS_T



Characteristics of the elements:

ORIENTATION:	in all the nodes	with an angle $\alpha = 53.130102^\circ$
DISCRETE:		
with nodal masses	all nodes	M_T_D_N in absolute reference mark ($m = 10.$)
matrices of rigidity	all meshes	K_T_D_L in local reference mark ($K_x = 1.10^5$)
with the nodes ends		K_T_D_N in local reference mark ($K_x = 1.10^5$)

Limiting conditions:

DDL_IMPO: (ALL: 'YES' DZ: 0.)
LIAISON_DDL : (such as $3D_y = 4D_x$ in all the nodes)

Names of the nodes: P_1, P_2, \dots, P_8
Point A = N1 N2

3.2 Characteristics of the grid

Many nodes: 8
Many meshes and types: 7 SEG2

3.3 Sizes tested and results

Identification	Reference
Number of the clean mode	
1	5.5274
2	10.8868
3	15.9155
4	20.4606
5	24.3840
6	27.5664
7	29.9113

8 31.3474

Normalized mode with 1 with the largest component

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 0.3473
	P2	- 0.6527
	P3	- 0.8793
	P4	- 1.
	P5	- 1.
	P6	- 0.8793
	P7	- 0.6527
	P8	- 0.3473
Translation 8 (Dy) Φ_8	P1	0.3473
	P2	- 0.6527
	P3	0.8793
	P4	- 1.
	P5	1.
	P6	- 0.8793
	P7	0.6527
	P8	- 0.3473

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 4.0781E-2
	P2	- 7.6654E-2
	P3	- 1.0327E-1
	P4	- 1.1743E-1
	P5	- 1.1743E-1
	P6	- 1.0327E-1
	P7	- 7.6654E-2
	P8	- 4.0781E-2
Translation 8 (Dy) Φ_8	P1	4.0781E-2
	P2	- 7.6654E-2
	P3	1.0327E-1
	P4	- 1.1743E-1
	P5	1.1743E-1
	P6	- 1.0327E-1
	P7	7.6654E-2
	P8	- 4.0781E-2

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized stiffness

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 1.1742E-3
	P2	- 2.2072E-3
	P3	- 2.9735E-3
	P4	- 3.3813E-3
	P5	- 3.3813E-3
	P6	- 2.9735E-3
	P7	- 2.2072E-3
	P8	- 1.1742E-3
Translation 8 (Dy) Φ_8	P1	2.0705E-4
	P2	- 3.8918E-4
	P3	5.2432E-4
	P4	- 5.9621E-4
	P5	5.9621E-4
	P6	- 5.2432E-4
	P7	3.8918E-4
	P8	- 2.0705E-4

Maximum error lower than: 0.03%.

One tests also the order `INFO_MODE`. The GEP being standard (real symmetrical matrices) its eigenvalues belongs only to the real axis. On this case, one can thus compare the two methods of enumeration (`COMPTAGE/METHODE=' STURM'` and `'APM'`) and to check that they give the same results well.

One determines thus the number of eigenvalues (`NB_FREQ`) contained strictly in a frequential band `[FREQ_MIN, FREQ_MAX]` (if Sturm) or in the disc of center `FREQ_CENTRE` and of ray, into frequential, $\frac{\sqrt{\text{FREQ_RAYON_CONTOUR}}}{2\pi}$ (if APM) . One specifies the method of enumeration used (Sturm or APM).

Concept	FREQ_MIN/ FREQ_CENTRE	FREQ_MAX/ FREQ_RAYON_ CONTOUR	NB_FREQ	Method of enumeration
NBMOD01	0.0	5	0	Sturm
NBMOD02	0.0	21	4 One counts $(\lambda_i)_{i=1,4}$	Sturm
NBMOD03	0.0	32	8 One counts $(\lambda_i)_{i=1,8}$	Sturm
NBMOD11	0.0+0.0j	986.96 (= $(5 \times 2\pi)^2$)	0 Idem NBMOD01	APM
NBMOD12	0.0+0.0j	1740.99 (= $(21 \times 2\pi)^2$)	4 Idem NBMOD02	APM
NBMOD13	0.0+0.0j	4042.58 (= $(32 \times 2\pi)^2$)	8 Idem NBMOD03	APM
NBMOD4	10000.0+0.0j	5000.0	1	APM

	$(= (15.91 \times 2\pi)^2)$		One counts λ_1	
NBMOD5	1000.0(10.0 + j)	900.0	0	APM

3.4 Remarks

Calculations carried out by:

```
CALC_MODES  
    OPTION=' AJUSTE',  
    CALC_FREQ=_F (FREQ= (5. , 10. , 15. , 20. , 24. , 27. , 30. ,  
32.)),  
    SOLVEUR_MODAL=_F (OPTION_INV=' DIRECT')
```

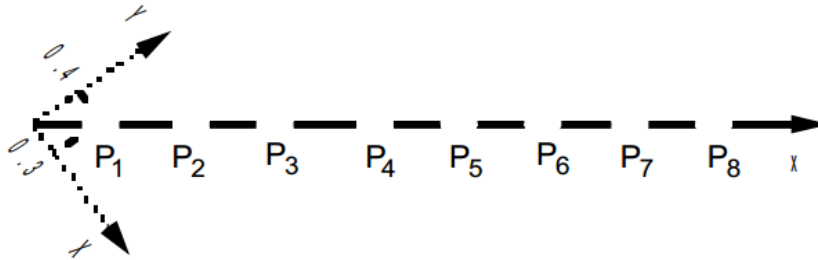
Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

4 Modeling B

4.1 Characteristics of modeling

Discrete element of rigidity in translation DIS_T



Characteristics of the elements:

ORIENTATION:	in all the nodes	with an angle $\alpha=53.130102^\circ$
DISCRETE:		
nodal masses all nodes	M_T_N	in absolute reference mark ($m=10.$)
matrices of rigidity all meshes	K_T_L	in local reference mark ($K_x=1.10^5$)
with the nodes ends	K_T_N	in local reference mark ($K_x=1.10^5$)

Limiting conditions:

DDL_IMPO: (ALL: 'YES' DZ: 0.)
LIAISON_DDL: (such as $3Dy=4Dx$ in all the nodes)

Names of the nodes: P_1, P_2, \dots, P_8

4.2 Characteristics of the grid

Many nodes: 8
Many meshes and types: 7 SEG2

4.3 Sizes tested and results

Identification	Reference
Number of the clean mode	
1	5.5274
2	10.8868
3	15.9155
4	20.4606
5	24.3840
6	27.5664
7	29.9113
8	31.3474

Normalized mode with 1 with the largest component

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 0.3473
	P2	- 0.6527
	P3	- 0.8793
	P4	- 1.
	P5	- 1.
	P6	- 0.8793
	P7	- 0.6527
	P8	- 0.3473
Translation 8 (Dy) Φ_8	P1	0.3473
	P2	- 0.6527
	P3	0.8793
	P4	- 1.
	P5	1.
	P6	- 0.8793
	P7	0.6527
	P8	- 0.3473

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 4.0781E-2
	P2	- 7.6654E-2
	P3	- 1.0327E-1
	P4	- 1.1743E-1
	P5	- 1.1743E-1
	P6	- 1.0327E-1
	P7	- 7.6654E-2
	P8	- 4.0781E-2
Translation 8 (Dy) Φ_8	P1	4.0781E-2
	P2	- 7.6654E-2
	P3	1.0327E-1
	P4	- 1.1743E-1
	P5	1.1743E-1
	P6	- 1.0327E-1
	P7	7.6654E-2
	P8	- 4.0781E-2

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized stiffness

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 1.1742E-3
	P2	- 2.2072E-3
	P3	- 2.9735E-3
	P4	- 3.3813E-3
	P5	- 3.3813E-3
	P6	- 2.9735E-3
	P7	- 2.2072E-3
	P8	- 1.1742E-3

	P1	2.0705E-4
	P2	- 3.8918E-4
Translation 8	P3	5.2432E-4
(Dy)	P4	- 5.9621E-4
Φ_8	P5	5.9621E-4
	P6	- 5.2432E-4
	P7	3.8918E-4
	P8	- 2.0705E-4

Maximum error lower than: 0.03%.

4.4 Remarks

Calculations carried out by:

```
CALC_MODES  
    OPTION=' PLUS_PETITE',  
    CALC_FREQ=_F (NMAX_FREQ = 8),
```

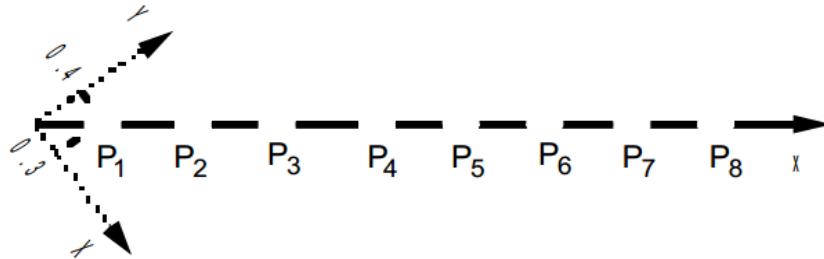
Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

5 Modeling C

5.1 Characteristics of modeling

Transposition of the test of reference to the case of the degrees of freedom of rotation (from torsion + inertia comes out) by using the discrete element of rigidity in translation/rotation DIS_TR.



Characteristics of the elements:

ORIENTATION:	in all the nodes	with an angle $\alpha=53.130102^\circ$
DISCRETE:		
with nodal masses	all nodes	M_TR_D_N in absolute reference mark ($I_{xx}=10.$)
matrices of rigidity	all meshes	K_TR_D_L in local reference mark ($KR_x=1.10^5$)
with the nodes	ends	K_TR_D_N in local reference mark ($KR_x=1.10^5$)

Limiting conditions:

DDL_IMPO: (ALL: 'YES' DX: 0. , DZ: 0. , DRZ: 0.)
LIAISON_DDL : (such as 3DRY=4DRY in all the nodes)

Names of the nodes: P_1, P_2, \dots, P_8

5.2 Characteristics of the grid

Many nodes: 8

Many meshes and types: 7 SEG2

5.3 Sizes tested and results

Identification	Reference
Number of the clean mode	
1	5.5274
2	10.8868
3	15.9155
4	20.4606
5	24.3840
6	27.5664
7	29.9113

8 31.3474

Normalized mode with 1 with the largest component

Nature of the clean mode	Not	Reference
Rotation 1 (<i>DRY</i>) Φ_1	P1	- 0.3473
	P2	- 0.6527
	P3	- 0.8793
	P4	- 1.
	P5	- 1.
	P6	- 0.8793
	P7	- 0.6527
	P8	- 0.3473
Rotation 8 (<i>DRY</i>) Φ_8	P1	0.3473
	P2	- 0.6527
	P3	0.8793
	P4	- 1.
	P5	1.
	P6	- 0.8793
	P7	0.6527
	P8	- 0.3473

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass

Nature of the clean mode	Not	Reference
Rotation 1 (<i>DRY</i>) Φ_1	P1	- 4.0781E-2
	P2	- 7.6654E-2
	P3	- 1.0327E-1
	P4	- 1.1743E-1
	P5	- 1.1743E-1
	P6	- 1.0327E-1
	P7	- 7.6654E-2
	P8	- 4.0781E-2
Rotation 8 (<i>DRY</i>) Φ_8	P1	4.0781E-2
	P2	- 7.6654E-2
	P3	1.0327E-1
	P4	- 1.1743E-1
	P5	1.1743E-1
	P6	- 1.0327E-1
	P7	7.6654E-2
	P8	- 4.0781E-2

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized stiffness

Nature of the clean mode	Not	Reference
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	P1	- 1.1742E-3
	P2	- 2.2072E-3
Rotation 1	P3	- 2.9735E-3
(DRY)	P4	- 3.3813E-3
Φ_1	P5	- 3.3813E-3
	P6	- 2.9735E-3
	P7	- 2.2072E-3
	P8	- 1.1742E-3

	P1	2.0705E-4
	P2	- 3.8918E-4
Rotation 8	P3	5.2432E-4
(DRY)	P4	- 5.9621E-4
Φ_8	P5	5.9621E-4
	P6	- 5.2432E-4
	P7	3.8918E-4
	P8	- 2.0705E-4

Maximum error lower than: 0.03%.

5.4 Remarks

Calculations carried out by:

```
CALC_MODES  
    OPTION=' AJUSTE',  
    CALC_FREQ=_F (FREQ= (5. , 10. , 15. , 20. , 24. , 27. , 30. ,  
32.)),  
    SOLVEUR_MODAL=_F (OPTION_INV=' DIRECT'),
```

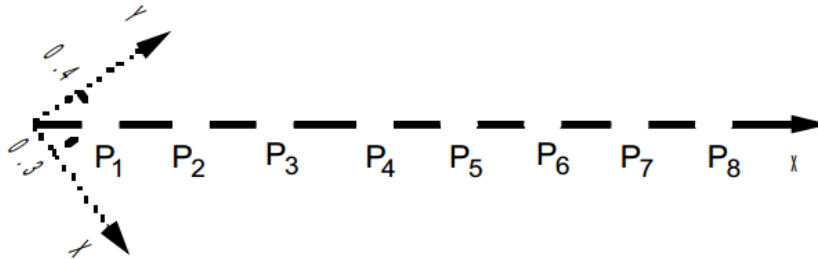
Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

6 Modeling D

6.1 Characteristics of modeling

Transposition of the test of reference to the case of the degrees of freedom of rotation (from torsion + inertia comes out) by using the discrete element of rigidity in translation/rotation: DIS_TR.



Characteristics of the elements:

ORIENTATION:	in all the nodes	with an angle $\alpha=53.130102^\circ$
DISCRETE:		
with nodal masses	all nodes	M_TR_N in absolute reference mark ($I_{xx}=10.$)
matrices of rigidity	all meshes	K_TR_L in local reference mark ($KR_x=1.10^5$)
with the nodes	ends	K_TR_N in local reference mark ($KR_x=1.10^5$)

Limiting conditions:

DDL_IMPO: (ALL: 'YES' DX: 0. , DY: 0. , DZ: 0. , DRZ: 0.)
LIAISON_DDL : (such as 3DRY=4DRY in all the nodes)

Names of the nodes: P_1, P_2, \dots, P_8

6.2 Characteristics of the grid

Many nodes: 8

Many meshes and types: 7 SEG2

6.3 Sizes tested and results

Identification	Reference
Number of the clean mode	
1	5.5274
2	10.8868
3	15.9155
4	20.4606
5	24.3840
6	27.5664
7	29.9113

8 31.3474

Normalized mode with 1 with the largest component

Nature of the clean mode	Not	Reference
Rotation 1 (<i>DRY</i>) Φ_1	P1	- 0.3473
	P2	- 0.6527
	P3	- 0.8793
	P4	- 1.
	P5	- 1.
	P6	- 0.8793
	P7	- 0.6527
	P8	- 0.3473
Rotation 8 (<i>DRY</i>) Φ_8	P1	0.3473
	P2	- 0.6527
	P3	0.8793
	P4	- 1.
	P5	1.
	P6	- 0.8793
	P7	0.6527
	P8	- 0.3473

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass

Nature of the clean mode	Not	Reference
Rotation 1 (<i>DRY</i>) Φ_1	P1	- 4.0781E-2
	P2	- 7.6654E-2
	P3	- 1.0327E-1
	P4	- 1.1743E-1
	P5	- 1.1743E-1
	P6	- 1.0327E-1
	P7	- 7.6654E-2
	P8	- 4.0781E-2
Rotation 8 (<i>DRY</i>) Φ_8	P1	4.0781E-2
	P2	- 7.6654E-2
	P3	1.0327E-1
	P4	- 1.1743E-1
	P5	1.1743E-1
	P6	- 1.0327E-1
	P7	7.6654E-2
	P8	- 4.0781E-2

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized stiffness

Nature of the clean mode	Not	Reference
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Rotation 1 (DRY) Φ_1	P1	- 1.1742E-3
	P2	- 2.2072E-3
	P3	- 2.9735E-3
	P4	- 3.3813E-3
	P5	- 3.3813E-3
	P6	- 2.9735E-3
	P7	- 2.2072E-3
	P8	- 1.1742E-3

Rotation 8 (DRY) Φ_8	P1	2.0705E-4
	P2	- 3.8918E-4
	P3	5.2432E-4
	P4	- 5.9621E-4
	P5	5.9621E-4
	P6	- 5.2432E-4
	P7	3.8918E-4
	P8	- 2.0705E-4

Maximum error lower than: 0.03%.

6.4 Remarks

Calculations carried out by:

```
CALC_MODES
      OPTION=' AJUSTE',
      CALC_FREQ=_F (FREQ= (5. , 10. , 15. , 20. , 24. , 27. , 30. ,
32.)),
      SOLVEUR_MODAL=_F (OPTION_INV=' DIRECT'),
```

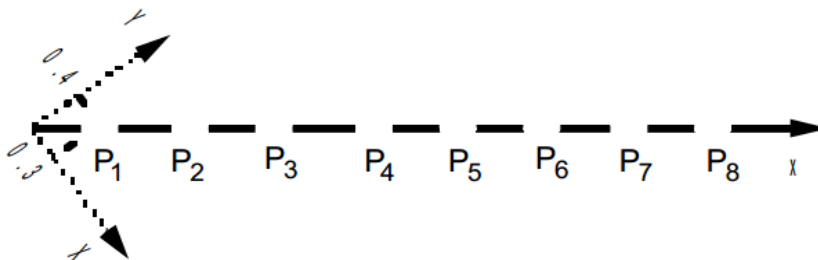
Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

7 Modeling E

7.1 Characteristics of modeling

Discrete element of rigidity in translation 2D_DIS_T



Characteristics of the elements:

ORIENTATION :	in all the nodes	with an angle $\alpha=53.130102^\circ$
DISCRETE :		
with nodal masses	all nodes	M_T_D_N in absolute reference mark ($m=10.$)
matrices of rigidity	all meshes	K_T_D_L in local reference mark ($K_x=1.10^5$)
with the nodes ends		K_T_D_N in local reference mark ($K_x=1.10^5$)

Limiting conditions:

LIAISON_DDL : (such as $3Dy=4Dx$ in all the nodes)

Names of the nodes: P_1, P_2, \dots, P_8

Point A = N1 N2

7.2 Characteristics of the grid

Many nodes: 8

Many meshes and types: 7 SEG2

7.3 Sizes tested and results

Identification	Reference
Number of the clean mode	
1	5.5274
2	10.8868
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4	20.4606
5	24.3840
6	27.5664
7	29.9113
8	31.3474

Normalized mode with 1 with the largest component

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 0.3473
	P2	- 0.6527
	P3	- 0.8793
	P4	- 1.
	P5	- 1.
	P6	- 0.8793
	P7	- 0.6527
	P8	- 0.3473
Translation 8 (Dy) Φ_8	P1	0.3473
	P2	- 0.6527
	P3	0.8793
	P4	- 1.
	P5	1.
	P6	- 0.8793
	P7	0.6527
	P8	- 0.3473

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 4.0781E-2
	P2	- 7.6654E-2
	P3	- 1.0327E-1
	P4	- 1.1743E-1
	P5	- 1.1743E-1
	P6	- 1.0327E-1
	P7	- 7.6654E-2
	P8	- 4.0781E-2
Translation 8 (Dy) Φ_8	P1	4.0781E-2
	P2	- 7.6654E-2
	P3	1.0327E-1
	P4	- 1.1743E-1
	P5	1.1743E-1
	P6	- 1.0327E-1
	P7	7.6654E-2
	P8	- 4.0781E-2

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized stiffness

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 1.1742E-3
	P2	- 2.2072E-3
	P3	- 2.9735E-3
	P4	- 3.3813E-3
	P5	- 3.3813E-3
	P6	- 2.9735E-3
	P7	- 2.2072E-3
	P8	- 1.1742E-3

	P1	2.0705E-4
	P2	- 3.8918E-4
Translation 8	P3	5.2432E-4
(Dy)	P4	- 5.9621E-4
Φ_8	P5	5.9621E-4
	P6	- 5.2432E-4
	P7	3.8918E-4
	P8	- 2.0705E-4

Maximum error lower than: 0.03%.

7.4 Remarks

Calculations carried out by:

```
CALC_MODES  
    OPTION=' AJUSTE',  
    CALC_FREQ=_F (FREQ= (5. , 10. , 15. , 20. , 24. , 27. , 30. ,  
32.)),  
    SOLVEUR_MODAL=_F (OPTION_INV=' DIRECT')
```

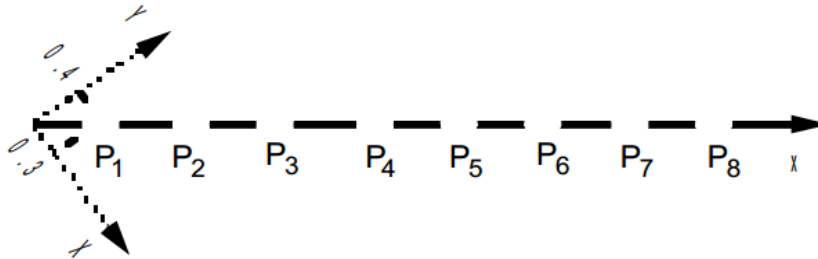
Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

8 Modeling F

8.1 Characteristics of modeling

Discrete element of rigidity in translation/rotation: 2D_DIS_TR



Characteristics of the elements:

ORIENTATION:	in all the nodes	with an angle $\alpha=53.130102^\circ$
DISCRETE:		
with nodal masses all nodes	M_T_D_N	in absolute reference mark ($m=10.$)
matrices of rigidity all meshes	K_T_D_L	in local reference mark ($K_x=1.10^5$)
with the nodes ends	K_T_D_N	in local reference mark ($K_x=1.10^5$)

Limiting conditions:

DDL_IMPO: (ALL: 'YES' DRZ: 0.)
LIAISON_DDL: (such as 3Dy=4Dx in all the nodes)

Names of the nodes: P_1, P_2, \dots, P_8

Not $A=N1$ $N2$

8.2 Characteristics of the grid

Many nodes: 8
Many meshes and types: 7 SEG2

8.3 Sizes tested and results

Identification	Reference
Number of the clean mode	
1	5.5274
2	10.8868
3	15.9155
4	20.4606
5	24.3840

6	27.5664
7	29.9113
8	31.3474

Normalized mode with 1 with the largest component

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 0.3473
	P2	- 0.6527
	P3	- 0.8793
	P4	- 1.
	P5	- 1.
	P6	- 0.8793
	P7	- 0.6527
	P8	- 0.3473
Translation 8 (Dy) Φ_8	P1	0.3473
	P2	- 0.6527
	P3	0.8793
	P4	- 1.
	P5	1.
	P6	- 0.8793
	P7	0.6527
	P8	- 0.3473

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized mass

Nature of the clean mode	Not	Reference
Translation 1 (Dy) Φ_1	P1	- 4.0781E-2
	P2	- 7.6654E-2
	P3	- 1.0327E-1
	P4	- 1.1743E-1
	P5	- 1.1743E-1
	P6	- 1.0327E-1
	P7	- 7.6654E-2
	P8	- 4.0781E-2
Translation 8 (Dy) Φ_8	P1	4.0781E-2
	P2	- 7.6654E-2
	P3	1.0327E-1
	P4	- 1.1743E-1
	P5	1.1743E-1
	P6	- 1.0327E-1
	P7	7.6654E-2
	P8	- 4.0781E-2

Maximum error lower than: 0.03%.

Mode normalized with the unit generalized stiffness

Nature of the clean mode	Not	Reference
--------------------------	-----	-----------

Translation 1 (Dy) Φ_1	P1	- 1.1742E-3
	P2	- 2.2072E-3
	P3	- 2.9735E-3
	P4	- 3.3813E-3
	P5	- 3.3813E-3
	P6	- 2.9735E-3
	P7	- 2.2072E-3
	P8	- 1.1742E-3
Translation 8 (Dy) Φ_8	P1	2.0705E-4
	P2	- 3.8918E-4
	P3	5.2432E-4
	P4	- 5.9621E-4
	P5	5.9621E-4
	P6	- 5.2432E-4
	P7	3.8918E-4
	P8	- 2.0705E-4

Maximum error lower than: 0.03%.

8.4 Remarks

Calculations carried out by:

```
CALC_MODES
      OPTION=' AJUSTE',
      CALC_FREQ=_F (FREQ= (5. , 10. , 15. , 20. , 24. , 27. , 30. ,
32.)),
      SOLVEUR_MODAL=_F (OPTION_INV=' DIRECT'),
```

Contents of the file results:

the first 8 Eigen frequencies, clean vectors and modal parameters

9 Summary of the results

For all the options of modeling of the discrete elements of rigidity and mass offered by `AFFE_CARA_ELEM` the solutions obtained are those of the reference solution (frequencies and clean modes with various standardisations).