SDLD400 – Spangled system mass-arises

Summary:

This test consists in calculating the Eigen frequencies of a spangled system mass-arises. The reference solution is analytical.

The interest of test is to check the methods available in modal analysis, in the presence of two discrete elements of translation and rotation:

- discrete elements `DIS_TR` on a node (modeling A);
- discrete elements `DIS_TR` on a segment (modeling B).

In this test, one also makes turn the structure of 30° in order to validate the entry of the data in local reference mark (keyword `ORIENTATION` in `AFFE_CARA_ELEM`).
One uses also a matrix of diagonal mass for these elements what makes it possible to obtain a complete cover of this functionality for the discrete elements.

1 Problem of reference

1.1 Geometry

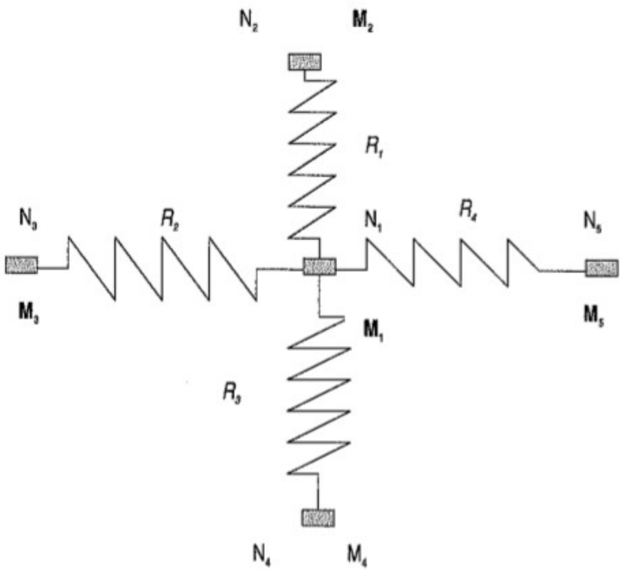

Figure 1.1 Geometry of the problem

1.2 Properties of material

The discrete elements have the characteristics of following stiffnesses in $\mathrm{N.m^{-1}}$:

$$R_1=R_3=\begin{bmatrix} 40 & & & & & \\ & 60 & & & & \\ & & 500 & & & \\ & & & 60 & & \\ & & & & 500 & \\ & & & & & 650 \end{bmatrix}$$

$$R_2=R_4=\begin{bmatrix} 40 & & & & & \\ & 30 & & & & \\ & & 140 & & & \\ & & & 30 & & \\ & & & & 140 & \\ & & & & & 330 \end{bmatrix}$$

The discrete elements have the characteristics of following masses in kg :

$$M_1=M_2=M_3=M_4=M_5=M_6=\begin{bmatrix} 10 & & & & & \\ & 10 & & & & \\ & & 10 & & & \\ & & & 10 & & \\ & & & & 10 & \\ & & & & & 10 \end{bmatrix}$$

1.3 Boundary conditions and loadings

Imposed displacement:

Embedding with the nodes $N2$, $N3$, $N4$ and $N5$	$DX=0$, $DY=0$, $DZ=0$, $DRX=0$, $DRY=0$, $DRZ=0$

2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is written for the degrees of freedom of the node $N1$:

$$\left(-\omega^2\begin{bmatrix}10&&&&&\\&10&&&&\\&&10&&&\\&&&10&&\\&&&&10&\\&&&&&10\end{bmatrix}+\begin{bmatrix}160&&&&&\\&180&&&&\\&&1280&&&\\&&&180&&\\&&&&1280&\\&&&&&1960\end{bmatrix}\right)x=0$$

2.2 Results of reference

One obtains the six pulsations squared ω_i^2 following in $\mathrm{rd.s}^{-2}$: 16 , 18 , 18 , 128 , 128 , 196 .

From where following frequencies: $f_i=\frac{\omega_i}{2\pi}$

Mode	Frequency (Hz)
1	0.636619
2	0.675237
3	0.675237
4	1.800633
5	1.800633
6	2.228169

2.3 Uncertainty on the solution

Analytical solution.

3 Modeling A

3.1 Characteristics of modeling A

Modeling DIS_TR.

3.2 Characteristics of the grid

Many nodes: 5
Many meshs and types: 4 SEG2

3.3 Sizes tested and results

OPTION = 'ADJUSTS'

Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

OPTION = 'SEPARATE'

Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

OPTION = 'BAND'

Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

OPTION = 'CENTER'

Identification	Value of reference	Type of reference	Tolerance (%)

Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

OPTION = 'PLUS_PETITE'

Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

METHODE=' JACOBI' and OPTION=' BANDE'

Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

4 Modeling B

4.1 Characteristics of modeling A

Modeling DIS_TR.

4.2 Characteristics of the grid

Many nodes: 1
Number of meshs and type: 1 POI1

4.3 Sizes tested and results

OPTION = 'BAND'

Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

OPTION = 'CENTER'

Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
Mode 2	0.675237	'ANALYTICAL'	0.003
Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

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Identification	Value of reference	Type of reference	Tolerance (%)
Mode 1	0.636619	'ANALYTICAL'	0.003
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Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

METHODE=' JACOBI' and OPTION=' BANDE'

Identification	Value of reference	Type of reference	Tolerance (%)

Mode 1	0.636619	'ANALYTICAL'	0.003
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Mode 3	0.675237	'ANALYTICAL'	0.003
Mode 4	1.800633	'ANALYTICAL'	0.003
Mode 5	1.800633	'ANALYTICAL'	0.003
Mode 6	2.228169	'ANALYTICAL'	0.003

5 Summary of the results

The results of frequencies obtained by all the methods are in very good agreement with the analytical solution (lower deviation than $1.E-6$ %).