SDLL01 - Short beam on simple supports

Summary:

This two-dimensional problem consists in searching the frequencies of vibration of a mechanical structure made up of a beam in simple supports at its two ends. This case test of Mechanics of the Structures corresponds to a dynamic analysis of a linear model having a linear behavior. One studies the influence of the position of the points considered as fulcrums (points on neutral fibre or points offset at the base of the beam) compared to neutral fibre of a thick beam.

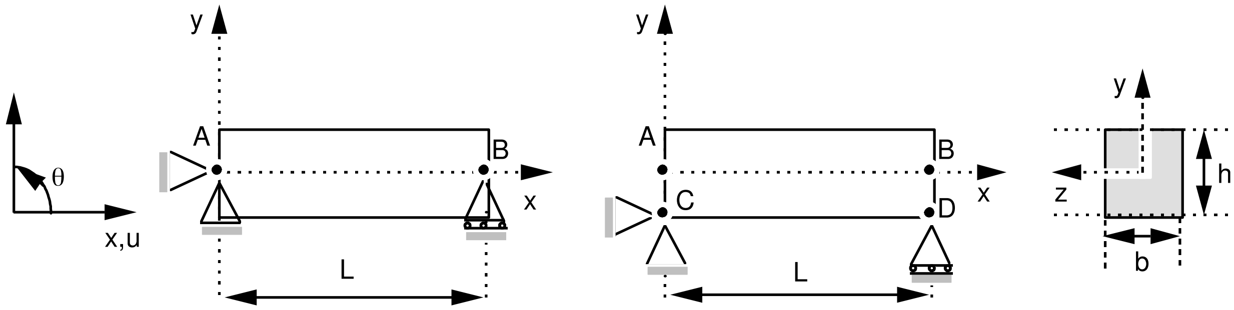
This test makes it possible to test part of the features which relate to the beams of Timoshenko, the rigid connections and the search for Eigen frequencies by iterations opposite.

The results got with the fulcrums on neutral fibre, is with the offset fulcrums are compared with analytical calculations on the beams of TImoshenko. The results got with the offset fulcrums are compared with results of not-regression.

When the fulcrums are offset, one observes a coupling between the various modes of traction - compression and inflection.

1 Problem of reference

1.1 Geometry



Rectangular cross-section:

height:	$h=0.2\,m$
width:	$b=0.1\,m$
surface:	$A=2.10^{-2}\,m^2$
inertia:	$Iz=6.667\,10^{-5}$
shearing:	$Ay=Az=1.17692$
torsion:	$Jx=0.45776042\,10^{-4}$

Length of the beam

$L=1.m$

Coordinates of the points (m) **:**

	A	B	C	D
x	0.	1.	0.	1.
y	0.	0.	– 0.1	– 0.1

1.2 Material properties

$E=2.10^{11}\,Pa$

$\nu=0.3$

$\rho=7800.\,kg/m^3$

1.3 Boundary conditions and loadings

Problem 1:	Not A	$u=v=0.$	Not B	$v=0.$
Problem 2:	Not C	$u=v=0.$	Not D	$v=0.$

2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is that given in the book of Timoshenko on the theory of the vibrations of the beams and plates ([1]):

Problem 1: Analytical calculation

The equation of inflection of the nonslim beams gives the formulation of Timoshenko, by superimposing the effects of the pure bending, the deformations of shearing action and the inertia of rotation.

The Eigen frequencies in traction and compression are given according to this theory by:

$$f_i=\frac{\lambda_i}{2\pi L}\sqrt{\frac{E}{\rho}} \text{ with } \lambda_i=\frac{(2i-1)}{2}\pi \quad i=1,2,\ldots$$

One finds in the reference [1] an equivalent formula for the modes of inflection.

Problem 2:

The problem not having an analytical solution, the solution is established by results of not-regression.

The modes of inflection and traction and compression are coupled.

2.2 Results of reference

Problem 1: the first 6 clean modes.

Problem 2: the first 5 clean modes.

2.3 Uncertainty on the solution

Problem 1: analytical solution. ‘

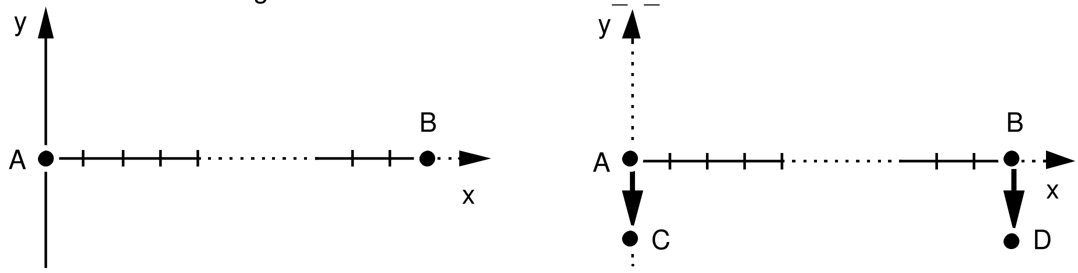
2.4 Bibliographical references

[1] S.P. TIMOSHENKO, D.H. YOUNG, W. WEAVER. Vibrations Problems in Engineering. New - York: Wiley & Sounds, 4° edition, p. 415 (1974).

3 Modeling A

3.1 Characteristics of modeling

One uses the element of right beam of Timoshenko: POU_D_T



Problem 1:

Cutting:	beam AB : 40 meshs SEG2
Limiting conditions:	
in all the nodes	DDL_IMPO = (GROUP_NO = 'AB', DZ=0., DRX=0, DRY=0.)
in A :	(NOEUD=' A', DX=0., D=0.)
in B :	(NOEUD=' B', DY=0.)

Problem 2:

Cutting:	beam AB : 40 meshs SEG2 2 rigid elements AC , BC : 2 meshs SEG2
Limiting conditions:	
in all the nodes	DDL_IMPO = (TOUT=' OUI', DZ=0., DRX=0, DRY=0.)
in C :	(NOEUD=' IT, DX=0., DY=0.)
in D :	(NOEUD=' OF, DY=0.)

Names of the nodes: Not A = $N100$ Not C = $N300$
Not B = $N200$ Not D = $N400$

3.2 Characteristics of the grid

Many nodes: 43
Many meshs and types: 42 SEG2

3.3 Remarks

Definition of the rigid beams AC and BD :

- Section: $Hy=0.2$, $Hz=0.2$.
- Material: $E=2.10^{16}$, $\rho=0$.

3.4 Sizes tested and results

Frequency (Hz)

	Clean mode	Reference	*Aster*	tolerance
Problem 1				
	inflection 1	431,555	431.8916	0.2%
	traction 1	1265.924	1266.0056	0.2%
	inflection 2	1498.295	1500.7635	0.2%
	inflection 3	2870.661	2873.5344	0.2%
	traction 2	3797.773	3799.9692	0.2%
	inflection 4	4377.837	4370.8206	0.2%

	Clean mode	Reference	*Aster*	tolerance
Problem 2				
	1	392.8	394.4774	0.5%
	coupling 2	922.2	922.6072	0.1%
	inflection 3	1592.0	1638.2311	3%
	traction 4	2629.2	2778.7000	5.8%
	compression 5	3126.2	3261.6699	4.5%

One calculates the kinetic energy of the first element of beam connected to the point A problem 1:

Option	Component	Reference (NON_REGRESSION)	*Aster*	% difference
ECIN_ELEM	TOTAL	51366.0	51366.027	1%

3.5 Remarks

Calculations carried out by:

Problem 1:

```
CALC_MODES
            OPTION=' AJUSTE'
            CALC_FREQ=_F (FREQ= (430. , 4500.))
```

Problem 2:

```
CALC_MODES
            OPTION=' AJUSTE'
            CALC_FREQ=_F (FREQ= (380. , 3300.))
```

Contents of the file results:

Problem 1:

the first 6 Eigen frequencies, clean vectors and modal parameters.

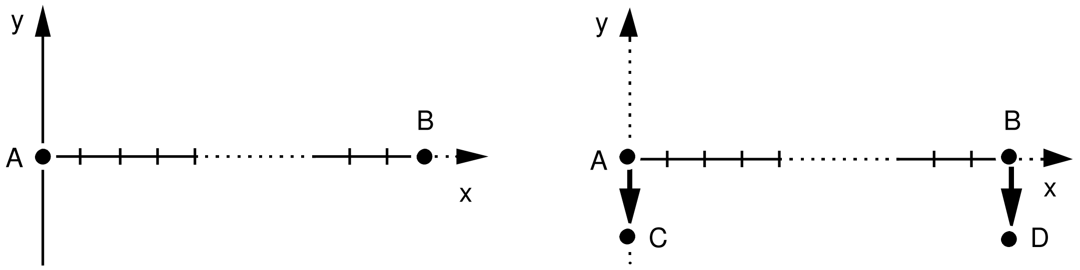
Problem 1:

the first 5 Eigen frequencies, clean vectors and modal parameters.

4 Modeling B

4.1 Characteristics of modeling

POU_D_TG



Problem 1:

Cutting:	beam AB : 40 meshs SEG2
Limiting conditions:	
in all the nodes	`DDL_IMPO = (GROUP_NO=' AB', DZ=0., DRX=0, DRY=0.)`
in A :	`(GROUP_NO=' A'   DX=0., DY=0. )`
in B :	`(GROUP_NO=' B',   DY=0. )`

Problem 2:

Cutting:	beam AB: 40 meshs SEG2 2 rigid elements AC , BD : 2 meshs SEG2
Limiting conditions:	
in all the nodes	`DDL_IMPO = (TOUT=' OUI', DZ=0., DRX=0, DRY=0.)`
in C :	`(GROUP_NO=' IT,   DX=0., DY=0. )`
in D :	`(GROUP_NO=' OF,   DY=0. )`

Names of the nodes:	Not A = $N100$	Not C = $N300$
	Not B = $N200$	Not D = $N400$

4.2 Characteristics of the grid

Many nodes:	43
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4.3 Remarks

Definition of the rigid beams AC and BD :

- Section: $Hy=0.2$, $Hz=0.2$.
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4.4 Sizes tested and results

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Problem 2				
1	392.8	$\pm$ 2.7%	394.4774	0.5%
coupling 2	922.2	$\pm$ 5.7%	922.6072	0.1%
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4.5 Remarks

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Problem 2:

```
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            OPTION=' AJUSTE'
            CALC_FREQ=_F (FREQ= (380. , 3300.))
```

Contents of the file results:

Problem 1:

the first 6 Eigen frequencies, clean vectors and modal parameters.

Problem 1:

the first 5 Eigen frequencies, clean vectors and modal parameters.

5 Summary of the results

With the problem without eccentricity is correctly dealt. That with eccentricity is validated only by not-regression.