SDNL301 – Vibration of a beam with impact multipoint

Summary:

The objective of this CAS-test is to simulate the dynamic response with damping of a beam with impact-multi-points:

- The beam is subjected has sinusoidal requests.
- The impacts (obstacles) have a normal rigidity and a normal damping.
- Only one modeling POU_D_T is carried out

One determines value RMS of the normal force at the loose lead with or without taking into account of the static modes.

1 Problem of reference

1.1 Geometry

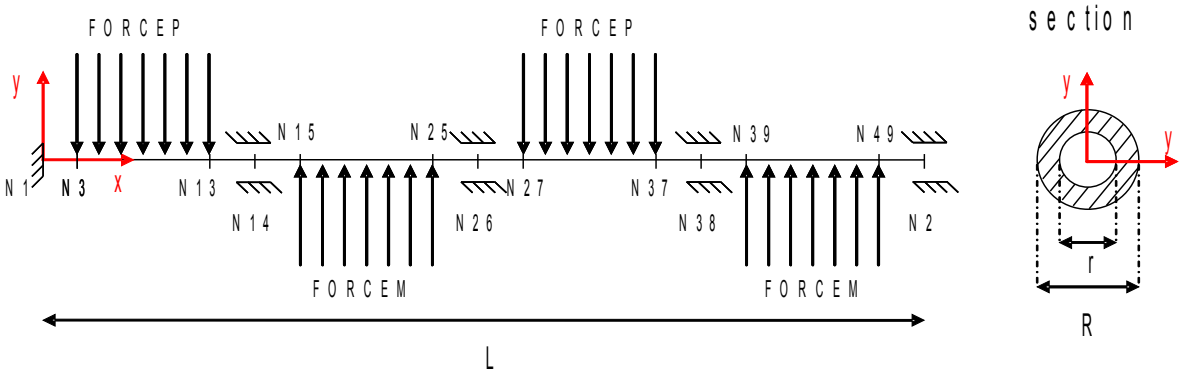

Figure 1.1 Geometry of the problem and system of loading

Geometry of the beam (m) :

$L=2.436$

$R=0.00795$

$r=0.00680$

1.2 Properties of material

Beam

$E=2.07\,E11\,Pa$	Young modulus
$\nu=0.3$	Poisson's ratio
$\rho=7870.0\,kg.m^{-3}$	Density
$AMOR\_ALPHA = 1.79\text{E}{-5}\,N.s.m^{-1}$	
$AMOR\_BETA = 0.1526\,N.kg^{-1}$	

Coefficients α and β allow to build a matrix of viscous damping proportional to rigidity and the mass $[C]=\alpha[K]+\beta[M]$

Obstacles

$RIGI\_NOR=1.0\text{E}5\,N.m^{-1}$	normal coefficient of rigidity
$AMOR\_NOR=0.28\,N.m.s^{-1}$	normal damping coefficient

1.3 Boundary conditions and loadings

Imposed displacement:

All the nodes of the beam:	$DZ=0$, $DRY=0$, $DRX=0$
Node $N1$:	$DX=0$, $DY=0$, $DRZ=0$

Imposed loading (N) :

Nodes $N3$ with $N13$ and $N27$ with $N37$	$FORCEP=4.138\ \sin(\omega t)$
Nodes $N5$ with $N25$ and $N39$ with $N49$	$FORCEM=-4.138\ \sin(\omega t)$

with $\omega=251.2\ rad.s^{-1}(40\ Hz)$

Obstacles located in the plan Y according to the direction y :

$N14$	Game = $0.406\mathrm{E}-3\ m$	origin = $(0.609,0.0,0.0)$
$N26$	Game = $0.406\mathrm{E}-3\ m$	origin = $(1.218,0.0,0.0)$
$N38$	Game = $0.406\mathrm{E}-3\ m$	origin = $(1.827,0.0,0.0)$
$N2$	Game = $0.406\mathrm{E}-3\ m$	origin = $(2.436,0.0,0.0)$

2 Reference solution

2.1 Size and result of reference

One tests the value of RMS in not-regression, over total time normal force at the loose lead of the beam.

Two types of analyses were carried out:

- First analysis to consist in calculating the transitory dynamic response on a modal basis made up by the first 30 clean modes.
- Second analysis to consist in calculating the transitory dynamic response on a modal basis made up by the first 30 clean modes to which one adds the static modes.

The procedure of calculation is following:
- one calculates the first 30 Eigen frequencies (until $4800\mathrm{Hz}$) and associated clean modes,
- one projects on the modal basis the matrices of rigidity, mass and damping,
- one projects on the modal basis the efforts.
- one calculates the transitory dynamic response on the modal basis
- one calculates the RMS over the total time of the normal force to the node $N2$

One thus does not have a value of reference RMS for this problem one has the two results independently.

2.2 Reference variable

- `RMS_T_TOTAL` : value RMS over the total time of the normal force (`FORCE_NORMALE`) with the node $N2$.

3 Modeling A

3.1 Characteristics of modeling A

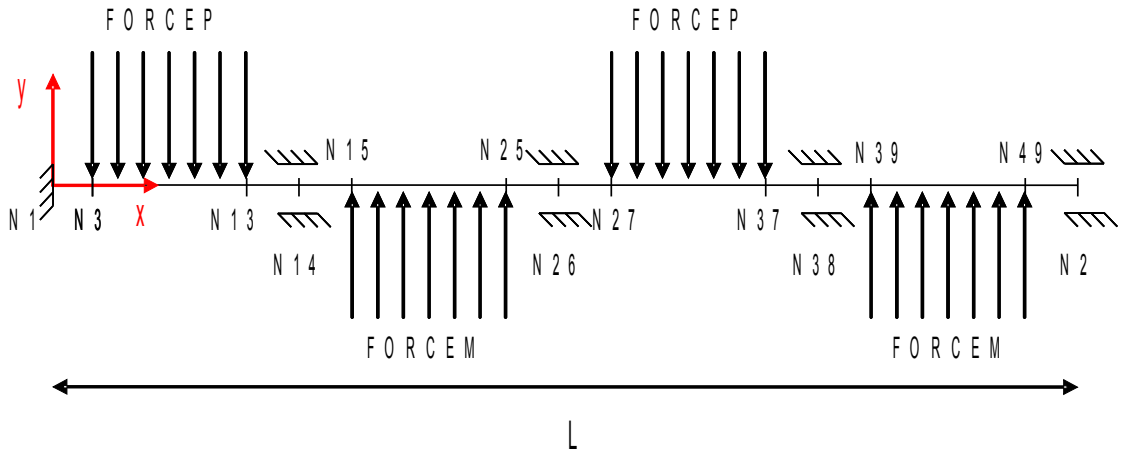

Figure 3.1. Grid of modeling A

Modeling POU_D_T :

Many nodes	49		
Many meshs	48	That is to say:	
		SEG2	48

Group of meshs

$GM1$: together meshs of the type SEG2 who compose the beam

3.2 Sizes tested and results

For the first analysis of modeling, by considering the transitory dynamic response on a modal basis only made up of the first 30 clean modes, one obtains a value of RMS as follows:

Size	Component	Node	Computed value
FORCE_NORMALE	RMS_T_TOTAL	$N2$	23.98

For the second analysis, by considering the static correction for the modal base, one obtains a value of RMS slightly different and certainly nearer to reality taking into account the improvement the modal base:

Size	Component	Node	Computed value
FORCE_NORMALE	RMS_T_TOTAL	N2	24.538

4 Summary of the results

The got results confirms the influence of the static correction of a modal base on the results. One notes a variation of 3.66% between values RMS over the total time of the normal force with and without without taking into account of the static modes.