SDNL104 - Nonlinear transitory substructuring: shock of a beam on 1 Summarized

bearing:

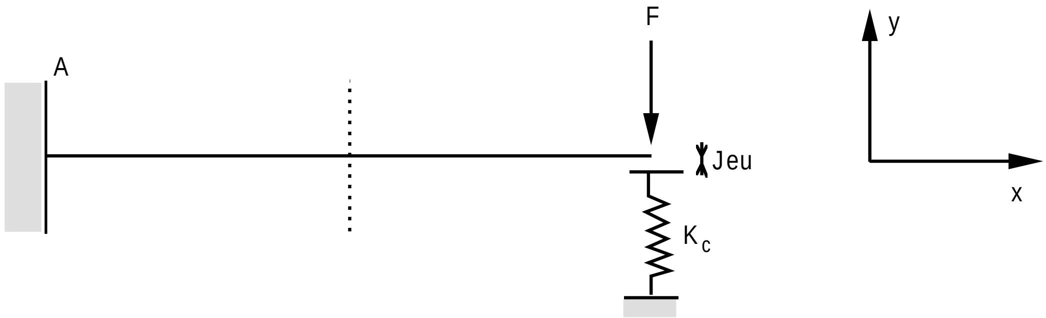
The scope of application of this test relates to the dynamics of structures, and more particularly the nonlinear computation of transient response per dynamic substructuring.

It is a question of calculating the nonlinear transient response of a beam in bending with shock on a bearing elastic and subjected to a constant force from initial time. The beam is modelled by elements of the type POU_D_E (beam of Eulerian models).

The results of reference result from a direct transient computation by modal recombination. This test thus makes it possible to validate the computational tools of transient response by under - structuring, in the case of the taking into account of non-linearities of type shock on a fixed obstacle.

1 Problem of reference

1.1 Geometry



the length of the beam is worth: $L=1\,m$

The cross-section of the beam is full circular of radius: $R=0.1\,m$

Clearance between the beam and the elastic bearing is worth: $J=1\,10^{-4}\,m$

1.2 Material properties

$E=1.10^{10}\,Pa$

$\nu=0.3$

$\rho=1.10^{6}\,kg/m^{3}$

the stiffness of the come out from contact is worth: $K_c=1.10^{8}\,N/m$

1.3 Boundary conditions and loadings

On all structure: $DX=DZ=DRY=DRX=0$.

With point: $A \quad DY=DRZ=0$.

At the loose lead of beam: from time $t=0\,s$, $Fy=-1000.\,N$

1.4 Initial conditions

Structure initially at rest.

2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is given by a direct transient computation by modal recombination (modelization A).

2.2 Results of reference

Value of displacements, velocity and acceleration of the loose lead of the beam according to the direction Y and at time $t=1\,s$.

	Displacement (m)	Velocity ($m.s^{-1}$)	Acceleration ($m.s^{-2}$)
Diagram of integration of Eulerians	– 1.255 10-4	8.352 10-4	3.640 10-1
Diagram of integration of Devogelaere	– 1.254 10-4	8.410 10-4	2.855 10-1
Diagram of integration to time step adaptive of order 2	– 1.255 10-4	8.327 10-4	3.458 10-1

2.3 Uncertainty on the solution

numerical Solution.

3 Modelization A

3.1 Characteristic of the modelization

the beam is with a grid in segments to which are affected of the elements of the type POU_D_E.

With the transitory problem dealt, project on the basis of eigen mode the first 5 of structure, is solved directly by the operator transient computation by modal recombination.

3.2 Characteristics of the mesh

Many nodes: 11

Number of meshes and types: 10 SEG2

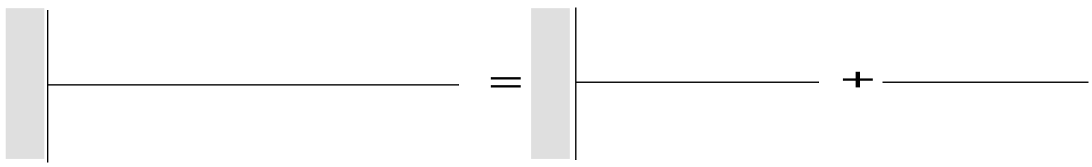
3.3 Actual values: references for modelization B

Identification	*Aster*
Diagram of integration of Eulerian	
Displacement (m)	– 1.254 10-4
Velocity ($m.s^{-1}$)	8.352 10-4
Acceleration ($m.s^{-2}$)	3.639 10-1
Diagram of integration of Devogelaere	
Displacement (m)	– 1.254 10-4
Velocity ($m.s^{-1}$)	8.409 10-4
Acceleration ($m.s^{-2}$)	2.854 10-1
Diagram of integration to time step adaptive of order 2	
Displacement (m)	– 1.255 10-4
Velocity (m.s^-1) 8.328	10-4 Acceleration
(m.s^-2) 3.457	10-1 Modelization

4 B Characteristic

4.1 of the modelization the beam

is cut out in 2 parts of equal size. Each substructure considered is with a grid in segments to which are affected of the elements of the type POU_D_E . `The structure`



is studied using the method of substructuring with interfaces of the type “Craig - Bampton” (blocked interfaces). The base

of the first 5 eigen modes of complete structure is calculated by under - structuring. Then, the transitory problem, project on this basis, are solved by the operator transient computation by modal recombination. Characteristics

4.2 of the mesh Many

nodes: 6 Number of meshes

and types: 5 SEG2 `Quantities`

4.3 tested and results Identification

Reference	Aster	*% difference*	Diagram
in integration of Eulerian Displacement			
() – 1.254 m	10-4 – 1.255	10-4 0.043	Velocity
() 8.352 $m.s^{-1}$	10-4 8.289	10-4 – 0.75	Acceleration
() 3.639 $m.s^{-2}$	10-1 3.870	10-1 6.32	Diagram
of integration of Devogelaere Displacement			
() – 1.254 m	10-4 – 1.254	10-4 0.042	Velocity
() 8.409 $m.s^{-1}$	10-4 8.319	10-4 – 1.1	Acceleration
() 2.854 $m.s^{-2}$	10-1 3.078	10-1 7.8 Diagram	
of integration to time step adaptive of a nature 2 Displacement			
() – 1.255 m	10-4 – 1.255	10-4 0.044	Velocity
() 8.328 $m.s^{-1}$	10-4 8.258	10-4 0.84	Acceleration
() 3.457 $m.s^{-2}$	10-1 3.683	10-1 6,5 Remarks	

4.4 In the case of

a transient computation nonlinear, it is not abnormal to obtain important uncertainties on not realised quantities. The variation of 6 with between 8% the reference solution and the solution obtained by substructuring for acceleration thus does not invalidate the method tested, more especially as the results in displacements are excellent (variation). Summary $< 0.1\%$

5 of the results the accuracy

on displacements of the loose lead of the beam at time is excellent $t=1.s$ (relative error). This $<0.1\%$ test thus validates the operators of nonlinear transient computation by dynamic substructuring. The values of acceleration with the diagram of Devogelaere are to be analyzed.