SDNL140 – Damped vibration of two beams while contact-rubbing

Summary:

This test models the nonlinear vibratory answer of two beams while contact-rubbing, subjected to the effect of a force concentrated with one of the ends of the beam. The ultimate goal is to validate the order DYNA_NON_LINE with a linear elastic behavior and contact-friction with DEFI_CONTACT. The reference solution is not analytical but resulting from a calculation finite elements with a method of penalization for the contact and an explicit diagram.

Modelings suggested depend on the diagrams of differences finished in time and on the space discretization.

- Modeling A : linear grid with TETRA4 and diagram of HHT (implicit). In this modeling, one tests the reference solution like one SOURCE_EXTERNE. One tests also various algorithms of Code_Aster (POINT_FIXE, PARTIAL NEWTON, GCP, PENALISEE) in not-regression.
- Modeling B : quadratic grid with TETRA10 and diagram of HHT (implicit).
- Modeling C : linear grid with HEXA8 and diagram of HHT (implicit).

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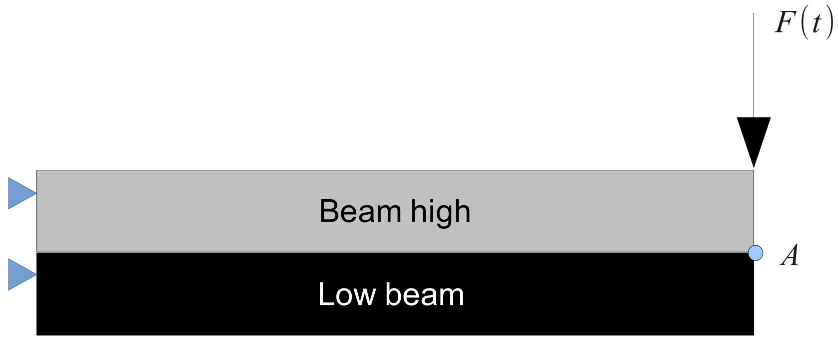
1 Problem of reference

1.1 Geometry



The coordinates of the points are given in meters (m):

Length	1
Height	0.1

1.2 Material properties

The material has an isotropic elastic behavior:

Young modulus	200GPa
Poisson's ratio	0.0
Density	7800kg/m^3
Coefficient of friction	0.2

1.3 Boundary conditions and loadings

Initially, the two beams at rest and are not deformed. The dynamic evolution of the two structures is such as: in $X=0$, the two beams are embedded and in $X=L$, the beam of bottom is free while the beam top is subjected to an impulse of " *Heaviside "(*Constant force concentrated in time).

1.4 Description of the interface

Two surfaces are initially in contact. Moreover, one made the choice to make initially these two surfaces of contact compatible.

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2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is drawn from [1]. It is about a calculation finite elements with a method of penalization and a diagram in explicit time of centered difference. The grid as well as the result of the calculation of reference are presented below.

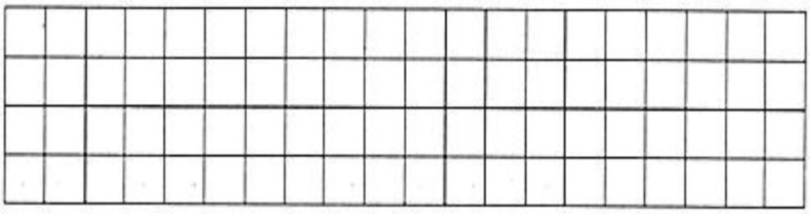
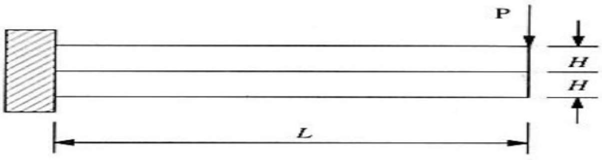


Figure: Grid finite element of the calculation of reference (Extracted from [1]).



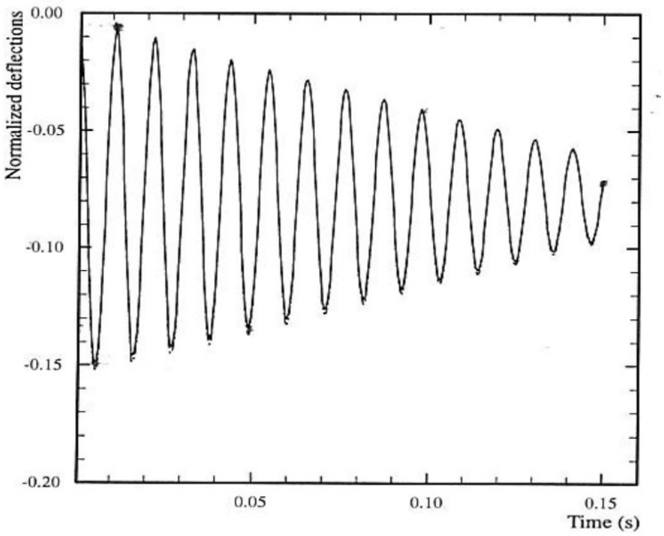


Figure: Solution in vertical displacement of the calculation of reference (Extracted from [1]).

It is seen well that the solution is deadened in time. Damping is strongly related to the parameters of connections (impact, friction, reactions to the supports)

2.2 Uncertainty on the solution

All the digital parameters of the reference solution not being known, one can expect differences between the solution SOURCE_EXTERNE and the solution of the code. One will be interested rather in the orders of magnitude.

In certain modelings, one seeks to compare the results of various algorithms and diagrams. With this intention, one does the same calculation with DYNA_NON_LINE while only changing definition of the

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contact following the algorithm or the definition of the diagram in time. Then one creates, from CREA_CHAMP, a structure of the type EVOL_NOLI representing the difference in results between two algorithms/diagrams. Lastly, one tests if the results of the two algorithms/diagrams are the same ones in a node.

2.3 References

[1] Zhi-Hooted Zong, Finite element procedures for Contact-Impact problems, Oxford Science Publication, p162.

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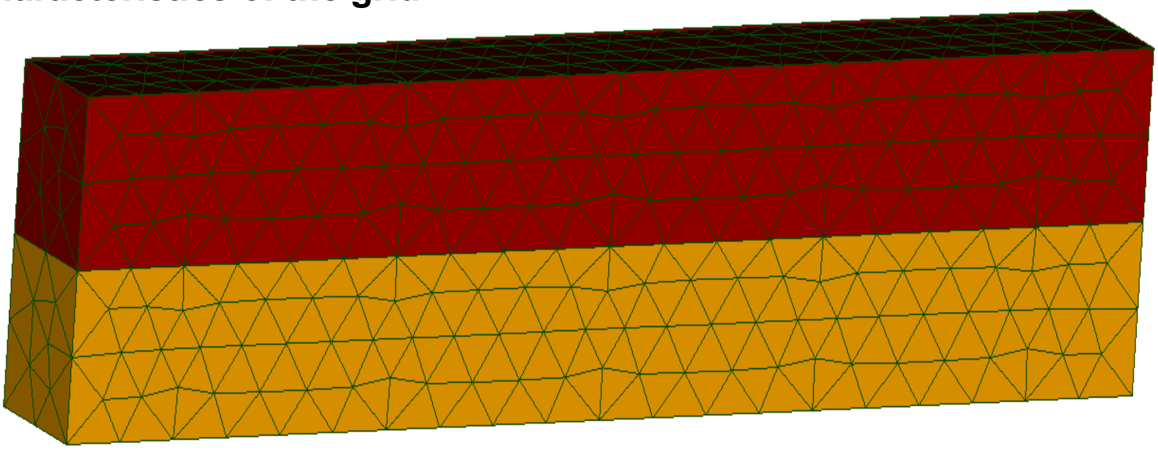
3 Modeling A

3.1 Characteristics of modeling

- Modeling `3D` (meshs `TETRA4`)
- Relation of elastic behavior linear.

3.2 Characteristics of the grid



- Many nodes 1,051
- Many nodes slaves 118
- Many meshs
  - TETRA4 3535
  - TRIA3 1584
  - Slave and Master 190*2
- Groups of nodes:
  - Clim_Bas
- Groups of meshs:
  - High
  - Bas_Encastre
  - Bas_Contact
  - Bas_Libre
  - Low
  - Haut_Pression
  - Haut_Contact
  - Haut_Encastre
  - Haut_Libre

3.3 Sizes tested and results

One tests to only it not regression of the fields of displacement for the various methods of contact used.

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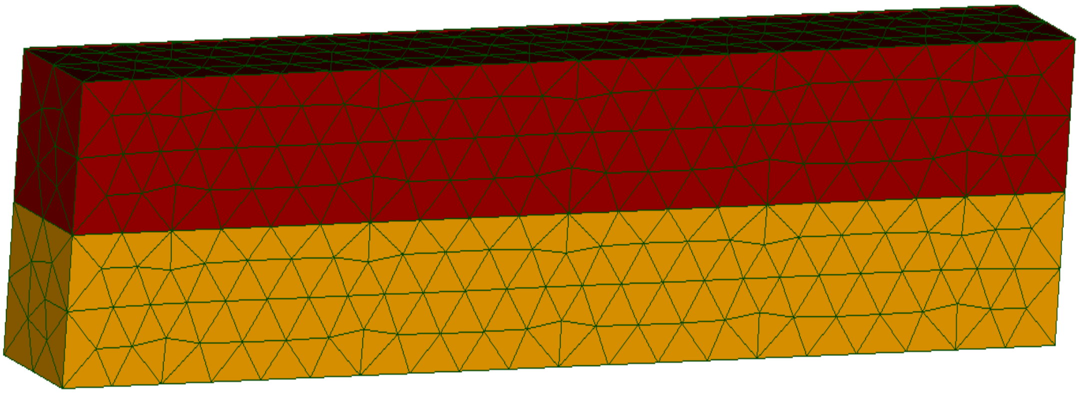
4 Modeling B

4.1 Characteristics of modeling

- Modeling `3D` (meshs `TETRA10`)
- Elastic relation of behavior linear.

4.2 Characteristics of the grid



- Many nodes 6,427
- Many nodes slaves 199
- Many meshs
  - TETRA10 3,535
  - TRIA6 1,584
  - Slave and Master 190*2
- Groups of nodes:
  - Clim_Bas
- Groups of meshs:
  - High
  - Bas_Encastre
  - Bas_Contact
  - Bas_Libre
  - Low
  - Haut_Pression
  - Haut_Contact
  - Haut_Encastre
  - Haut_Libre

4.3 Sizes tested and results

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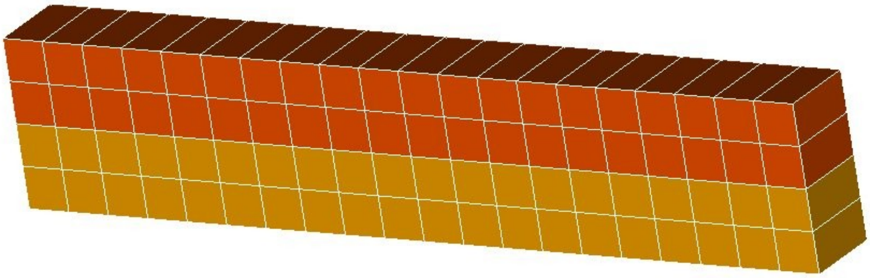
5 Modeling C

5.1 Characteristics of modeling

- Modeling 3D (meshs HEXA8)
- Elastic relation of behavior linear.

5.2 Characteristics of the grid



- Many nodes 252
- Many nodes slaves 42
- Many meshs
  - HEXA8 80
  - QUAD4 248
  - Slave and Master 20* *2
- Groups of meshs:
  - Bas_Encastre
  - Bas_Contact
  - Clim_Bas
  - Haut_Pression
  - Haut_Contact
  - Haut_Encastre

5.3 Sizes tested and results

Identification	Moment (S)	Type of reference	Value of reference	Tolerance (%)
DY ('N90')	0.012	'SOURCE_EXTERNE'	-0.03	60

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6 Summaries of the results

This test shows the influence of the space-time discretization in a nonlinear calculation of dynamics with taking into account of friction.

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