SDLL302 – Beam subjected to the accelerogram “El Centro” with each one of its ends, one out of phase compared to the other

Abstract:

The purpose of this test is to validate the multi-bearing out of transient on the simple case of a beam subjected to an acceleration on each one of its ends. The accelerogram is out of phase between the two ends.

1 Problem of reference

1.1 Geometry

One considers a beam length $L=7{,}62\,m$, of rectangular section ($Hy=0{,}0508\,m$ and $Hz=0{,}0254\,m$). It is directed according to the axis Ox .

1.2 Properties of the material

the material is elastic isotropic whose properties are:

- Young modulus: $E=206{,}8\ 10^9\,Pa$
- Poisson's ratio: $\nu=0{,}3$
- density: $\rho=7780{,}0\,Kg/m^3$

1.3 Boundary conditions and loadings

the beam is embedded with each one of its ends.
The loading is a seismic excitation perpendicular to the direction of the beam, expressed in the shape of an accelerogram. It is drawn from a record of the seisme known as of El Centro (Illustration 1: Accelerogram known as of “El Centro”). The direction of the seisme is the axis Oy .

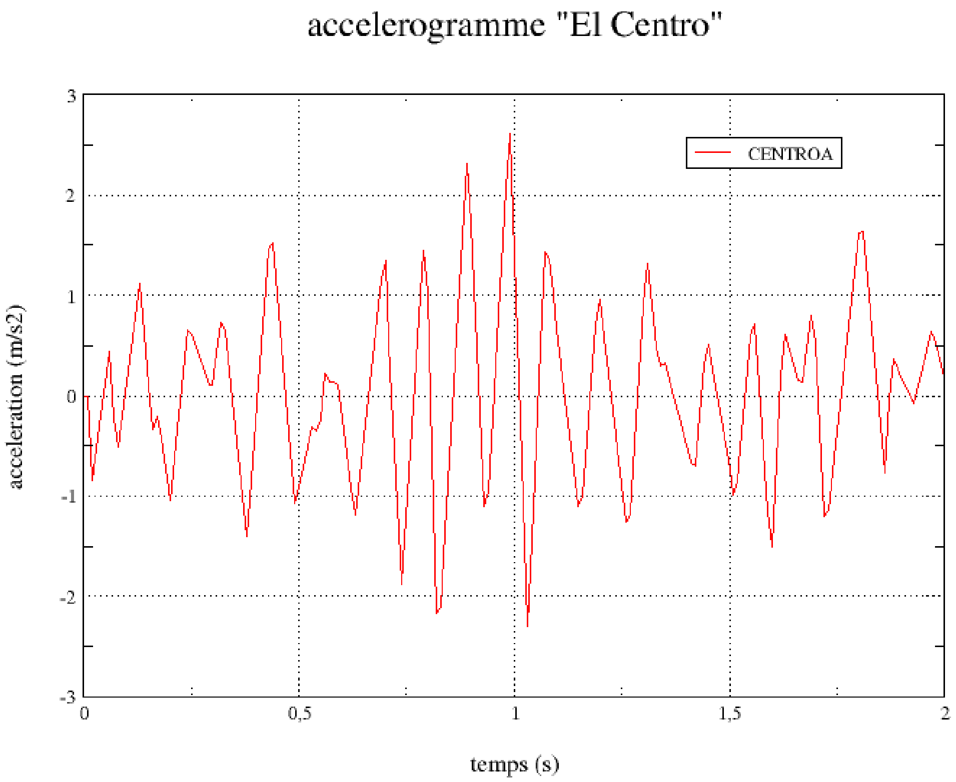

Illustration 1: Accelerogram known as of “El Centro”

For the modelization A, one considers a mono-supported excitation: the same accelerogram is imposed at the two ends of the beam.

For the modelization B, one considers a multi-supported excitation: the accelerogram imposed at the two ends is the same one as out of mono-bearing but, in this case, at the opposite end it is applied with a delay from $0{,}25\,s$ ratio at the origin.

1.4 Initial conditions

One considers the beam at rest before the arrival of the seisme.

2 Reference solution

This case test is resulting from the campaign validation independent of *Code_Aster* to computations of seisme. This document refers to the computations obtained with software ABAQUS [1]. However, in the absence of more information, one regards the results of case test as results of NON-regression and intercomparison between various operators (linear transient computation on modal base, direct linear transient computation) and various integration methods in time (NEWMARK, DEVOGELAERE).

[1] Note HP-52/97/0168 GUIHOT P., DEVESA G., DUMOND A., WAECKEL FeValidation independent of version 3 of the Code_Aster: synthesis of the validation of the batch seisme

3 Modelization A

3.1 Characteristic of the modelization

One uses a modelization `POU_D_T`.

3.2 Characteristics of the mesh

The mesh contains 20 elements of the type `SEG2`.

3.3 Quantities tested and results

One tests the first 6 eigenfrequencies of the clamped beam.
One tests the displacement of the center of the beam in the direction of the seisme at various times.

3.4 Remarks

One can compare the evolution of the displacement of the center of the beam between computation on physical base and computation on modal base (Illustration 2: SDLL302a: transitory comparison on physical base vs modal base).

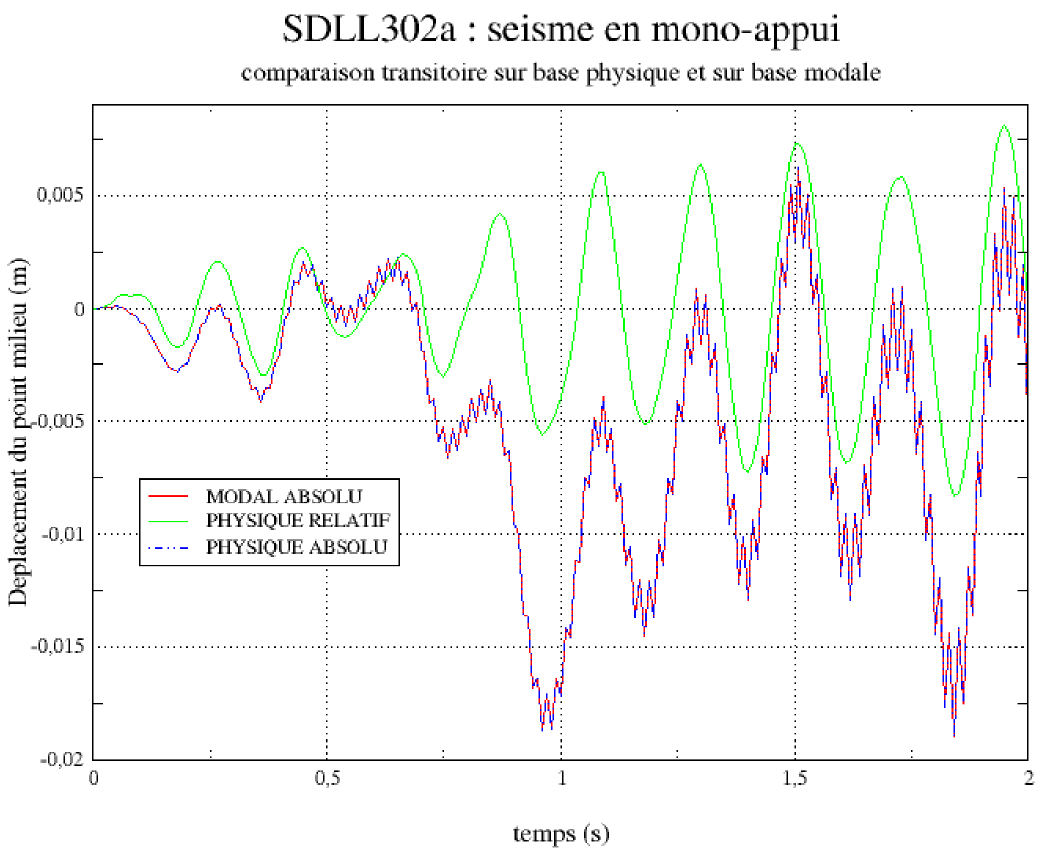

Illustration 2: SDLL302a: transitory comparison on physical base vs modal base

One notes that the absolute displacement calculated out of transient on physical base or by transient on modal base are identical. On the other hand it appears very irregular, particularly in comparison with relative displacement of the same point. It is about an artefact due to the method used to integrate the accelerogram and to determine the displacement of training. In the case test one employed the method known as of SIMPSON whereas method known as TRAPEZE is recommended. It is checked that with this last integration method of the signal one obtains an evolution of absolute displacement definitely smoother.

4 Modelization B

4.1 Characteristic of the modelization

One uses a modelization POU_D_T.

4.2 Characteristics of the mesh

The mesh contains 20 elements of the type SEG2.

4.3 Quantities tested and results

One tests the first 6 eigenfrequencies of the clamped beam.
One tests the displacement of the center of the beam in the direction of the seisme at various times.

4.4 Remarks

One traces on the following figure (Illustration 3: SDLL302b: computation multi-bearing) evolution of the displacement of the center of the beam by computation on physical base and it by computation on modal base. It should be noted that these two displacements are not comparable in the meaning where computation on physical base gives a relative displacement which it is difficult to interpret in the case multi-bearing: the notion of displacement of training is not commonplace any more for computation out of multi-bearing. One cannot thus compare the two results, nor to draw some from conclusion.

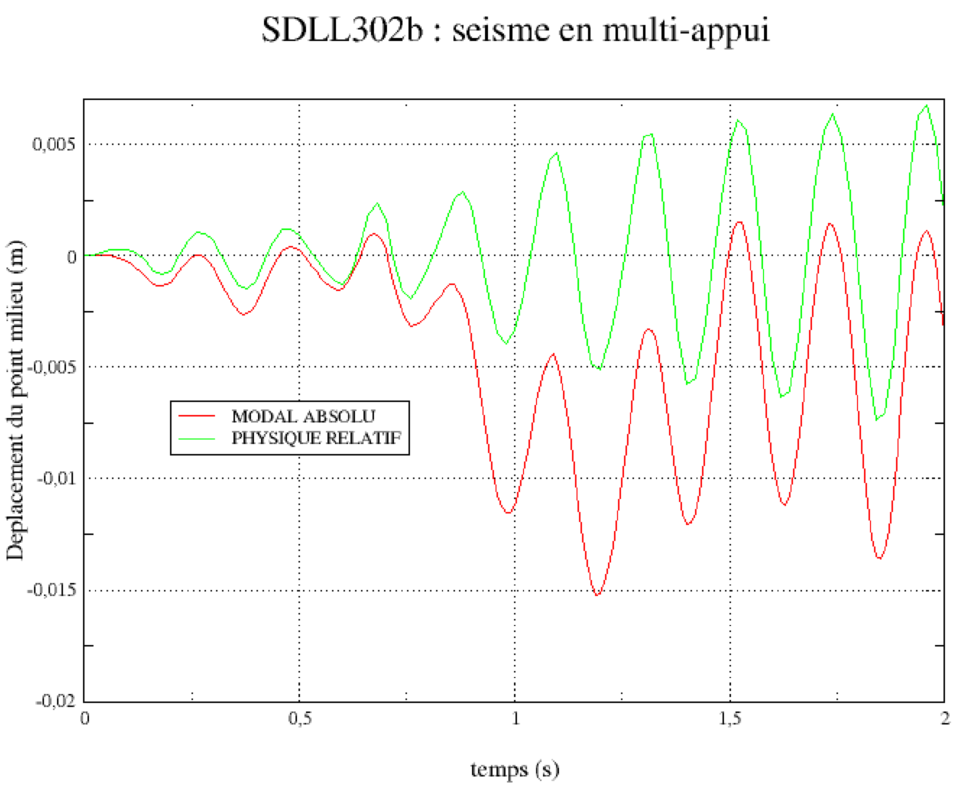

Illustration 3: SDLL302b: computation multi-bearing

One notices in addition that by contrast with the modelization A, the displacement calculated on modal base appears quite smooth (in accordance with the "physical meaning" of the engineer). This is simply due to the fact that in the modelization B, one left the default option (method TRAPEZE) to integrate the accelerogram. However she is recommended because she does not create factitious oscillations such as those produced by method SIMPSON).

5 Summary of the results

This case test constitutes a checking by results of NON-regression of transient computation out of multi-bearing. In the absence of external reference and of real intercomparison between the various methods, one cannot however not consider that it represents a validation of the functionality.