SDLL302 – Beam subjected to the accélérogramme "El Centro" with each one of its ends, one out of phase compared to the other

Summary:

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

1 Problem of reference

1.1 Geometry

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

1.2 Properties of 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 form of a accélérogramme. It is drawn from a recording of the earthquake known as of El Centro (Illustration 1: Accélérogramme known as of "El Centro"). The direction of the earthquake is the axis Oy.

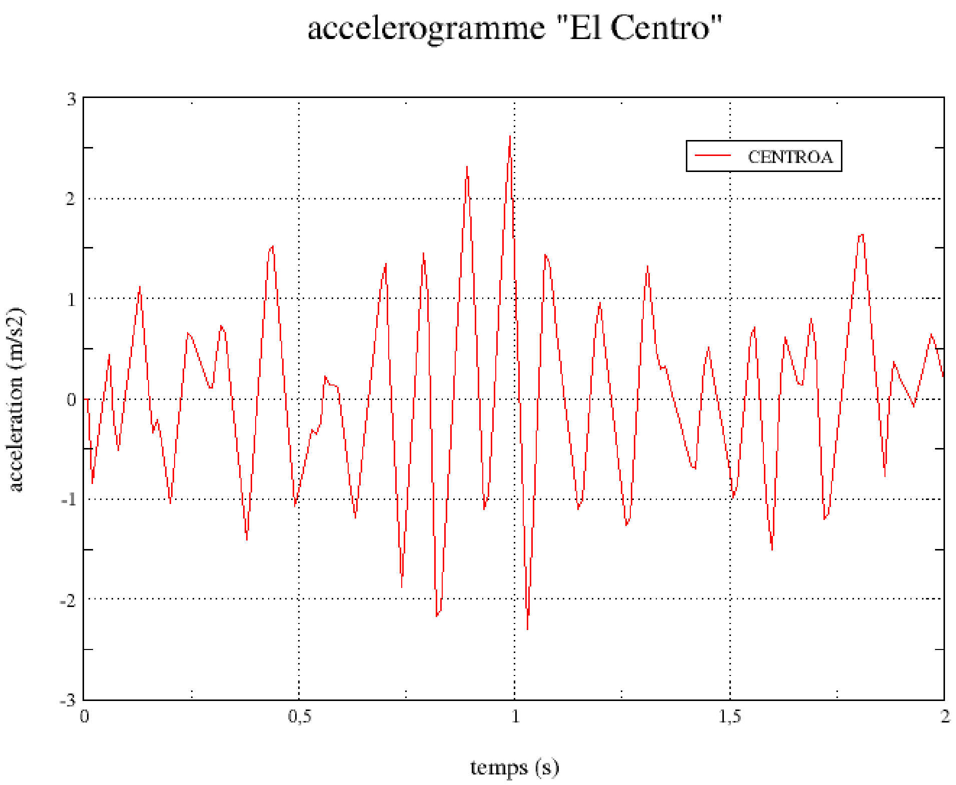

Illustration 1: Accélérogramme known as of "El Centro"

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

For modeling B, one considers a multi-supported excitation: the accélérogramme imposed at the two ends is the same one as in mono-support but, in this case, at the opposite end it is applied with a delay of $0,25\,s$ compared to the origin.

1.4 Initial conditions

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

2 Reference solution

This case test is resulting from the validation campaign independent of *Code_Aster* with calculations of earthquake. This document refers to the calculations obtained with software ABAQUS [1]. However, in the absence of more information, one regards the results of case test as results of not-regression and intercomparison between various operators (linear transitory calculation on modal basis, direct linear transitory calculation) and various methods of integration in time (NEWMARK, DEVOGELAERE).

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

3 Modeling A

3.1 Characteristics of modeling

A modeling is used `POU_D_T`.

3.2 Characteristics of the grid

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

3.3 Sizes tested and results

One tests the first 6 Eigen frequencies of the fixed beam.
One tests the displacement of the center of the beam in the direction of the earthquake at various moments.

3.4 Remarks

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

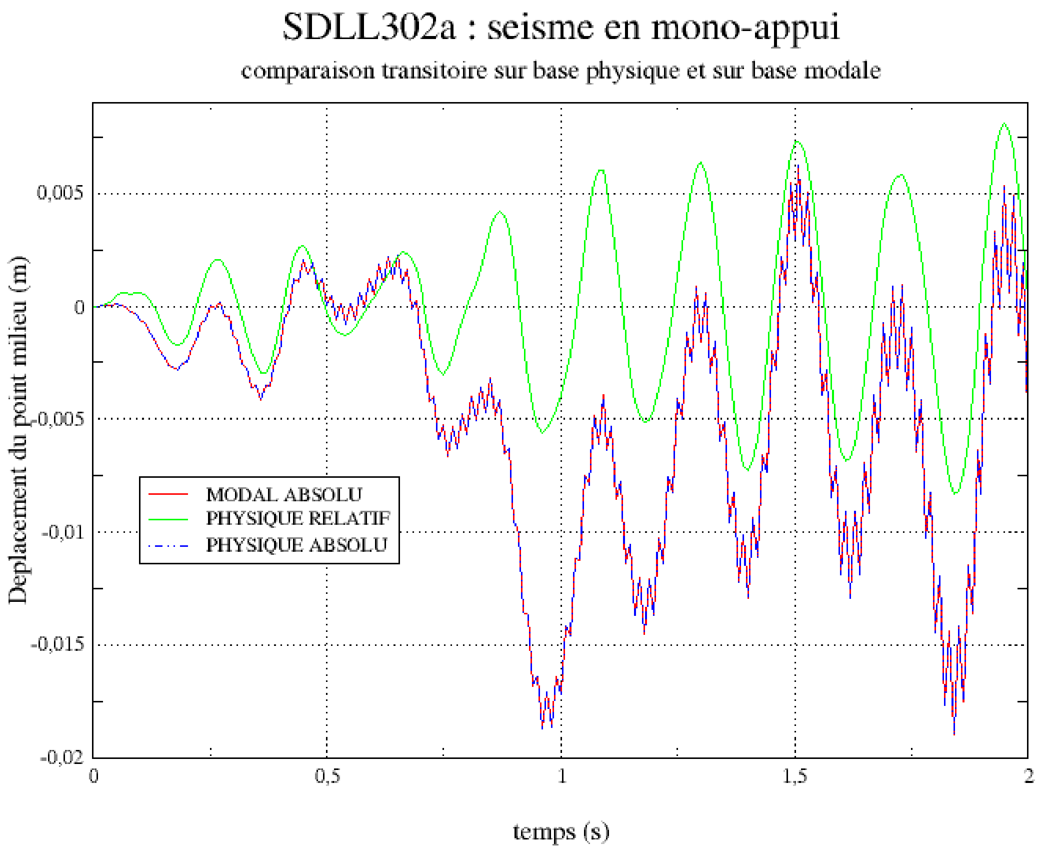

Illustration 2: SDLL302a: transitory comparison on physical basis vs bases modal

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

4 Modeling B

4.1 Characteristics of modeling

A modeling is used POU_D_T.

4.2 Characteristics of the grid

The grid contains 20 elements of the type SEG2.

4.3 Sizes tested and results

One tests the first 6 Eigen frequencies of the fixed beam.
One tests the displacement of the center of the beam in the direction of the earthquake at various moments.

4.4 Remarks

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

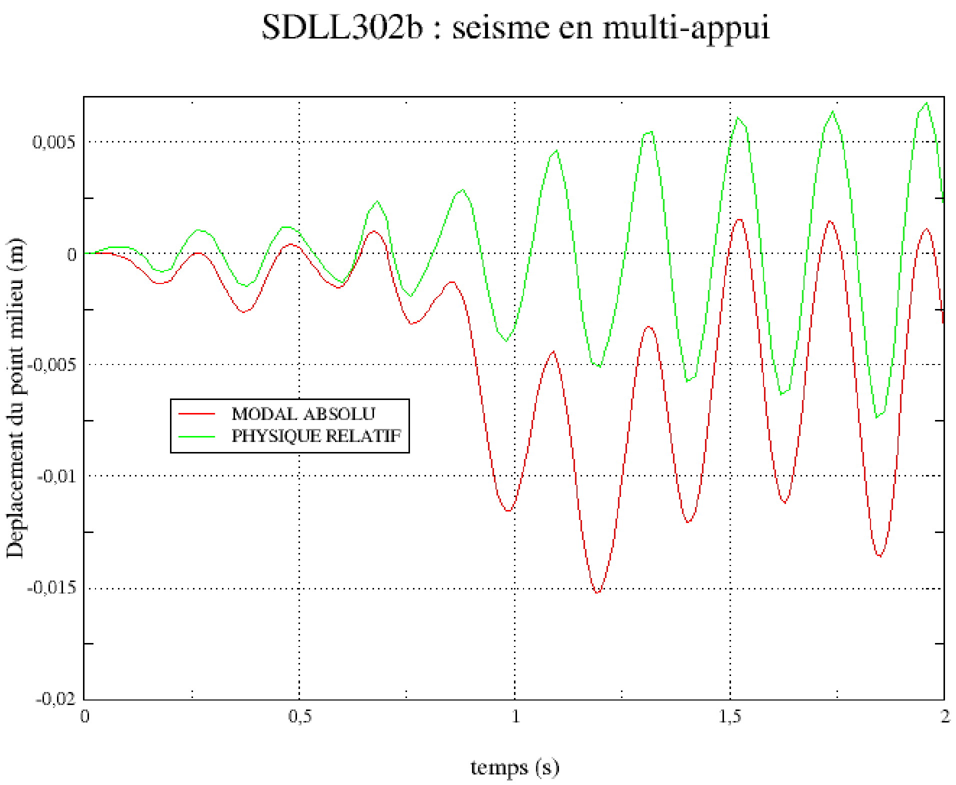

Illustration 3: SDLL302b: calculation multi-support

It is noticed in addition that by contrast with modeling A, the displacement calculated on modal basis appears quite smooth (in accordance with the "physical direction" of the engineer). This is simply due to the fact that in modeling B, one has left the option by default (method TRAPEZOID) to integrate the accélérogramme. However she is recommended because she does not create factitious oscillations such as those produced by the method SIMPSON).

5 Summary of the results

This case test constitutes a checking by results of not-regression of transitory calculation in multi-support. 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.