SDLV124 – Voluminal paving stone subjected to a harmonic pressure

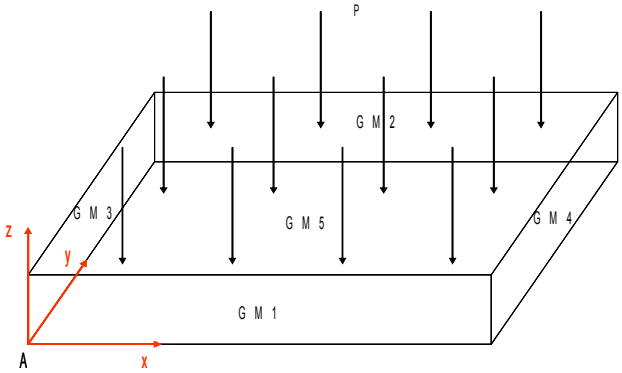
Abstract:

The purpose of this benchmark is to validate the harmonic computation of a rectangular paving stone modelled in voluminal elements subjected to a sinusoidal pressure. One also validates the harmonic computation of response on a matrix projected on modal base.

The reference solution is obtained using a transient computation carried out on the same model.

1 Problem of reference

1.1 Geometry



Dimensions of the paving stone (m) :
length (according to x): 0.35
width (according to y): 0.25
thickness (according to z): 0.01

1.2 Elastic properties of the material

$E=1.8\times10^{11}\,Pa$	Modulus Young
$\nu=0.3$	Poisson's ratio
$\rho=7800.0\,kg.m^{-3}$	Density
$\alpha=3\times10^{-5}\,s$	
$\beta=0.001\,s^{-1}$	

the coefficients α and β make it possible to build a viscous damping matrix proportional to the stiffness and the mass $[C]=\alpha[K]+\beta[M]$.

1.3 Boundary conditions and loadings

- Fixed support of the side sides
- harmonic Pressure of amplitude $p=10^5\,Pa$ to a frequency $f=1500\,Hz$ on the upper face

2 Reference solution

2.1 Method of calculating

It acts to calculate the response of a voluminal paving stone subjected to a harmonic pressure on its upper face. The reference solution is obtained by carrying out a computation of transient response on physical base by means of the diagram of integration of Newmark with the parameters $alpha=0.25$ and $delta=0.5$.

2.2 Quantities and results of reference

One proposes to test the following quantities:

- Displacement following x to the point of coordinates $(1.575, 1.25, 0)$
- Forced and strain to the Gauss point of a mesh containing the node of coordinates $(0.3325, 0.05, 0)$
- Forced and strain to the node of coordinates $(0.3325, 0.05, 0)$

2.3 Uncertainties on the solution

One considers that the mode is established at the end of 90 periods of the excitation. The values of reference selected are those raised on 98ième and the 99ième periods of the transient response.

3 Modelization A

3.1 Characteristic of the modelization A

One calculates the harmonic response (with $1500\,Hz$) on physical base and the matrix projected on the first fifteen eigen modes of structure.

The paving stone is modelled using the voluminal elements 3D

3.2 Characteristic of the mesh

Many nodes: 1764
Number of meshes:
QUAD4 : 1040
HEXA8 : 1200

Names and coordinates of the nodes of control:
$N433$: $(1.575, 1.25, 0)$
$N627$: $(0.3325, 0.05, 0)$

3.3 Quantities tested and results

Identification	Reference
Computation on physical base: DX with the node $N433$	$9.0386\,E-7\,m$
Computation on projected matrix: DX with node $N433$	$9.0386\,E-7\,m$
SIXX at the Gauss point number 1 of the mesh $M1145$	$4.5806\,E6\,Pa$
SIXX with node $N627$ of the mesh $M1145$	$4.7080\,E6\,Pa$
EPXX at the Gauss point number 1 of the mesh $M1145$	$2.31494\,E-5$
EPXX with the node $N627$ of the mesh $M1145$	$2.14060\,E-5$

Note:: the tests are made by intercomparison between harmonic computation and transient computation on physical base.

One calculates kinetic energy ECIN_ELEM of the mesh $M1145$:

Component	option	Reference (NON_REGRESSION)
ECIN_ELEM	TOTAL	7.02862 10-7

4 Summary of the results

the computation results of the harmonic response (on physical base and modal base) are very close to those obtained with an equivalent transient computation which was used as reference.