Summary:

The objective of this CAS-test is to validate the calculation of a plate in plane deformation (D_PLAN) subjected to a sinusoidal pressure using a harmonic calculation.

For that, one carries out two calculations on the same model, a harmonic calculation and a transitory calculation. Transitory calculation is used as reference.
1 Problem of reference

1.1 Geometry

Coordinates of the points expressed in meters:
- $A: (0.0, 0.0)$
- $B: (0.35, 0.0)$
- $C: (0.35, 0.6)$
- $D: (0.0, 0.6)$

1.2 Elastic properties of material

- $E = 1.8 \times 10^{11} \text{ Pa}$ (Young modulus)
- $\nu = 0.3$ (Poisson's ratio)
- $\rho = 7800.0 \text{ kg/m}^3$ (Density)
- $\alpha = 3 \times 10^{-5} \text{ s}$
- $\beta = 0.001 \text{ s}^{-1}$

Coefficients $\alpha$ and $\beta$ allow to build a matrix of viscous damping proportional to rigidity and the mass $[C] = \alpha [K] + \beta [M]$.

1.3 Boundary conditions and loadings

- Embedding on the side $AD$
  $DX = 0.0 \text{ m}$, $DY = 0.0 \text{ m}$

- The side $BC$ is subjected to a harmonic pressure of amplitude $p = 10^5 \text{ Pa}$ at a frequency $f = 1500 \text{ Hz}$

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2 Reference solution

2.1 Method of calculating

It is a question of calculating the answer of a plate subjected to a harmonic pressure on a side of the plate and embedded on the opposite side.

The reference solution is obtained by carrying out a transitory calculation of answer with the operator DYNA_VIBRA by using the diagram of integration of Newmark with the parameters $alpha = 0.25$ and $delta = 0.5$.

2.2 Sizes and results of reference

One proposes to test the following sizes:

- Following displacement $x$ at the point of coordinates $(0.0816, 0.165)$
- Constraint and deformation at the point of Gauss of a mesh containing the node of coordinates $(0.3383, 0.39)$
- Constraint and deformation with the node of coordinates $(0.3383, 0.39)$

2.3 Uncertainties on the solution

It is considered that the mode is established at the end of 90 periods. The values of reference selected are those raised on the 98th and 99th periods of the transitory answer.
3 Modeling A

3.1 Characteristics of modeling A

Modeling D_PLAN

3.2 Characteristics of the grid

Many nodes: 1271
Many meshes:
- SEG2 : 140
- QUAD4 : 1200

Group of meshes:
- GM1 : dimensioned AB
- GM2 : dimensioned CD
- GM3 : dimensioned BC
- GM4 : dimensioned AD
- GM5 : face ABCD

N433 : (0.0816, 0.165)
N1328 : (0.3383, 0.39)
3.3 Sizes tested and results

<table>
<thead>
<tr>
<th>Identification</th>
<th>Reference</th>
<th>Type of reference</th>
<th>tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX with the node N433</td>
<td>$3.9896 \times 10^{-8} m$</td>
<td>AUTRE_ASTER</td>
<td>0.1 %</td>
</tr>
<tr>
<td>SIXX at the point of Gauss number 1 of the mesh M194</td>
<td>98461 Pa</td>
<td>AUTRE_ASTER</td>
<td>0.1 %</td>
</tr>
<tr>
<td>SIXX with the node N1328 mesh M194</td>
<td>98100 Pa</td>
<td>AUTRE_ASTER</td>
<td>0.1 %</td>
</tr>
<tr>
<td>EPXX at the point of Gauss number 1 of the mesh M194</td>
<td>$5.2747 \times 10^{-7}$</td>
<td>AUTRE_ASTER</td>
<td>0.1 %</td>
</tr>
<tr>
<td>EPXX with the node N1328 mesh M194</td>
<td>$5.2772 \times 10^{-7}$</td>
<td>AUTRE_ASTER</td>
<td>0.1 %</td>
</tr>
</tbody>
</table>

The kinetic energy is calculated ECIN_ELEM mesh M194:

<table>
<thead>
<tr>
<th>Option</th>
<th>Component</th>
<th>Reference</th>
<th>Type of reference</th>
<th>tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonic calculation</td>
<td>ECIN_ELEM TOTAL</td>
<td>$1.91599 \times 10^{-6}$</td>
<td>NON_REGRESSION</td>
<td>-</td>
</tr>
<tr>
<td>Transitory calculation</td>
<td>ECIN_ELEM TOTAL</td>
<td>$1.78915 \times 10^{-6}$</td>
<td>NON_REGRESSION</td>
<td>-</td>
</tr>
</tbody>
</table>
4 Modeling B

4.1 Characteristics of modeling B

Modeling B is a copy of the modeling A in which one replaced material ELAS by a material ELAS_ORTH isotropic in order to validate the taking into account of the parameters of damping in this case.

4.2 Sizes tested and results

Modeling A is used as reference for all the sizes tested.

<table>
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</thead>
<tbody>
<tr>
<td>DX with the node N433</td>
<td>3.99011179996e-08 m</td>
<td>AUTRE_ASTER</td>
<td>1E-4 %</td>
</tr>
<tr>
<td>SIXX at the point of Gauss number 1 of the mesh M194</td>
<td>98510.5400395 Pa</td>
<td>AUTRE_ASTER</td>
<td>1E-4 %</td>
</tr>
<tr>
<td>SIXX with the node N1328 mesh M194</td>
<td>98149.5819288 Pa</td>
<td>AUTRE_ASTER</td>
<td>1E-4 %</td>
</tr>
<tr>
<td>EPXX at the point of Gauss number 1 of the mesh M194</td>
<td>5.27795672536e-07</td>
<td>AUTRE_ASTER</td>
<td>1E-4 %</td>
</tr>
<tr>
<td>EPXX with the node N1328 mesh M194</td>
<td>5.27546476125e-07</td>
<td>AUTRE_ASTER</td>
<td>1E-4 %</td>
</tr>
</tbody>
</table>

The kinetic energy is calculated ECIN_ELEM mesh M194 :

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5 Summary of the results

The computation results of the harmonic answer are very close to those obtained with a transitory calculation are equivalent which was used as reference.