SDLL112 – Seismic analysis of a multimedia beam (spectral response)

Summarized

This test relates to the seismic analysis with the spectral method of a beam vertical, embedded at its base and articulated in two points of different altitude. The structure is subjected to an excitation provided in the form of an oscillator spectrum in pseudo-acceleration.
Via this problem, one tests modal combinations SRSS and CQC of operator COMB_SISM_MODAL [U4.84.01], with taking into account or not of the neglected modes.

In addition, one tests the operators of preprocessing MODE_ITER_SIMULT [U4.52.02], NORM_MODE [U4.64.02], MODE_STATIQUE [U4.52.04], DEFI_FONCTION [U4.21.02] and DEFI_NAPPE [U4.21.03].

The validation consists with:

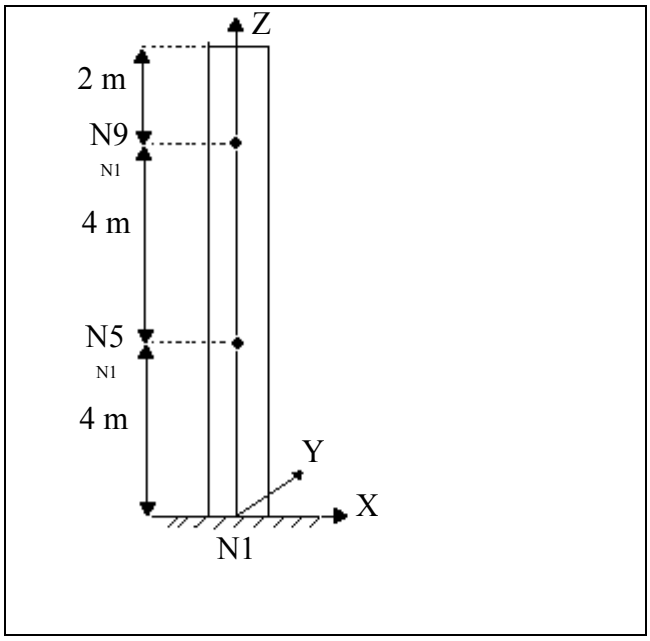
- A to compare the results with those obtained using CASTEM 2000 (modelization 3D): mono-bearing combination CQC, multi-bearing excitation identical to the bearings combination CQC);
- to find the response mono-bearing by the path multi-bearing, in the case of excitations identical to the bearings (modelizations A (3D) and B (2D), combination CQC);
- to check the NON-regression of the response if it does not exist of bench-mark data (different excitations to the bearings).

The got results result in agreement with those from CASTEM 2000. In the case of excitations equal to the bearings, the response calculated out of multi-bearing via option "CORRELE" is identical to the response calculated out of mono-bearing.

1 Problem of reference

1.1 Geometry

the chimney is a beam vertical length $10\,m$, embedded at its base and articulated in two points of altitude $4\,m$ and $8\,m$.



Cross section of beam:

Area: $A = 3.4390\,10^{-3}\,m^2$

Main moments of inertia: $I_y = 1.3770.\,10^{-5}\,m^4$

$I_z = 1.3770.\,10^{-5}\,m^4$

$J_x = 2.7540\,10^{-5}\,m^4$

1.2 Material properties

Beam	modulus Young	$E = 1.658\,10^{11}\,Pa$
	density	$\rho = 1.3404106\,10^{4}\,kg/m^3$
	Poisson's ratio	$\nu = 0,3$

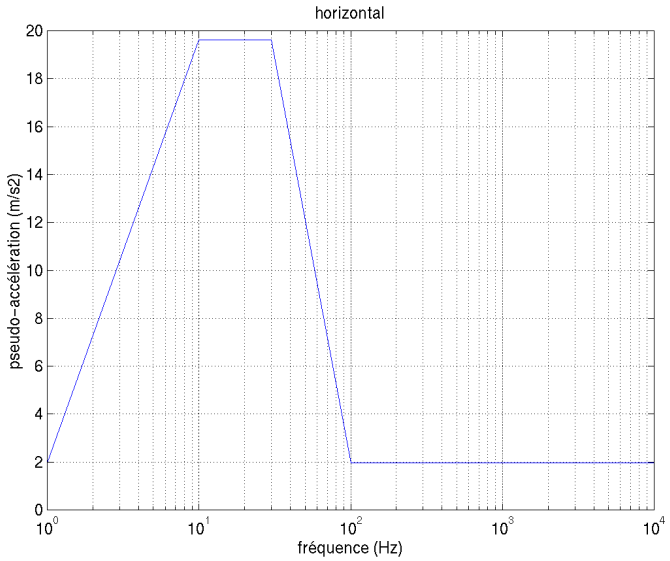
1.3 Boundary conditions and loadings

Modelization A (3D)
Not $N1$ clamped: $DX=DY=DZ=DRX=DRY=DRZ=0$
Points $N5$ and $N9$ attached: $DX=DY=0$
Horizontal oscillator spectrums in acceleration applied to the points $N1$, $N5$ and $N9$ in the directions (x) and (x and y).

Modelization B (2D plane XZ)
plane Problem XZ : $DY=DRX=DRZ=0$
Not $N1$ clamped: $DX=DZ=DRY=0$
Points $N5$ and $N9$ attached: $DX=0$
Horizontal oscillator spectrums in acceleration applied to the points $N1$, $N5$ and $N9$ in the direction (x).

Identical spectrums of values for 3 depreciation $0,5\%$, 1% and $1,5\%$.

Frequency (Hz)	Pseudo-acceleration ($m.s^{-2}$) in x	Pseudo-acceleration ($m.s^{-2}$) in y
1	1.962	1.962
10	19.62	19.62
30.100	19.62	19.62
	1.962	1.962
10000	1.962	1.962



For computation, one uses a reduced damping of 3%, with an interpolation (LOG LOG) in frequency and (LIN LOG) damping.

Case multi-bearing with different excitations:
point: $N1$ excitation $\times 1$
point: $N5$ excitation $\times 1.5$
point: $N9$ excitation $\times 2$

1.4 Initial conditions

Without object for the spectral analysis

2 Reference solution

2.1 Méthode de calcul used for the reference solution

Comparison between the results and those obtained using CASTEM 2000 (modelization A (3D): mono-bearing combination CQC and SRSS, multi-bearing excitation identical to the bearings combination CQC);

If not, the validation consists with:

- to find the response mono-bearing by the path multi-bearing, in the case of excitations identical to the bearings (modelizations A (3D) and B (2D), combination CQC);
- to check the NON-regression of the response if it does not exist of bench-mark data (different modelizations A and B, excitations with the bearings).

2.2 Results of reference

Results got using CASTEM 2000: displacements with the nodes $N3$, $N7$ and $N11$ for the following cases:
modelization A (3D)
mono-bearing, combination CQC
multi-bearing excitation identical to the bearings combination CQC.

2.3 Bibliographical references

reference No published.

3 Modelization A

3.1 Characteristic of the modelization

The modelization is three-dimensional. The beam is broken up into 10 elements of modelization POU_D_E.

3.2 Characteristics of the mesh

Many nodes: 11

Number of meshes and types: 10 meshes of type SEG2 (POU_D_E)
the nodes group *encastre* contains the node *N1* ($dx=dy=dz=drx=dry=drz=0$).
The nodes group *attache* contains the nodes *N5* and *N9* ($dx=dy=0$).

3.3 Parameters of modelization

Response out of mono-bearing on the first 10 modes, excitation according to x, without static correction (combination of modal responses CQC and SRSS)
Response out of mono-bearing on the first 10 modes, excitation according to x, with static correction (combination of modal responses CQC)
Response out of multi-bearing on the first 10 modes with excitation identical according to x in all the bearings, without static correction and displacements of anchorage (combination of modal responses CQC)

Response out of multi-bearing on the first 10 modes with excitations in x and y different and correlated with the bearings, with static correction (combination of modal responses CQC)
quadratic Combination of directional responses (QUAD)
the linear Combination of loading case.

3.4 Quantities tested and results

3.4.1 Excitation mono-bearing according to X

3.4.1.1 Modal analysis

```
--- VALUES OF THE SPECTRUM ---
 MODE       TOTAL    FREQUENCY    AMORTISSEMENT          DIR
SPECTRUM     1-2        1.54569D+01      3.00000D-02          X
1.96200D+01    3-4        3.35823D+01      3.00000D-02          X
1.58128D+01    5-6        4.73076D+01      3.00000D-02          X
8.21089D+00      7        5.45850D+01      3.00000D-02          X
6.24517D+00      8        8.80156D+01      3.00000D-02          X
2.50454D+00   9-10        1.01614D+02      3.00000D-02          X

1.96200D+00 MASSE OF STRUCTURE:  4.60967D+02

 MASSE MODAL EFFECTIVE CUMULEE:
       DIRECTION: X, CUMUL:  3.09868D+02, IS  67.221%
```

3.4.1.2 seismic Analysis out of mono-bearing

Quantity: "depl" NOM_MODE: ("to dir" "X") NOM_CMP: "dx"
Combination "CQC" without static correction

Identification	Reference	Aster	% difference
Displacements according to x	CASTEM 2000	Aster 9.02.11	
NODE N3	1.78952 E -04	1.784933 E -04	-0.256
NODE N7	3.29499 E -04	3.292709 E -04	-0.069
NODE N11	1.09032 E -03	1.089717 E -03	-0.055
Absolute acceleration	Aster 5.3.13	Aster 9.02.11	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 5.3.13	Aster 9.02.11	
NODE N1	6.696036 E +02	6.696036 E +02	1.6 E -06
N5 NODE	1.164223 E +03	1.164223 E +03	-2.7 E -05
N9 NODE	9.281995 E +02	9.281995 E +02	-2.8 E -06

Combination CQC with correction static

Identification	Reference	Aster	% difference
Displacements according to x	CASTEM 2000	Aster 9.02.11	
NODE N3	1.78952 E -04	1.784937 E -04	-0.256
NODE N7	3.29499 E -04	3.292709 E -04	-0.069
NODE N11	1.09032 E -03	1.089718 E -03	-0.055
Absolute acceleration	Aster 5.3.13	Aster 9.02.11	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 5.3.13	Aster 9.02.11	
NODE N1	6.716683 E +02	6.716683 E +02	-2.3 E -07
N5 NODE	1.169727 E +03	1.169727 E +03	-9.9 E -06
N9 NODE	9.373269 E +02	9.373269 E +02	-2.6 E -06

Combination "SRSS" without static correction

Identification	Reference	Aster	% difference
Displacements according to x	Aster 9.02.21	Aster 9.02.28	
NODE N3	1.515199 E -04	1.515199 E -04	-1.2E-05
NODE N7	2.598416 E -04	2.598416 E	-04.3.3E-06
NODE N11	8.365025 E -04	8.365025 E	-04.1.5E-06
Absolute acceleration	Aster 9.02.11	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 9.02.11	Aster 9.02.21	
NODE N1	5.570235 E +02	5.570235 E +02	6.2E-09
N5 NODE	9.194161 E +02	9.194161 E +02	1.3E-06
N9 NODE	7.692216 E +02	7.692216 E +02	-1.3E-07

3.4.2 Excitation multi-bearing according to X

3.4.2.1 Modal analysis

```
--- VALUES OF THE SPECTRUM ---
 MODE       TOTAL    FREQUENCY    AMORTISSEMENT    DIR          SUPPORT
    SPECTRUM     1-2        1.54569D+01          3.00000D-02      X N1  N5        N9
    1.96200D+01   3-4       3.35823D+01          3.00000D-02      X N1  N5        N9
    1.58128D+01   5-6      4.73076D+01          3.00000D-02      X N1  N5        N9
    8.21089D+00     7       5.45850D+01          3.00000D-02      X N1  N5        N9
    6.24517D+00     8      8.80156D+01          3.00000D-02      X N1  N5        N9
    2.50454D+00  9-10       1.01614D+02          3.00000D-02      X N1  N5        N9

1.96200D+00 MASSE OF STRUCTURE:  4.60967D+02

 MASSE MODAL EFFECTIVE CUMULEE:
       DIRECTION: X, CUMUL:  3.09868D+02, IS  67.221%
```

3.4.2.2 seismic Analysis out of multi-bearing (with excitations identical to the bearings, without static correction, displacements of anchorages)

Combination "CQC" without static correction

Identification	Reference	Aster	% difference
Displacements according to x	CASTEM 2000	Aster 9.02.21	
NODE N3	1.78952 E -04	1.784933 E -04	-0.256
NODE N7	3.29499 E -04	3.292709 E -04	-0.069
NODE N11	1.09032 E -03	1.089717 E -03	-0.055
Absolute acceleration	Aster 9.02.11	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
NODE N5	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
Reaction nodal	Aster 9.02.11	Aster 9.02.21	
NODE N1	6.696036 E +02	6.696036 E +02	1.6E-06
NODE N5	1.164223 E +03	1.164223 E +03	-2.7E-05
N9 NODE	9.281995 E +02	9.281995 E +02	-2.8E-06

3.4.3 Excitation multi-bearing according to X and there

3.4.3.1 Modal analysis

```
--- VALUES OF THE SPECTRUM ---
 MODE       TOTAL   FREQUENCY   AMORTISSEMENT   DIR      SUPPORT
 SPECTRUM       1-2     1.54569D+01           3.00000D-02 X    Y          N1
                                                        1.96200D+01          N5
                                                        2.94300D+01          N9
 3.92400D+01        3-4     3.35823D+01        3.00000D-02 X    Y          N1
                                                        1.58128D+01          N5
                                                        2.37192D+01          N9
    3.16256D+01         5     4.73076D+01          3.00000D-02 X    Y          N1
                                                        8.21089D+00          N5
                                                        1.23163D+01          N9
    1.64218D+01         6     4.73076D+01          3.00000D-02 X    Y          N1
                                                        8.21089D+00          N5
                                                        1.23163D+01          N9
    1.64218D+01         7     5.45850D+01          3.00000D-02 X    Y          N1
                                                        6.24517D+00          N5
                                                        9.36775D+00          N9
    1.24903D+01         8     8.80156D+01          3.00000D-02 X    Y          N1
                                                        2.50454D+00          N5
                                                        3.75681D+00          N9
    5.00908D+00       9-10      1.01614D+02         3.00000D-02 X    Y          N1
                                                        1.96200D+00          N5
                                                        2.94300D+00          N9

3.92400D+00 MASSE OF STRUCTURE:  4.60967D+02

 MASSE MODAL EFFECTIVE CUMULEE:
       DIRECTION: X, CUMUL:  3.09868D+02, IS  67.221%
       DIRECTION: Y, CUMUL:  3.09868D+02, IS  67.221%
```

3.4.3.2 seismic Analysis out of multi-bearing (with correlated different excitations, static correction, displacements of anchorages)

identical Excitations in the two directions x and y
Combination of modes "CQC"
Combination of the loading cases: "LIN"
Combination of the directions "QUAD"

Identification	Reference	*Aster*	% difference
Directional response according to x			
Displacements according to x	Aster 9.02.11	Aster 9.02.21	
NODE N3	5.8865524E-04	5.8865524E-04	4.1 E -07
NODE N5	1.0000000E-03	1.0000000E-03	0.00
NODE N7	1.1592562E-03	1.1592562E-03	4.3 E -06
NODE N9	1.0000000E-03	1.0000000E-03	0.00
NODE N11	3.1715622E-03	3.1715622E-03	8.1 E -07
Absolute acceleration	Aster 9.02.11	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 9.02.11	Aster 9.02.21	

NODE N1	1.2923446E+03	1.2923446E+03	-2.9E-06
NODE N5	1.9925394E+03	1.9925394E+03	1.6E-06
NODE N9	2.0643776E+03	2.0643776E+03	2.2 E -06
Directional response according to y			
Displacements according to y	Aster 9.02.11	Aster 9.02.21	
NODE N3	5.8865524E-04	5.8865524E-04	4.1 E -07
NODE N5	1.0000000E-03	1.0000000E-03	0.00
NODE N7	1.1592562E-03	1.1592562E-03	4.3 E -06
NODE N9	1.0000000E-03	1.0000000E-03	0.00
NODE N11	3.1715622E-03	3.1715622E-03	8.1 E -07
Absolute acceleration	Aster 9.02.11	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
total Response in Component			
displacements according to x			
NODE N3	5.8865524E-04	5.8865524E-04	4.1 E -07
NODE N5	1.0000000E-03	1.0000000E-03	0.00
NODE N7	1.1592562E-03	1.1592562E-03	4.3 E -06
NODE N9	1.0000000E-03	1.0000000E-03	0.00
NODE N11	3.1715622E-03	3.1715622E-03	8.1 E -07
Component according to y			
NODE N3	5.8865524E-04	5.8865524E-04	4.1 E -07
NODE N5	1.0000000E-03	1.0000000E-03	0.00
NODE N7	1.1592562E-03	1.1592562E-03	4.3 E -06
NODE N9	1.0000000E-03	1.0000000E-03	0.00
NODE N11	3.1715622E-03	3.1715622E-03	8.1 E -07

3.5 Remarks

the results with excitations equal to the bearings are identical via the two modelizations mono-bearing and multi-bearing.

4 Modelization B

4.1 Characteristic of the modelization

The modelization is two-dimensional. The beam is broken up into 10 elements of modelization POU_D_E.

4.2 Characteristics of the mesh

Many nodes: 11

Number of meshes and types: 10 meshes of type SEG2 (POU_D_E)
plane Problem: for all the nodes: $dy=0$; $drx=drz=0$
The nodes group $encastre$ contains the node $N1$ ($dx=dz=dry=0$).
The nodes group $attache$ contains the nodes $N5$ and $N9$ ($dx=0$).

4.3 Parameters of modelization

Response out of mono-bearing on the first 5 modes, excitation according to x, without static correction (combination of modal responses CQC and SRSS)
Response out of mono-bearing on the first 5 modes, excitation according to x, with static correction (combination of modal responses CQC)
Response out of multi-bearing on the first 5 modes with excitation identical according to x in all the bearings, without static correction and displacements of anchorage (combination of modal responses CQC)

Response out of multi-bearing on the first 5 modes with excitations into x different and correlated with the bearings, with static correction (combination of modal responses CQC)
linear Combination of the loading cases.

4.4 Quantities tested and results

4.4.1 Excitation mono-bearing according to X

4.4.1.1 Modal analysis

```
--- VALUES OF THE SPECTRUM ---
 MODE      TOTAL    FREQUENCY    AMORTISSEMENT         DIR
    SPECTRUM    1      1.54569D+01      3.00000D-02     X
    1.96200D+01    2      3.35823D+01      3.00000D-02     X
    1.58128D+01    3      4.73076D+01      3.00000D-02     X
    8.21089D+00    4      8.80156D+01      3.00000D-02     X
    2.50454D+00    5      1.01614D+02      3.00000D-02     X

1.96200D+00 MASSE OF STRUCTURE:  4.60967D+02

 MASSE MODAL EFFECTIVE CUMULEE:
       DIRECTION: X, CUMUL:  3.09868D+02, IS  67.221%
```

4.4.1.2 seismic Analysis out of mono-bearing

```
NOM_CHAMP:"depl"            NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
NOM_CHAMP:"acce_absolu"     NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
NOM_CHAMP:"reac_noda"       NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
```

Combination "CQC" without static correction

Identification	Reference	Aster	% difference
Displacements according to x	Aster 5.3.13	Aster 9.02.21	
NODE N3	1.78952 E -04	1.784933 E -04	-0.256
NODE N7	3.29499 E -04	3.292709 E -04	-0.069
NODE N11	1.09032 E -03	1.089717 E -03	-0.055
Absolute acceleration	Aster 5.3.13	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 5.3.13	Aster 9.02.21	
NODE N1	6.696036 E +02	6.696036 E +02	1.6 E -06
N5 NODE	1.164223 E +03	1.164223 E +03	-2.7 E -05
N9 NODE	9.281995 E +02	9.281995 E +02	-2.8 E -06

Combination CQC with correction static

Identification	Reference	Aster	% difference
Displacements according to x	Aster 5.3.13	Aster 9.02.21	
NODE N3	1.78952 E -04	1.784937 E -04	-0.256
NODE N7	3.29499 E -04	3.292709 E -04	-0.069
NODE N11	1.09032 E -03	1.089718 E -03	-0.055
Absolute acceleration	Aster 5.3.13	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 5.3.13	Aster 9.02.21	
NODE N1	6.716683 E +02	6.716683 E +02	-2.3 E -07
N5 NODE	1.169727 E +03	1.169727 E +03	-9.9 E -06
N9 NODE	9.373269 E +02	9.373269 E +02	-2.6 E -06

Combination "SRSS" without static correction

Identification	Reference	Aster	% difference
Displacements according to x	Aster 9.02.18	Aster 9.02.21	
NODE N3	1.804848E-04	1.804848E-04	-1.1E-05
NODE N7	3.290407E-04	3.290407E-04	4.9E-06
NODE N11	1.088706E-03	1.088706E-03	-9.2 E -06
Absolute acceleration	Aster 9.02.18	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 9.02.18	Aster 9.02.21	
NODE N1	6.762012E+02	6.762012E+02	6.6E-06
NODE N5	1.164525E+03	1.164525E+03	-2.6E-06
NODE N9	9.172971E+02	9.172971E+02	4.0 E -06

4.4.2 Excitation multi-bearing according to X

4.4.2.1 Modal analysis

```
--- VALUES OF THE SPECTRUM ---
 MODE      TOTAL   FREQUENCY   AMORTISSEMENT   DIR          SUPPORT
    SPECTRUM        1     1.54569D+01      3.00000D-02      X N1 N5          N9
    1.96200D+01        2     3.35823D+01      3.00000D-02      X N1 N5          N9
    1.58128D+01        3     4.73076D+01      3.00000D-02      X N1 N5          N9
    8.21089D+00        4     8.80156D+01      3.00000D-02      X N1 N5          N9
    2.50454D+00        5     1.01614D+02      3.00000D-02      X N1 N5          N9

1.96200D+00 MASSE OF STRUCTURE:  4.60967D+02

 MASSE MODAL EFFECTIVE CUMULEE:
```

4.4.2.2 Seismic analysis out of multi-bearing (with excitations identical to the bearings, without static correction, displacements of anchorages)

```
NOM_CHAMP : "depl"            NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
NOM_CHAMP : "acce_absolu"     NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
NOM_CHAMP : "reac_noda"       NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
```

Combination "CQC" without static correction

Identification	Reference	*Aster*	% difference
Displacements according to x	Aster 9.02.18	Aster 9.02.21	
NODE N3	1.78952 E -04	1.784933 E -04	-7.3E-06
NODE N7	3.29499 E -04	3.292709 E -04	-8.8E-06
NODE N11	1.09032 E -03	1.089717 E	-03.4.0E-05
Absolute acceleration	Aster 9.02.18	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
N5 NODE	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
nodal Reaction	Aster 9.02.18	Aster 9.02.21	
NODE N1	6.696036 E +02	6.696036 E +02	1.6E-06
N5 NODE	1.164223 E +03	1.164223 E +03	-2.7E-05
seismic N9	NODE 9.281995 E	+02 9.281995 E	+02

4.4.2.3 -2.8E-06 Analysis out of multi-bearing (with correlated different excitations, with static correction, with displacements of anchorages)

```
NOM_CHAMP: "depl"             NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
NOM_CHAMP: "depl"             NOEUD_CMP: ("to dir" "there")        NOM_CMP: "Dy"
NOM_CHAMP: "acce_absolu"      NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
NOM_CHAMP: "reac_noda"        NOEUD_CMP: ("to dir" "X")     NOM_CMP: "dx"
NOM_CHAMP: "depl"             NOEUD_CMP: ("to dir" "X")        NOM_CMP:    "combi"
"quad"
NOM_CHAMP: "depl"             NOEUD_CMP: ("to dir" "there")              NOM_CMP:
"combi" "quad"
```

Combination of modes "CQC"
Combination of the loading cases: "LIN"

Identification	Reference	*Aster*	% difference
Response according to x			
Displacements according to x	Aster 9.02.18	Aster 9.02.21	
NODE N3	5.8865524E-04	5.8865524E-04	4.1 E -07

NODE N5	1.0000000E-03	1.0000000E-03	0.00
NODE N7	1.1592562E-03	1.1592562E-03	4.3 E -06
NODE N9	1.0000000E-03	1.0000000E-03	0.00
NODE N11	3.1715622E-03	3.1715622E-03	8.1 E -07
Absolute acceleration	Aster 9.02.18	Aster 9.02.21	
NODE N1	1.96200 E +00	1.96200 E +00	0.00
NODE N5	1.96200 E +00	1.96200 E +00	0.00
NODE N9	1.96200E+00	1.96200E+00	0.00
Reaction nodal	Aster 9.02.18	Aster 9.02.21	
NODE N1	1.2923446E+03	1.2923446E+03	-2.9E-06
NODE N5	1.9925394E+03	1.9925394E+03	1.6E-06
NODE N9	2.0643776E+03	2.0643776E+03	2.2 E -06

5 Summary of the results

the results are in concord with those obtained by CASTEM 2000, compared to the combination of modes CQC (error < 0.3%), for the cases mono-bearing and multi-bearing. The results got out of mono-bearing on the one hand, and multi-bearing with excitations identical to the bearings on the other hand, are equal and in conformity with those obtained by CASTEM 2000.