ZZZZ108 - Test of the interface *Code_Aster-MISS3D*

Summary:

This test makes it possible to model in harmonic linear dynamics and transient a structure of type skewer of building models (discrete elements and beams) supplemented at its base of voluminal and surface elements.

Its interest is to test the orders of *Code_Aster* specific to the interaction ground-structure for the interfacing with software MISS3D (ECP-LMSSMat).

In this test, one also tests in postprocessing LE displacement into cubes check-points located in the ground and additions at the modeling of the structure by *Code_Aster*.

Lastly, it is checked that the accélérogrammes can be given directly on frequential basis by reproducing the calculation for which they are given on a basis temporal.

1 Problem of reference

1.1 Geometry

One uses a model skewer of the building with a foundation raft which is modelled by a layer of 136 surface meshs TRIA3 and one assigns 6 degrees of freedom to his lower face.

Modeling presented is a simplified modeling for which the building is represented by a plane structure. Four substructures are represented by four nonheavy vertical beams, of inertia of variable and bearing inflection of the masses and nodal inertias representing the civil engineer and the equipment. Discrete elastic connections connect these beams at various levels. The four beams are embedded on a foundation raft general of great inertia of inflection.

1.2 Material properties

$E=4.0\,10^{10}\,Pa$

$\rho=2500\,kg/m^3$ (heavy elements only)

$\nu=0.15$

+ characteristic of specific masses (`'M_TR_D_N'`) and of connections node-node (`'K_TR_D_L'`).

1.3 Boundary conditions and loadings

Solid connections on the faces higher and lower of the foundation raft (`LIAISON_SOLIDE` on the groups of nodes $HRADIER$ and $SRADIER$).

- Blocking of the central node ($N98$) lower face (6 degrees of freedom) to calculate the modes of rigid body,
- Nodal force of $10^4\,Newtons$ applied to the node $N1500$,
- Or transitory acceleration spectrum EUR in the direction X of amplitude $0.25\,g$,
- Or unit harmonic acceleration in the directions X and Y

1.4 Initial conditions

Displacements, speeds and zero acceleration.

2 Reference solution

2.1 Method of calculating used for the reference solution

Resolution in modal base of projection (consisted clean modes with blocked interface and of the constrained static modes calculated by *Code_Aster*) carried out by MISS3D in the field of the frequencies on the finite elements of border. There is also the possibility of proceeding to this resolution by *Code_Aster* by using the harmonic operator of resolution after having recovered MISS3D impedances of ground and seismic forces variable according to the frequency.

Return in time post-treaty by MISS3D by opposite transformation of Fourier.

Return on the basis of physical a harmonic evolution or transitory result of *Code_Aster*.

2.2 Results of reference

Harmonic answers to the nodes higher (N800, N1500 and N2700) than frequencies close to resonances.

Maximum transitory accelerations in these same points for an Euro spectrum of $0.25\,g$.

2.3 Uncertainty on the solution

Digital solution.

2.4 Bibliographical references

- And reference instruction manual of MISS3D - (version 5.6) (D. CLOUTEAU - Laboratory MSSM-ECP).
- Interface *Aster*- MISS3D: principle and use (G. DEVESA - Note Technical HP - 62/95/038/B.

3 Modeling C

3.1 Characteristics of modeling

25 elements of beam `POU_D_T`,

5 connection elements node-node (`DIS_TR_L`),

26 elements `POI1` of specific mass (`DIS_TR_N`),
2 elements `POI1` of worthless specific mass (`DIS_T`) to model check-points in the ground post-to be treated,

136 voluminal elements (modeling `'3D'`) for the foundation raft and 136 DST elements for its lower face.

the 1st harmonic calculation: in the interval $(0,10\,Hz)$ by step of $0.1\,Hz$,
the 2nd harmonic calculation: in the interval $(0,10\,Hz)$ by step of $0.1\,Hz$,

the 3rd transitory calculation: in the interval $(0,10\,s)$ by step of $10^{-2}\,s$.

This modeling is characterized by the presence of check-points in the ground in order to model the déconvolution of a vertical sinusoidal signal imposed on the surface of the ground.

3 elements `POI1` of worthless specific mass (`DIS_T`) are thus introduced in order to model check-points in the ground post-to be treated.

They correspond to 3 in-depth levels of a homogeneous ground: on the surface and shifted respectively quarter and of a half-length of plane wave of pressure to vertical incidence.

This ground is a homogeneous ground whose characteristics are summarized in the table hereafter:

Sleep	Thickness (m)	ρ (kg/m^3)	ν	E (MPa)	β
Lay down 1	35	2400	0.4	70	0.1

Table 6.1-1: Soil mechanics characteristics homogeneous

These values induce a speed of wave of pressure $V_P=250\,m/s$, which gives a wavelength of pressure of 50 meters for a frequency of excitation of $5\,Hz$. The second and the third check-points are thus inserted of respectively $12.5\,m$ and $25\,m$ in the vertical direction.

One carries out a transitory calculation in the interval $(0,4\,s)$ by step of $10^{-2}\,s$ with a sinusoidal acceleration of frequency $5\,Hz$ imposed on the surface of the ground in the vertical direction Z.

3.2 Characteristics of the grid

Many nodes: 190

Number of meshs and type: 136 PENTA6, 136 TRIA3, 30 SEG2, 28 POI1

3.3 Reference solution

For a sinusoidal request of frequency f in a ground speed of wave C and of damping hysteretic β, one obtains analytically like crest factor to the depth Z :
$$Az=sh(\beta\pi\, f\, Z/C)\sin(2\pi\, f\, Z/C)+ch(\beta\pi\, f\, Z/C)\sin(2\pi\, f\, Z/C)$$

One can only note, as comparison, that the peaks of the harmonic answers correspond well to the frequencies of resonance obtained with a model of springs of equivalent ground.

In addition, for the resolution in the field of the frequencies of the harmonic problem project on a modal basis consisted clean modes with blocked interface and of the constrained static modes, one gets the same results by *Code_Aster* and by MISS3D.

3.4 Sizes tested and results

Transitory calculation (real) resolution by MISS3D and postprocessing at the check-points.

Calculation with accélérogramme provided on temporal basis:

Identification	Value of reference	Type of reference	Tolerance
Transfert, $FREQ=5$, Not $NC1$	-	'NON_REGRESSION'	-
Transfert, $FREQ=50$, Not $NC3$	-	'NON_REGRESSION'	-
Acceleration AZ , Not $NC1$ $(50,0,0)$, $T=0.05\,s$	1.0	'AUTRE_ASTER'	1 %
Acceleration AZ , Not $NC2$ $(50,0,-12.5)$, $T=0.20\,s$	0.0781346	'AUTRE_ASTER'	2 %
Acceleration AZ, Not $NC3$ $(50,0,-25.0)$, $T=0.05\,s$	-1.01214	'AUTRE_ASTER'	1 %

Calculation with accélérogramme provided on frequential basis:

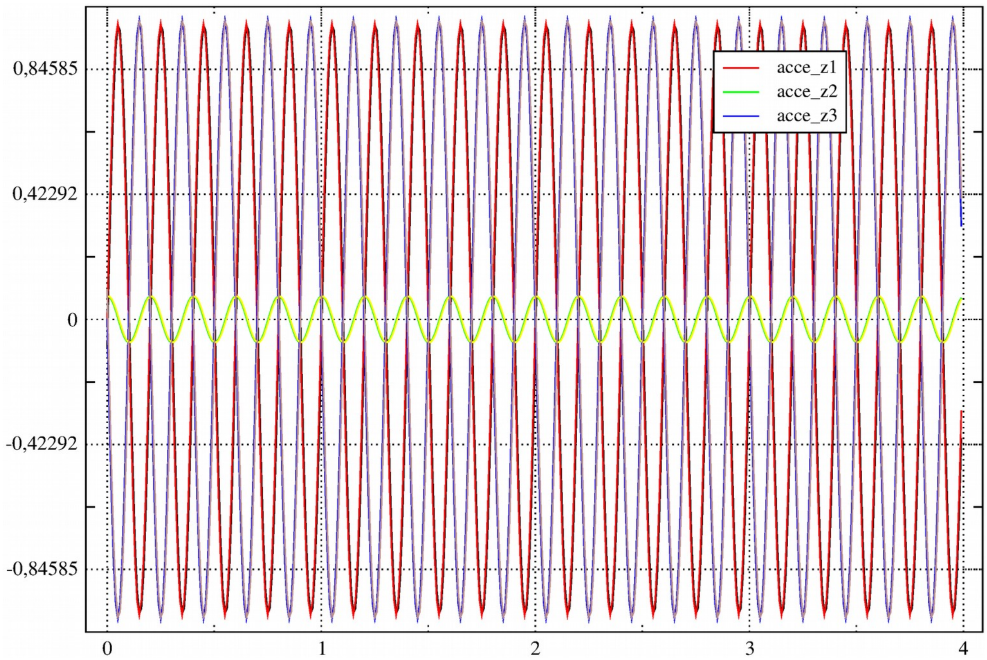
The reference is provided by calculation with accélérogramme on temporal basis.

Identification	Value of reference	Type of reference	Tolerance
Transfert, $FREQ=5$, Not $NC1$	9.95035E-01 - 9.95046E-02j	'AUTRE_ASTER'	0,1 %
Acceleration AZ , Not $NC1$ $(50,0,0)$, $T=0.05\text{s}$	0.99503686	'AUTRE_ASTER'	0,1 %
Acceleration AZ , Not $NC2$ $(50,0,-12.5)$, $T=0.20\text{s}$	0.077163903	'AUTRE_ASTER'	0.1 %
Acceleration AZ, Not $NC3$ $(50,0,-25.0)$, $T=0.05\text{s}$	-1.0069431	'AUTRE_ASTER'	0.1 %

3.5 Summary of the results of modeling C

The results are very close (*cf.* superposition of the curves) those obtained beforehand with the former operator MACRO_MISS_3D. There is a very light dephasing.
The amplitudes are very close, by recording the values at the moments given, the variation is about 1 %.

It is also noted that the results are the same ones with the accélérogrammes on temporal basis or frequential basis.



Comparison with solution MACRO_MISS_3D