ZZZZ102 - To see accélérogramme and spectrum of oscillator

Summary:

This test concerns:

1) reading under various formats of a accélérogramme on an external file (LIRE_FONCTION [U4.21.08]) and the test of the attributes of the function and the maximum value,
2) the checking of the calculation of the spectrum of oscillator by CALC_FONCTION [U4.62.04] and of the value of high frequency acceleration ($>35.5\,Hz$) according to the value max of the accélérogramme,
3) reading of a spectrum of oscillators in free format on an external file (LIRE_FONCTION [U4.21.08]).

There is no grid nor of model finite element.

1 Problem of reference

Several reading of signals are to be realized:

- reading of a accélérogramme not centered (maximum amplitudes >0 and <0 different) expressed in g ($9.81\,m.s^{-2}$) and research of the maximum amplitude,
- calculation of the spectra of oscillator for a reduced damping $\xi=0.01$ (1%) with the options of calculation:
  - pseudonym absolute acceleration and to find the acceleration of high frequency training ($f\geq 100\,Hz$),
  - relative displacement,
- reading of a accélérogramme centered (LBEW: earthquake of Long Beach East West) and research of the maximum amplitude,
- calculation of the spectrum of oscillator in pseudonym absolute acceleration,
- reading of a spectrum of oscillator in free format.

2 Reference solution

2.1 Results of reference

- Accélérogramme not centered

$t=7.935$	$a_{max}=-0.638$		
$f=100$	$\xi=0.01$	pseudonym absolute acceleration	$0.638\times 9.81=6.25878$
		Displacement	$0.638\times 9.81/(2\pi\times 100)^2=1.61607.10^{-6}$

- Centered Accélérogramme

$t=3.1$	$a_{max}=1.$		
$f=100\,Hz$	$\xi=0.01$	pseudonym absolute acceleration	$1.$

- Spectrum of oscillator

$f=0.5\,Hz$	$\xi=0.01$	pseudonym absolute acceleration	1.09558
	$\xi=0.05$	pseudonym absolute acceleration	0.657348
	$\xi=0.1$	pseudonym absolute acceleration	0.109558

2.2 Uncertainty on the solution

Analytical solution.

2.3 Bibliographical references

1. J.R. LEVESQUE, L. VIVAN, D. SELIGMANN “seismic Answer by spectral method” [R4.05.03].

3 Modeling A

3.1 Files read

- Accélérogramme SEPTEN not centered read on unit 19.
- Accélérogramme centered doseism read on unit 20.

3.2 Test and calculation

- for each signal read:
  - research of the value max,
  - calculation of the spectrum of oscillator.

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CALC_FONCTION    MAX
                 SPEC_OSCI    NATURE: 'OCCC'
                              NATURE: 'DEPL' or 'ACCE'
                              NORMALIZES: 1. /g or 1.
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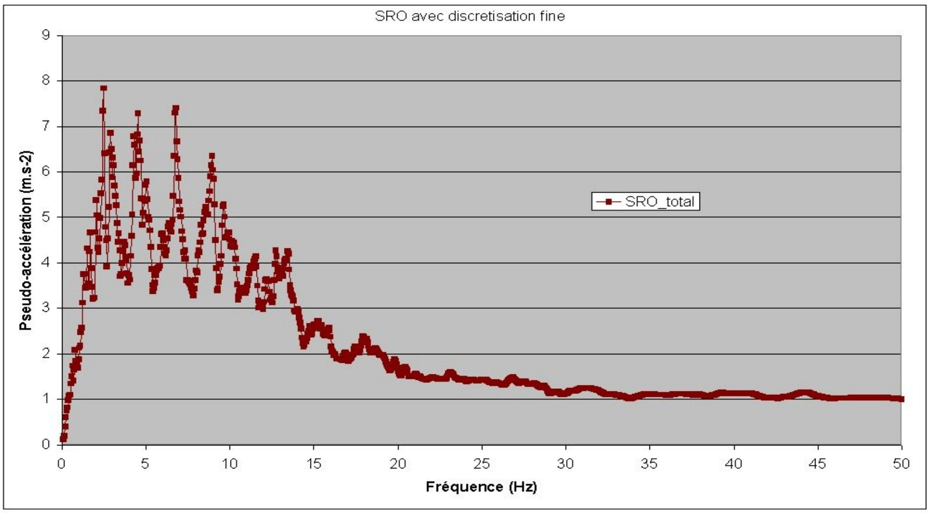
3.3 Sizes tested and results

Identification	Reference	% tolerance
amplitude max accélérogramme 1 $t=7.935$	– 0,638	0.1
spectrum of oscillator 1 (not centered) $freq.\ 100$ acceleration displacement	 6.258778 1.61607288E-06	 0.1 0.1
amplitude max accélérogramme 2 $t=3.1$	1.0	0.1
spectrum of oscillator 2 (centered) $freq.\ 100$	1.0	0.1

3.4 Remarks



The precision of integration of the spectrum of oscillator is not always satisfactory with the frequential list by default (on the asymptotic value, the variation with the reference solution reaches almost 10%). Indeed, this list crosses to $35,5\,Hz$, whereas the entry signal presents considerable frequential contents until more $50\,Hz$ … As one can see it on the figure below (spectrum 2):

Generally, one strongly advises with the user always to check as a preliminary the frequential contents (cut-off frequency, sampling) of the signal to be treated. Thus, it will be then possible as well as possible to adapt the list of frequencies for the calculation of the spectrum of oscillator.
This CAS-test is precisely the example for which it is necessary to widen the frequential beach, in order to collect the high frequencies of the entry signal well.
In practice, one defines a list of frequencies going from $0,1\,Hz$ with $100\,Hz$ by step of $0,05\,Hz$, which will be used for the calculation of the spectrum of oscillator. The variation with the value of reference for the asymptote of pseudo-acceleration becomes lower than 0,02% then.

All these attributes of the functions read or created are tested and exact.

4 Modeling B

4.1 File read

- Spectrum of oscillator

7 frequencies	0.2	0.25	0.3	0.35	0.4	0.45	0.5
5 depreciation	0.01	0.1	0.2		0.3	0.5	

4.2 Extraction of the values

For $FREQ=0.5\,Hz$

test of the values associated with the spectrum of oscillator for:

$\xi=0.01$ and 0.1 (values read)
$\xi=0.05$ (values to be interpolated linearly)

4.3 Extracted values

$FREQ=0.5\,Hz$	**Reference**	**Tolerance**
Damping $\xi=0.01$	1.09558	0.
Damping $\xi=0.05$ (interpolated value)	0.657348	0.
$\xi=0.1$	0.109558	0.

4.4 Remarks

All the attributes of the tablecloth read are good.

5 Summary of the results

The calculation algorithm of the spectrum of oscillator does not give a sufficient precision with the list of frequencies of integration by default. Indeed the entry signal has frequential contents until worms $50\,Hz$, whereas the list of frequencies by default for the keyword SPEC_OSCI of CALC_FONCTION stop with $35{,}5\,Hz$.

On this example, it is thus necessary to modify the list of frequencies as starter of the operator. It is thus advisable to be attentive with the spectral contents of the signal and not to trust blindly the values by default (the list by default is appropriate well for the lawful signals that one usually meets in France whose cut-off frequency is lower: about 20 with $30\,Hz$). In the same way, if the entry signal is characterized by a particularly fine frequential discretization, it can prove to be relevant to use a list of frequencies defined consequently for the calculation of the spectrum of oscillator. Here still, the values by default can prove to be unsuited, and to induce a loss of precision on the results thus calculated.