ZZZZ317 – Generation of seismic signals with GENE_ACCE_SEISME

Summary:

The objective of this test is to validate the generation of seismic signals with GENE_ACCE_SEISME.
This test is primarily a data-processing test: IL does not have there grid nor of model finite element. Modelings A, B and C check the generation of seismic signals with the model of spectral concentration of power (DSP) evolutionary of Kanai-Tajimi whereas modelings D, E and F check the generation of signals compatible with the data of a spectrum of answer of oscillator (SRO). In the tests requiring of the calls repeated with GENE_ACCE_SEISME, realized via loops Python, a list of germs is provided. This list of germs (well informed via INIT_ALEA) allows to get same the results from one realization to another.

1 Modeling A

1.1 Characteristics of modeling

In modeling A, one tests the simulation of a process (seismic signal) with separable spectral concentration. One makes tests for the three types of temporal modulation:

- function of Jennings&Housner;
- function Gamma;
- without modulation (option constant).

In the three cases, one considers one duration of strong phase of $Ts=8\mathrm{s}$. For the constant modulation, the duration of $8\mathrm{s}$ correspond to the total duration of the stationary signal. For each of the three models, one considers the two following cases of simulation:

- Intensity of Arias given: `INTE_ARIAS`= $0.05\mathrm{g}$ ($g=9{,}81\,m/s^2$),
- Standard deviation given `ECART_TYPE`= $1/9.81\mathrm{g}$.

For the modulation of Jennings & Housner, one considers in more the case of horizontal signals 2D correlated with `COEF_CORR`=0.4.
One generates a signal and one makes then a test on the parameters imposed like over the duration of the strong phase.

1.2 Sizes tested and results

1) function of Jennings & Housner
Tests on `INTE_ARIAS` and `ECART_TYPE` of not-regression bus the values for a realization are depend on pullings.

Identification	Type of reference	Value of reference	Tolerance machine	Precision
INTE_ARIAS DUREE_PHAS_FORT	NON_REGRESSION NON_REGRESSION	- -	defect defect	- -
ECART_TYPE ECART_TYPE and COEF_CORR	ANALYTICAL ANALYTICAL	1.0 1.0	Defect defect	0.10* 0.10*

*confer remarks below.

2) function Gamma
Idem, but `ECART_TYPE` also in not-regression.

identification	Type of reference	Value of reference	Tolerance machine	Precision
INTE_ARIAS DUREE_PHAS_FORT ECART_TYPE	NON_REGRESSION NON_REGRESSION NON_REGRESSION	- -	defect defect defect	- -

3) constant modulation
Tests on INTE_ARIAS and ECART_TYPE of not-regression bus the values for a realization are depend on pullings.

Identification	Type of reference	Value of reference	Tolerance machine	Precision
INTE_ARIAS DUREE_PHAS_FORT	NON_REGRESSION NON_REGRESSION	-	defect defect	-
ECART_TYPE	ANALYTICAL	1.0	defect	0.10*

*confer remarks below.

For the constant modulation (i.e. not of modulation) One in addition carries out a test on the interspectres. This case corresponds indeed to the generation of the stationary signals (over the duration Ts) starting from the spectral concentration of Kanai-Tajimi. One carries out $Nsim=26$ simulations and one considers the spectral concentration. One carries out a test on the value of the spectral concentration (DSP) at the frequencies 10Hz and with 1Hz . The standard deviation is obtained directly starting from the spectral concentration by POST_DYNA_ALEA. They are statistical estimates on a sample, it is thus necessary to accept differences compared to the analytical value.

Identification	Type of reference	Value of reference	Tolerance machine	Precision
DSP 10Hz 1.0Hz	ANALYTICAL ANALYTICAL	1.48288849E. -4 3.61601202E. -3	defect	0.25 0.1
ECART_TYPE	ANALYTICAL	1.0/9.81	defect	0.1

1.3 Remarks

The values of duration of strong phase, standard deviation and intensity of Arias provided by the user must be understood as of the averages for which the model of spectral concentration is built. The actual values on the generated seismic signals can vary from one realization to another. The values taken as references in the tests are the median values, from where the difference between the actual values and the reference.

2 Modeling B

2.1 Characteristics of modeling

In modeling B, one tests the simulation of a process (seismic signal) to nonseparable spectral concentration with evolution of the centre frequency. For that, the slope of the centre frequency is taken equalizes with FREQ_PENTE= -0.01 . ON makes tests for the two types of temporal modulation:

- function of Jennings&Housner;
- function Gamma.

For the two models, one considers the case of simulation with intensity of Arias given: INTE_ARIAS= $0.05g$. For the function Gamma, one considers moreover the case of simulation of horizontal signals 2D correlated: COEF_CORR=0.5.

2.2 Sizes tested and results

One carries out tests of not-regression on the indicators INTE_ARIAS, DUREE_PHAS_FORT and ECART_TYPE.

3 Modeling C

3.1 Characteristics of modeling

In modeling C, one tests the simulation of a process (seismic signal) with spectral concentration separable (without evolution of the centre frequency) and the option with PGA given. For that, one chooses ACCE_MAX= $0.2g$. One makes tests for the three types of temporal modulation:

- function of Jennings&Housner;
- function Gamma;
- without modulation (option constant).

The tests are of not-regression for a given seismic signal. Then, one compares the median of a set of 25 signals with the target value of reference.

3.2 Sizes tested and results

Initially, one carries out tests of not-regression for the three functions of modulations. The maximum ones are tested ACCE_MAX (PGA) and ECART_TYPE generated signals.
In the second time, one carries out tests on the median maximum on in unit of 25 signals generated without modulation (constant modulation). This test of not-regression is carried out for the three functions of modulation.

3.3 Remarks

The values of standard deviation and PGA provided by the user must be understood like averages and medians for which the model of spectral concentration is built. The actual values on the generated seismic signals naturally vary from one realization to another. The values taken as references in the tests are the median values and medians, from where the difference between the actual values on a signal and the reference.

The analytical value of reference for the standard deviation comes directly from the link, through the factor of peak, between the maximum (median) of the signals generated and the standard deviation of the process, confer documentation [R4.05.05]. This factor of peak depends amongst other things on the duration of the signal.

4 Modeling D

4.1 Characteristics of modeling

In modeling D, one tests the generation of compatible seismic signals in median (SPEC_MEDIANE) with a target SRO. One uses the function of modulation Gamma. The target spectrum is resulting the law from attenuation of Campbell&Bozorgnia. One also tests the generation of correlated horizontal signals.

4.2 Sizes tested and results

1) Initially, one does not introduce evolution of the centre frequency (FREQ_PENTE nonwell informed). One draws N=20 accélérogrammes, one calculates the SRO and one compares their median with the target:

Identification	Type of reference	Value of reference	Tolerance	Precision
Median SRO F=0.1Hz	ANALYTICAL	0.0080	defect	0.1
Median SRO F=25Hz	ANALYTICAL	0.1901	"	0.1
Median SRO F=50Hz	ANALYTICAL	0.1618	"	0.1

One also tests the generation of correlated horizontal signals. For that, one generates N=20 pairs of signals (2D) and one carries out the same tests as on the first game of N=20 signals (1D).

Then, one carries out tests of not-regression on two accélérogrammes obtained while choosing METHODE=' HARMO' and METHODE=' NIGAM' respectively. For that, one determines spectra of answer by CALC_FONCTION (SPEC_OSCI) with the two methods 'HARMO' and 'NIGAM',and this for each of the two signals. One thus tests 4 values of SRO, and this for 3 frequencies: 0,5Hz, 25Hz and 50Hz.

2) In the second time, one introduces an evolution of the worthless centre frequency (one chooses a value FREQ_PENTE near to zero). One draws 2 accélérogrammes and one makes tests on the first. One starts with tests of not-regression. Then, for the same initialization of the risk, one must to find the same SRO (one draws same the accélérogrammes but by algorithms different) that before (FREQ_PENTE nonwell informed) for the first pulling.

Identification	Type of reference	Value of reference	Tolerance machine	Precision
SRO Acce1 F=0.1Hz	NON_REGRESSION	0.0080	defect	-
SRO Acce1 F=25Hz	''	0.1901	"	
SRO Acce1 F=50Hz	''	0.1618	"	

Identification	Type of reference	Value of reference	Tolerance machine	Precision
SRO Acce1 F=0.1Hz	AUTRE_ASTER	0.01058748	defect	defect
SRO Acce1 F=25Hz	''	0.20405387	"	"
SRO Acce1 F=50Hz	''	0.17959194	"	"

5 Modeling E

5.1 Characteristics of modeling

In modeling E, one tests the generation of compatible seismic signals one by one (SPEC_UNIQUE). One uses again the function of modulation Gamma, the target spectrum is resulting the law from attenuation from Campbell & Bozorgnia.

5.2 Sizes tested and results

One draws from the accélérogrammes in choosing METHODE=' HARMO' and the SRO are calculated. One also tests the generation of 2 signals correlated for COEF_CORR=0.5 and COEF_CORR=0.99. In the second case, the 2 signals are correlated almost perfectly and must have identical characteristics. One compares the values of the first SRO with the target:

Identification	Type of reference	Value of reference	Tolerance machine	Precision
SRO 1 F=0.1Hz	–	-	defect	-
SRO 1 F=25Hz	ANALYTICAL	0.1901	defect	0.1
SRO 1 F=50Hz	ANALYTICAL	0.1618	"	0.1

One draws from the accélérogrammes in choosing METHODE=' NIGAM' and the SRO are calculated. One compares the values of the first SRO with the target:

Identification	Type of reference	Value of reference	Tolerance machine	Precision
SRO 2 F=0.2Hz	ANALYTICAL	0.0245	defect	0.1
SRO 2 F=25Hz	ANALYTICAL	0.1901	"	0.1
SRO 2 F=50Hz	ANALYTICAL	0.1618	"	0.1

6 Modeling F

6.1 Characteristics of modeling

In modeling F, one tests the generation of seismic signals of which the median spectrum and the spectrum with a sigma are compatible with the target (SPEC_FRACTILE). One also tests the generation of signals 3D whose horizontal components are correlated: COEF_CORR=0.2. The ratio enters the amplitudes of the horizontal and vertical movement (RATIO_HV) is worth $\frac{3}{2}$. As before, one uses the function of modulation Gamma and a target spectrum is resulting the law from attenuation of Campbell&Bozorgnia.

6.2 Sizes tested and results

One draws $N=20$ accélérogrammes, one calculates the SRO and one compares their median and the value with a sigma with the target:

Identification	Type of reference	Value of reference	Tolerance machine	Precision
SRO MED F=25Hz SRO MED F=50Hz	ANALYTICAL ANALYTICAL	0.1901 0.1618	defect " "	0.1 0.1

Identification	Type of reference	Value of reference	Tolerance machine	Precision
SRO 1 F=25Hz SIGMA SRO 1 F=50Hz SIGMA	ANALYTICAL ANALYTICAL	0.3248 0.2697	defect " "	0.1 0.1

For the signals 3D, one also makes a test of not-regression for maximum acceleration (parameter PGA).

7 Modeling G

7.1 Characteristics of modeling

In modeling F, one tests the generation of seismic signals of which the spectrum means is compatible with the target (SPEC_AVERAGE). One also tests the generation of signals 3D whose horizontal components are correlated: COEF_CORR=0.2. As before, one uses the function of modulation Gamma and a target spectrum is resulting the law from attenuation of Campbell&Bozorgnia.

7.2 Sizes tested and results

One draws $N=5$ accélérogrammes, one calculates the SRO and one compares them average with the target:

Identification	Type of reference	Value of reference	Tolerance machine	Precision
SRO MOY F=13Hz	ANALYTICAL	0.0127	defect	0.1
SRO MOY F=25Hz	ANALYTICAL	0.1901	"	0.1
SRO MOY F=50Hz	ANALYTICAL	0.1618	"	0.1

If no iteration is carried out (NB_ITER = 0), then the option SPEC_MOYENNE and SPEC_MEDIANE must provide the same result. This is checked by a test of nonregression.
Lastly, one makes a test of regression for the option METHODE=' HARMO' (calculation of spectra by a harmonic calculation) for modeling with SPEC_MOYENNE.

8 Summary of the results

The tests made it possible to check the various options of the generator of seismic signals GENE_ACCE_SEISME. For certain tests, the precision is weak because one compares the value of a realization of the statistical size with his average or median.