Operator GENE_MATR_ALEA

1 Drank

To generate achievements of generalized matrixes considered as random for structures or substructures. The model of probability of the matrixes is built according to the principle of the maximum of entropy by considering information available (average and coefficient of variation) and their algebraic properties (definite symmetry positivity) [R4.03.05].

Product a data structure `matr_asse_gene_R` or `macr_elem_dyna` according to the type of data input.

2 Syntax

```
[ macr_elem_dyna ]  / [ matr_asse_gene_R ] = GENE_MATR_ALEA

    (   ♦/♦MATR_MOYEN          =moyenne                [matr_asse_gene_R]

                ◊  COEF_VAR     =/delta                   [R]
                                   /0.1                   [DEFAULT]

           /♦MATR_MOYEN        =moyenne                [macr_elem_dyna]

              ◊COEF_VAR_RIGI      =/delta_R             [R]
                                    /0.1                  [DEFAULT]

              ◊COEF_VAR_MASS      =/delta_M             [R]
                                    /0  .               [DEFAULT]

                ◊  COEF_VAR_AMOR    =/DELTA_C           [R]
                                    /0  .               [DEFAULT]

        ◊INIT_ALEA=ni                                        [I]

        )
```

So `average = [matr_asse_gene_R]` then `[matr_asse_gene_R] = So`

average `GENE_MATR_ALEA = [macr_elem_dyna]` then `[macr_elem_dyna] = GENE_MATR_ALEA`

3 Operands

With or without substructuring, this operator consists in fine generating achievements of one or more noted random matrixes in a generic way $[\mathbf{A}]$. $[\mathbf{A}]$ is a random variable with value in all the positive definite real matrixes of dimension (n, n) whose model is parameterized by its mean value $[\underline{A}]$ and its scatter coefficient [R4.03.05].

3.1 Key word MATR_MOYEN

♦MATR_MOYEN = average

average indicates the average matrix $[\underline{A}]$ of the random matrix $[\mathbf{A}]$.

So average is of type [matr_asse_gene_R], then $[\underline{A}]$ is obtained by projection of an average matrix assembled of the average model to the finite elements on a given number of eigen modes of the dynamic system (operator PROJ_BASE for example $[\underline{A}]$). The achievements of $[\mathbf{A}]$ generated by GENE_MATR_ALEA can thus be generalized mass matrixes, stiffness or damping.

Caution:

The average matrix $[\underline{A}]$ *must be stored in mode of full storage (operator NUME_DDL_GENE , key word STOCKAGE=' PLEIN' or operator PROJ_BASE , key word PROFIL=' PLEIN' .).*

So average is of type [macr_elem_dyna] (substructuring), then $[\underline{A}]$ is a concept containing the stiffness matrixes, of mass and possibly of damping projected on modal base of the substructure supplemented by the matrixes of connection of the interfaces, of the average model.

3.2 Key word COEF_VAR

- COEF_VAR =/delta
  /0.1 [DEFAULT]

This key word informs the parameter δ of control of the dispersion of the random generalized matrix $[\mathbf{A}]$ which can be of mass, stiffness or dissipation. This coefficient of variation δ is defined by:

$$\delta=\sqrt{\frac{(n+1)\cdot\|A\|_F^2}{tr(A)^2+tr(A^2)}}\times\sqrt{\frac{E\{\|[\mathbf{A}]-[A]\|_F^2\}^{1/2}}{\|[A]\|_F^2}}$$

with:

1) $\|[A]\|_F=\left(tr\{[A][A]^T\}\right)^{1/2}$
2) n the dimension of $[A]$
3) $\sqrt{\frac{E\{\|[\mathbf{A}]-[A]\|_F^2\}^{1/2}}{\|[A]\|_F^2}}$ the scatter coefficient of the matrix $[\mathbf{A}]$

δ can also be written:

$$\delta=\left\{\frac{E\|[\mathbf{G}_A]-[\underline{G}_A]\|_F^2}{\|[\underline{G}_A]\|_F^2}\right\}$$

with $[\underline{L}_A]$ the lower triangular matrix resulting from the factorization of Cholesky $[\underline{A}]=[\underline{L}_A]^T[\underline{G}_A][\underline{L}_A]$ of the average matrix $E\{[\mathbf{A}]\}=[\underline{A}]$.

One must have (cf [R4.03.05]):

$$0<\delta_A<\sqrt{\frac{n_0+1}{n_0+5}},$$

where $n_0\in\mathbb{N}$ is a constant of the probabilistic model selected so that $n_0<n$.

- `COEF_VAR_RIGI` =/delta_R [R]
  /0.1 [DEFAULT]

  This key word substructure informs δ_R the parameter of control of the dispersion of the random matrix of stiffness of one. This coefficient of variation is defined in a way identical to the definition given for key word `COEF_VAR`.

- `COEF_VAR_MASS` =/DELTA_M [R]
  /0 . [DEFAULT]

  This key word substructure informs δ_M the parameter of control of the dispersion of the random matrix of mass of one. This coefficient of variation is defined in a way identical to the definition given for key word `COEF_VAR`.

- `COEF_VAR_AMOR` =/DELTA_C [R]
  /0 . [DEFAULT]

  This key word substructure informs δ_C the parameter of control of the dispersion of the random matrix of dissipation of one. This coefficient of variation is defined in a way identical to the definition given for key word `COEF_VAR`.

3.3 Operand INIT_ALEA

◊INIT_ALEA=ni [I]

Causes the initialization with its ni – ième term of the continuation of pseudo-random numbers used for the generation of the matrixes.

If key word `INIT_ALEA` is absent, the terms used of the continuation are those immediately consecutive with those already used. If no term were still used, the continuation is initialized in its first term.

Recommendation:

A less than one particular use, it is advised not to inform key word `INIT_ALEA` in the operators according to: `GENE_FONC_ALEA`, `GENE_VARI_ALEA` and `GENE_MATR_ALEA`. In this case, with the first call to the one of these operators, the continuation of pseudo-random numbers is initialized in its first term. The omission of key word `INIT_ALEA` to each call of these operators in the command file guarantees the statistical independence of the pseudo-random numbers used.

Note:

The germ of the continuation remains identical of one execution to the other of Code_Aster; the results thus remain rigorously identical (one can thus test non regression of the results statistical ones not converged). If one wishes to generate results statistically independent from one execution to another, then it is necessary to use key word `INIT_ALEA` *with values raising the number of terms used in the former executions.*

Caution:

The generator of random variable used is that of the modulus "random" of Python. It depends on the version of Python exploited by Code_Aster. Not statistically converged results can thus vary from one version to another of Code_Aster or platform to another, if the version of Python is not the same one and that between the two versions the modulus random evolved (case between Python 2.1 and 2.3).

Note:

In version Python 2.3, the period of the generator is of $2^{19937}-1$.

4 Example

By call, the command generates only one realization of the random matrix to simulate. To generate several achievements of the same random matrix, it is necessary to repeat the command without changing its parameters or placing the command in a loop of the language of command of Code_Aster - the language python.

In the following example, one generates ns achievements of a random matrix of mean value `MATR_MOYEN` with one $\delta=0.1$. These achievements are then used as values of mass matrix.

```
ns=100

for K in arranges (1, ns+1):

# Generation
   MAT_ALEA=GENE_MATR_ALEA (
                              MATR_MOYEN=MAT_MOY,
                              COEF_VAR=0.1,
                           )

   DYN=DYNA_TRAN_MODAL (
                 … MASS_GENE= MAT_ALEA,
                                  )
  # Here for example, statistical processing DYN

   TO DESTROY (CONCEPT=_F (NOM= (DYN, MAT_ALEA)))

  # End of the loop (indentation)
```

For more complete examples, to consult the cases test SDNS01 [V5.06.001], SDNL105d [V5.02.105] and SHLS200a [V2.06.200], like [U2.08.05].