Operator DEFI_PROP_ALEA

1 Goal

This operator allows to define random fields to take into account the space variability of the properties mechanics as the Young modulus (by exEmple of the ground or the concrete). The operator builds analytical expressions of the random fields by decomposition of Karhunen-Loeve. The fields follow a lognormal law and are defined by the lengths of correlation in the 1.2 or 3 directions of space, the median and the coefficient of variation. In addition, it is necessary to inform the size of the field (*bounding volume*) and the number of terms to be retained. One can generate fields 1D (process), 2D or 3D.
DEFI_PROP_RISK product a formula whose parameters are X and/or Y and/or Z according to the data who can be transmitted as parameters material to DEFI_MATERIAU.

Product a concept of the type formula.

2 Syntax

```
field [formula] = DEFI_PROP_ALEA (
      ♦ INIT_ALEA       =  nor                              [I ]
      ♦ MEDIAN       =  med                              [R]
      ♦ COEF_VARI       =  Co                               [R]
      ♦ | LONG_CORR_X      =  Lcx                           [R]
          ♦ X_MINI       =  xmin                           [R]
          ♦ X_MAXI       =  xmax                           [R]
          ♦ NB_TERM_X    =  / Nbt                          [I]
        | LONG_CORR_Y      =  Lcy                          [R]
          ♦ Y_MINI       =  ymin                           [R]
          ♦ Y_MAXI       =  ymax                           [R]
           ♦ NB_TERM_Y    =  / Nbt                         [I]
        | LONG_CORR_Z      =  Lcz                          [R]
          ♦ Z_MINI       =  zmin                           [R]
          ♦ Z_MAXI       =  zmax                           [R]
          ♦ NB_TERM_Z    =  / Nbt                          [I]

       ◊ NB_TERM      =  / Nbt                            [I]
       ◊ PRECISION    =  / prec                           [R]
    )
```

3 Operands

3.1 Keyword INIT_ALEA

♦ INIT_ALEA = nor [I]

keyword INIT_ALEA initialize the germ of the random continuations used to define the random fields. Two consecutive calculations with same initialization produce the same one then result.

3.2 Keyword MEDIAN

♦ MEDIAN = med [R]

Keyword to define the median value of the lognormal random field. In general, the median value ESt associated with the value *best-estimate*.

3.3 Keyword COEF_VARI

♦ COEF_VARI = cov [R]

Keyword to define the coefficient of variation of the random fields. The coefficient of variation is defined like the relationship between the standard deviation and the average of the random field. In the case of fields of lognormal laws, the standard deviation logarithmic curve β is related to the coefficient of variation by the formula $cov=\sqrt{(\exp^{(\beta^2)}-1)}$.

3.4 WordS- keyS LONG_CORR_X, LONG_CORR_Y and LONG_CORR_Z

♦| LONG_CORR_X = LcX [R]
| LONG_CORR_Y = LcY [R]
| LONG_CORR_Z = LcZ [R]

Keyword to define the length of correlation of the random fields according to the direction X (so well informed).
The definition lengths of correlation is that of Vanmarcke: $L_c=\int_{-\infty}^{+\infty} R(u)du$ where $R(u)$ is the function of correlation for the variable u (here: the distance according to the direction X). The function of correlation is exponential simple $R(u)=\exp^{(-u/(0.5\,L_c))}$ according to each direction.
LONG_CORR_Y and LONG_CORR_Z are similar to those of LONG_CORR_X for the directions Y and Z .

3.5 WordS- keyS NB_TERM_X, X_MINI and X_MAXI

Cbe wordS- keyS are obligatory if LONG_CORR_X is well informed.

♦ NB_TERM_X = NRX [I]

The number of terms to be retained for the decomposition of Karhunen-Loève according to the direction X . The number of terms defines the number of function clean and thus the small fluctuations of the variable parameter. As the random field is generated on unit fields $[0,1]$, it is necessary to choose the number of terms per report the size of the field and the discretization. Failing this, it is recommended to take Nbt equalize with the extension of the field (here xmax-xmin).

♦ X_MINI = xmin [I]

The coordinate min according to the extension of the field in direction X .

♦ X_MAXI = xmax [I]

The coordinate max according to the extension of the field in direction X .

Both last wordS- keyS allow to define the extension of the field on which one must generate the random fields (*bounding volume*).

3.6 Word S - key S NB_TERM_ Y , Y _MINI and Y _MAXI

These word S - key S are obligatory if LONG_CORR_ Y is informed.

3.7 Word S - key S NB_TERM_ Z , Z _MINI and Z _MAXI

These word S - key S are obligatory if LONG_CORR_ Z is informed.

3.8 WordS- keyS NB_TERM or PRECISION to reduce the model

```
◊ NB_TERM       =  / Nbt                                    [I]
◊  PRECISION    =  / prec  (min=0.0, max=1.0)                [ R ]
```

These keywords optional can be used to reduce the model in the case of fields 2D or 3D.
Obligatory keywords NB_TERM_X, NB_TERM_Y and NB_TERM_Z allow to define the number of terms for the representation of Karhunen-Loève (KL) to calculate for each component (X and/or Y and/or Z). In the case of a random field 2D, one has two components, and for the 3D, one has 3 components. Total energy for this representation of KL is calculated as the sum of all the combinations of products of eigenvalues. For example in the case of a field 2D according to directions X and Y with Nx and Ny clean functions respectively, the representations of KL comprises Nxy=Nx*Ny terms.
In order to retain a reduced number of reduced terms, while preserving a good representation of the fields, one carries out a ranking of the terms crossed according to their contribution to the total energy of the decomposition. One can then reduce the model by retaining Nbt the energy terms. For the example above, it is necessary that Nbt < Nxy.

If PRECISION is well informed, then one retains prec*100 % of the energy terms among the totality of the calculated terms.
If NB_TERM is informed, then one retains NB_TERM energy among totality calculated terms.

4 Examples

One can consult the case test zzzz100g [V1.01.100].