Operator CALC_CHAR_SEISME

1 Goal

To establish the seismic loading for a calculation of answer moving relative compared to the supports. For a better theoretical comprehension of this loading, one will refer to the document [R4.05.01].

The produced concept is directly usable during a direct transitory analysis with DYNA_LINE_TRAN [U4.53.02] or by modal synthesis with DYNA_TRAN_MODAL [U4.53.21]. On the other hand for a nonlinear direct transitory analysis with DYNA_NON_LINE [U4.53.01], this concept should be transformed charges some starting from the operator AFFE_CHAR_MECA [U4.44.01].

Product a field with the nodes of size DEPL_R .

2 Syntax

```
S  [cham_no_sdaster] = CALC_CHAR_SEISME

        (  ♦  MATR_MASS = m                              [matr_asse_DEPL_R]

           ♦  DIRECTION = (d1, d2, D 3,r 1,r 2,r 3)          [l_R]

           ♦  /  MONO_APPUI = 'YES'
              /  MODE_STAT = mode                        [mode_meca]

                    ♦  GROUP_NO = g_noeu            [l_gr_noeud]

           ◊  TITLE = title                             [l_Kn]

        )
```

3 Operands

3.1 Operand MATR_MASS

♦ MATR_MASS = m

Matrix of mass of the system.

3.2 Operand DIRECTION

♦ DIRECTION = (d1, d2, D 3,r 1,r 2,r 3)

Components of a vector giving the direction of the earthquake in the total reference mark. It is a list of three realities if the imposed accélérogrammes are only translations. If accelerations of rotations are also imposed, a list of six realities is expected (valid for modelings with discrete elements).

3.3 Description of the movement of training

3.3.1 Operand MONO_APPUI

♦ / MONO_APPUI = 'YES'

The structure is uniformly excited in all the supports (movement of training of solid body).

3.3.2 Excitation multi-supports

In this case, the accelerations undergone by the whole of the points of anchoring of the studied structure are not inevitably identical and in phase.

3.3.2.1 Operand MODE_STAT

/ MODE_STAT = mode

Static modes of the structure: concept of the type mode_meca product by the operator MODE_STATIQUE [U4.52.14] with the option MODE_STAT. They correspond to $6 \times nb_{supports}$ static modes where $nb_{supports}$ is the number of accélérogrammes different undergone by the structure.

Note:

If the structure is requested only by translations, there is then $3\,nb_{supports}$ static modes.

3.3.2.2 Operand GROUP_NO

♦ GROUP_NO = g_noeu

List of groups of nodes (g_noeu) structure subjected to the seismic excitation: these nodes support the degrees of freedom of supports of the structure to which are applied the imposed movements.

3.4 Operand TITLE

◊ TITLE = title

Title attached to the concept produced by this operator [U4.03.01].

4 Examples

The two examples which follow illustrate the employment of the operator CALC_CHAR_SEISME in the cases of a seismic excitation mono support and in the case multi-supports (identical acceleration then different on each support).

4.1 Calculation of a second member in mono support

One considers seismic modeling beam of the building represented in test SDLL109B, as presented in the documentation of the operator POST_ELEM [U4.81.22].

One wishes to determine efforts at the time of the transitory dynamic response of the structure to an earthquake in the direction X. The transitory calculation of answer is carried out here by modal recombination by DYNA_TRAN_MODAL [U4.53.21].

One calculates the modes of vibrations of the structure of the model resting on only one elastic support (comes out from ground):

```
# --- research of the clean modes of vibration -------------------------

MODES = CALC_MODES (MATR_RIGI = RIGIDITY,
                    MATR_MASS = MASS,
                    OPTION = 'PLUS_PETITE',
                    CALC_FREQ =_F (NMAX_FREQ = 33),
                   )
```

The accélérogramme of the earthquake is defined:

```
# --- excitation -------------------------------------------------------

LBNSNL1 = DEFI_FONCTION (NOM_RESU = 'ACCE',   NOM_PARA = 'INST',
                         PROL_GAUCHE = 'EXCLUDED',  PROL_DROIT =
'EXCLUDED',
                         VALE = (

      0.00000E+00   9.98700E-02   1.00000E-02   6.60700E-02
      2.00000E-02  -5.65000E-03   3.00000E-02  -9.46800E-02
-------------------------------------------------------
      1.19800E+01   1.68110E-01   1.19900E+01   8.80300E-02
      1.20000E+01   0.00000E+00   9.98700E-02   0.00000E+00   )

                           ) ;

ACCELERO = CALC_FONCTION (COMB =_F (FONCTION= LBNSNL1,  COEF= 1.47));
```

One calculates the second member (field with the nodes of the inertial forces of training) and one defines the direction of the earthquake

```
DIRSEISM = CALC_CHAR_SEISME (MATR_MASS = MASS,
                             MONO_APPUI = 'YES',
                             DIRECTION = (-1. , 0. , 0. ));
```

One carries out the calculation of the transitory answer in modal space

```
# --- projection of the matrices and vector assembled on the modes

PROJ_BASE (  BASE=MODE,
                  NB_VECT=33, MATR_ASSE_GENE= (
                  _F (
```

```
                                MATRIX = CO ("MASSGENE"),
                                MATR_ASSE = MASS),
                        _F (
                                MATRIX = CO ("RIGIGENE"),
                                MATR_ASSE = RIGIDITY)),
                        VECT_ASSE_GENE=_F (
                                VECTOR = CO ("VECTGENE"),
                                VECT_ASSE = EARTHQUAKE)
                             );

# --- calculation by modal combination ----------------------------------

LISTAMOR= (0.055,0.055,0.070,0.070,0.071,0.072,0.157,0.085,0.086,
           0.070,0.076,0.074,0.071,0.072,0.115,0.073,0.076,0.086,
           0.081,0.070,0.072,0.075,0.074,0.070,0.152,0.148,0.074,
           0.297,0.074,0.075,0.089,0.138,0.118,)


TRANGENE=DYNA_TRAN_MODAL (  MASS_GENE=MASSGENE,  RIGI_GENE=RIGIGENE,
                            METHODE=METHODE,
                            AMOR_REDUIT=LISTAMOR,
                            INCREMENT=_F (  INST_INIT = 0. ,
                                            INST_FIN = 4. ,  NOT = 0,002,
                                            VERI_PAS = 'NOT'),
                         EXCIT=_F (  VECT_GENE = VECTGENE,
                                     FONC_MULT = ACCELERO),
                                           ))
```

One used here the accélérogramme of the imposed movement.

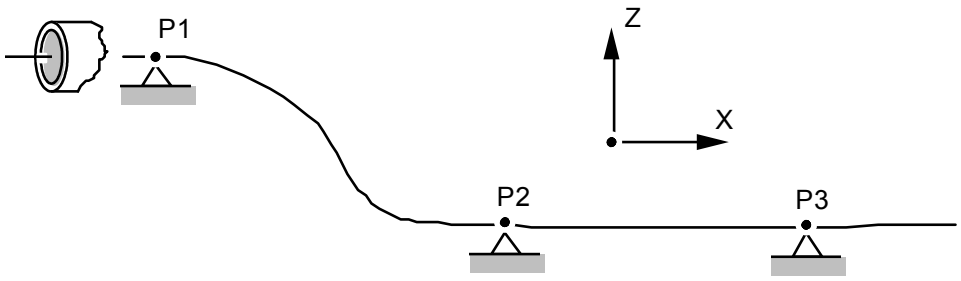
One passes by again in physical space:

```
# --- restitution in physical base ----------------------------------


LISTINST=DEFI_LISTE_REEL (DEBUT=1.334,
                          INTERVALLE=_F (JUSQU_A = 3,154, NUMBER = 1))

TRANPHYS=REST_GENE_PHYS (  RESU_GENE=TRANGENE,
                           CRITERE=' RELATIF',   PRECISION=1.E-06,
                           LIST_INST=LISTINST,   TOUT_CHAM=' OUI')
```

4.2 Calculation of a second member in multi-supports

The example which follows watch the calculation of the second members when the earthquakes are different on the supports.

One considers modeling in elements of beam of the line of following piping to which an earthquake is applied in the direction X :



One calculates the static modes to express the vector of training like a linear combination of those.

```
MODST   = MODE_STATIQUE (MATR_RIGI = RG,
                         MATR_MASS = MS,
                         MODE_STAT =_F ( GROUP_NO =
                                        ('GP1', 'GP2', 'GP3'),)
                                      (AVEC_CMP = 'DX'),));
```

One must calculate three second members different (field with the nodes of the inertial forces of training) for each group from nodes subjected to the same seismic signal.

```
SMP1   = CALC_CHAR_SEISME (MATR_MASS = MS,
                           DIRECTION = (1. , 0. , 0.),
                           MODE_STAT = MODST,
                           GROUP_NO = 'GP1');

SMP2   = CALC_CHAR_SEISME (MATR_MASS = MS,
                           DIRECTION = (1. , 0. , 0.),
                           MODE_STAT = MODST,
                           GROUP_NO = 'GP2');

SMP3   = CALC_CHAR_SEISME (MATR_MASS = MS,
                           DIRECTION = (1. , 0. , 0.),
                           MODE_STAT = MODST,
                           GROUP_NO = 'GP3');
```

In accordance with what is explained in the reference document [R4.05.01] the operator CALC_CHAR_SEISME calculate the following expression:

$$-\boldsymbol{M}\left(\Psi_{P1,X}+\Psi_{P2,X}+\Psi_{P3,X}\right)\boldsymbol{s}$$

with $\boldsymbol{s}=(1,0,0)$, direction of the earthquake.

Calculation of the transitory answer (without damping) with three different seismic signals ACCELP1, ACCELP2 and ACCELP3 :

```
TRANGENE = DYNA_LINE_TRAN (MATR_MASS = MS,
                           MATR_RIGI = RG,
                           NEWMARK =_F (),
                           LIST_INST = LI,
                           EXCIT = (
                          _F (VECT_ASSE = SMP1, FONC_MULT = ACCELP1),
                          _F (VECT_ASSE = SMP2, FONC_MULT = ACCELP2),
                          _F (VECT_ASSE = SMP3, FONC_MULT = ACCELP3),
                                      )
                           ) ;
```

One will be able to find other examples of multimedia structures subjected to seismic requests by consulting tests SDLD103 and SDND102.