

Operator CALC_CHAR_SEISME

1 Goal

To establish the seismic loading (unit inertial forces of training) for a calculation of answer moving relative compared to the movements of 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 or by modal synthesis with DYNA_VIBRA [U4.53.03]. On the other hand for a nonlinear direct transitory analysis with DYNA_NON_LINE [U4.53.01], this concept should be transformed charges some using 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 \mathbf{M} system, built with the boundary conditions of blocking of the supports.

3.2 Operand DIRECTION

◆ DIRECTION = (d1, d2, D3, r1, r2, r3)

Components of the vector giving the direction of the movement of training of the earthquake in the total reference mark. It is a list of three realities if the imposed accélérogrammes are only translations. If one also imposes accelerations of infinitesimal rotations, one expects a list of six realities (valid for modelings with discrete elements or finite elements of structures having degrees of freedom of rotation). This vector Δ will be standardized in an automatic way by the operator. For example, if one provides: DIRECTION = (1. , 2. , 2. ,), the result will be the same one as for: DIRECTION = (0,333, 0.666,0.666,).

3.3 Description of the movement of training

3.3.1 Operand MONO_APPUI

◆ / MONO_APPUI = 'YES'

The structure is uniformly excited on all its supports: the movement of training is rigid body, in the direction given by the keyword DIRECTION (in general of translation, but one can also consider an infinitesimal rotation).

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

$$-\mathbf{M} \cdot \Delta$$

with Δ direction of the earthquake specified by the operand DIRECTION.

3.3.2 Excitation multi-supports

In this case, the accelerations undergone by the whole of the something to lean on of the studied structure are not inevitably identical nor in phase. Lbe movements of training are not rigid body, but are described by linear elastic static modes.

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 $6 \times nb_{appuis}$ linear elastic static modes with degree of unit freedom imposed on the supports where nb_{appuis} is the number of accélérogrammes (translations, rotations) different undergone by the structure and defined on each degree of unit freedom imposed on each support considered.

Note:

| If the structure is requested only by degrees of freedom of translation, there is then
| $3 nb_{appuis}$ static modes.

3.3.2.2 Operand GROUP_NO

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◆ 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.

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

$$-M \cdot \Psi_{Pj} \cdot s$$

with s direction of the earthquake, specified by the operand DIRECTION, and Ψ_{Pj} unit linear static modes, specified by the operand MODE_STAT, calculated for each degree of freedom of the blocked supports listed in the groups of nodes (g_noeu).

3.4 Operand TITLE

◆ TITLE = title

Title attached to the concept produced by this operator [U4.63.01].

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_VIBRA [U4.53.03].

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_VIBRA (TYPE_CALCUL=' TRAN', BASE_CALCUL=' GENE',  
MATR_MASS=MASSGENE, MATR_RIGI=RIGIGENE,  
AMOR_MODAL=_F (AMOR_REDUIT=LISTAMOR,),  
SCHEMA_TEMPS=_F (SCHEMA=METHODE,),  
INCREMENT=_F (INST_INIT = 0. , INST_FIN = 4. ,  
NOT = 0,002, VERI_PAS = 'NOT'),  
EXCIT=_F (VECT_ASSE_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 -----

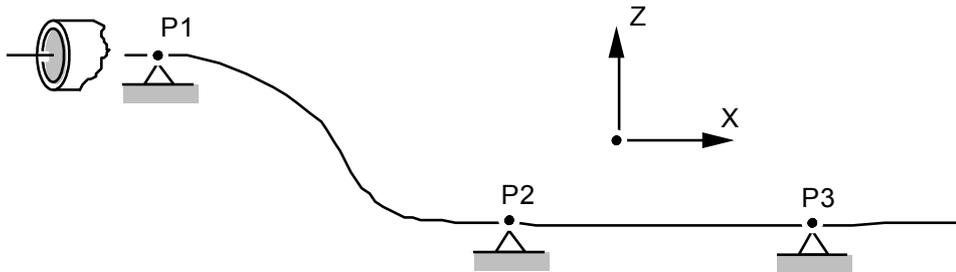
```
LISTINST=DEFI_LISTE_REEL (DEBUT=1.334,  
INTERVALLE=_F (JUSQU_A = 3,154, NUMBER = 1))
```

```
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 of inertial forces of training when the seismic signals 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 unit linear static modes for each degree of freedom of the supports blocked in the direction X , to then express the vector of the inertial forces 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:

$$-\mathbf{M} \cdot \Psi_{Pj,X} \cdot s$$

with $s=(1,0,0)$, direction of the earthquake, specified by the operand DIRECTION, and $\Psi_{Pj,X}$ unit linear static modes, specified by the operand MODE_STAT, calculated for each degree of freedom of the supports blocked in the direction X .

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

```
TRANGENE = DYNA_VIBRA (TYPE_CALCUL=' TRAN', BASE_CALCUL=' PHYS',
                       MATR_MASS = MS, MATR_RIGI = RG,
                       SCHEMA_TEMP= _F (SCHEMA=' NEWMARK '),)
                       INCREMENT= _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.