SDND124 – seismic Excitation of discrete affected of behavior DIS_ECRO_TRAC

Summary:

One tests the answer of the nonlinear model of behavior DIS_ECRO_TRAC, formulated on discrete elements for meshs SEG2.

Operators DYNA_NON_LINE and DYNA_VIBRA are employed for the validation. One analyzes the answer of discrete elements supporting a nonlinear law of behavior under a seismic loading.

Modelings and discrete elements tested are in $3D$ with modeling DIS_T on a mesh SEG2.

This behavior is also validated for not-dynamic requests in the CAS-test SSND117 [V6.08.117] with the operator STAT_NON_LINE.

1 Problem of reference

1.1 Description of the device

The studied system is represented by the rheological model below. It is composed of an affected non-linear element of the behavior DIS_ECRO_TRAC (between the nodes N1 and N2), of a mass assigned to the node N2, of a linear element (between the nodes N2 and N3).

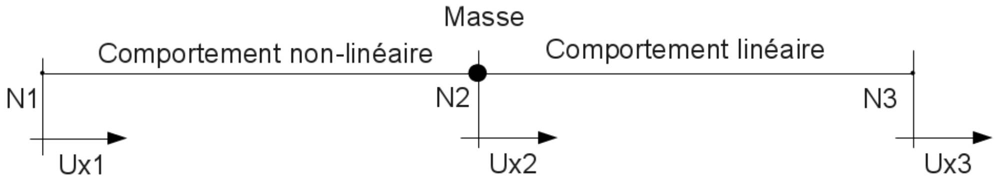

Figure 1.1-a : Model of the device.

The equations governing the behavior of the non-linear element are in [R5.03.17].

1.2 Modelings

Modelings tested are on elements DIS_T, meshs SEG2. The characteristics of the discrete elements are of the type: K_T_D_L.

Note: The units of the parameters must be in agreement with the unit of the efforts, the unit lengths [R5.03.17]. For all modelings the units are homogeneous with [NR], [mm].

Note: Modelings A and B treats the same system, with the same boundary conditions, the same loading.

1.2.1 Modeling A

This modeling makes it possible to test the nonlinear behavior of standard isotropic work hardening, in local direction X of discrete, law DIS_ECRO_TRAC with the operator DYNA_NON_LINE.

1.2.2 Modeling B

This modeling makes it possible to test the nonlinear behavior of standard isotropic work hardening, in local direction X of discrete, law DIS_ECRO_TRAC with the operator DYNA_VIBRA.

1.2.3 Modeling C

This modeling makes it possible to test the nonlinear behavior of standard isotropic work hardening, in the local tangent plan of discrete, law DIS_ECRO_TRAC with the operator DYNA_NON_LINE.

1.2.4 Modeling D

This modeling makes it possible to test the nonlinear behavior of standard isotropic work hardening, in the local tangent plan of discrete, law DIS_ECRO_TRAC with the operator DYNA_VIBRA.

1.2.5 Modeling E

This modeling makes it possible to test the nonlinear behavior of standard kinematic work hardening, in the local tangent plan of discrete, law DIS_ECRO_TRAC with the operator DYNA_NON_LINE.

1.2.6 Modeling F

This modeling makes it possible to test the nonlinear behavior of standard kinematic work hardening, in the local tangent plan of discrete, law `DIS_ECRO_TRAC` with the operator `DYNA_VIBRA`.

1.3 Properties materials

1.3.1 ModelingS With and B

The stiffness of the linear device is $k_{lin} = 400\,N.mm$.
The mass is $M = 200\,kg$.

The non-linear behavior used in the case test is presented to the figure 1.3.1-a :

- Elastic behavior up to the point $(0.5\text{mm}, 200.0\text{N})$.
- Non-linear behavior, governs by the following equation:

$$R(p) = \frac{K_{elas} \cdot p}{\left[1+\left(\frac{k_{elas} \cdot p}{F_u - F_y}\right)^n\right]^{(1/n)}} \quad \text{with} \quad K_{elas} = \frac{200.0\,N}{0.5\,mm} = 400\ N/mm, \quad F_y = 200.0\,N, \quad F_u = 450.0\,N, \quad n = 1.5$$

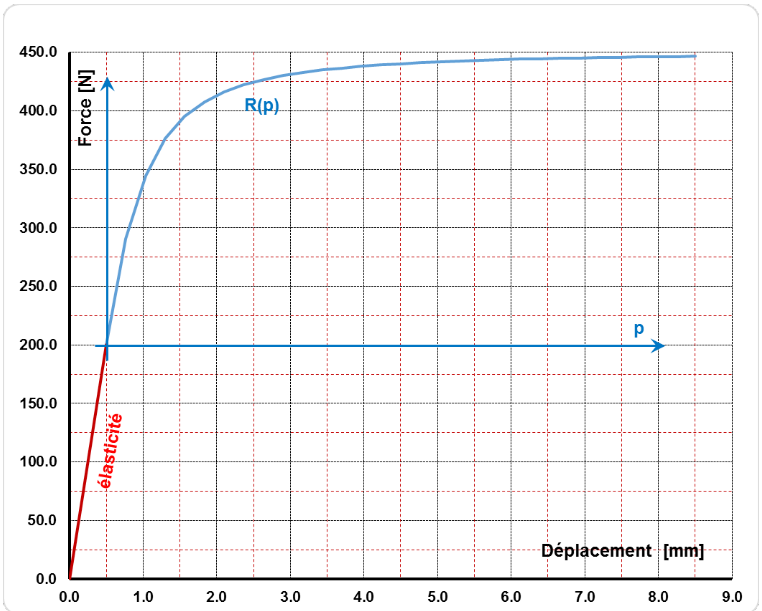

Figure 1.3.1-a **: Non-linear behavior**

1.3.2 Modelings C and D

The stiffness of the linear device is $k_{lin} = 400\,N.mm$.
The mass is $M = 200\,kg$.

The behavior is of standard "isotropic work hardening" in the local tangent plan with the element. It is defines by the following function:

```
fctsy2 = DEFI_FONCTION (NOM_PARA="DTAN",
   VALE = (0.0, 0.0, 0.1, 100.0, 0.2, 120.0, 20.2, 370.0),
)
```

1.3.3 ModelingS E and F

The stiffness of the linear device is $k_{lin} = 400\, N.mm$.
The mass is $M = 200\, kg$.
The behavior is of standard "work hardening kinematics " in the local tangent plan with the element. It is defines by the following function:

```
fctsy2 = DEFI_FONCTION ( NOM_PARA= "D TAN " ,
    VALE = (0.0, 0.0, 0.1, 100.0, 20.1, 350.0),
)
```

1.4 Boundary conditions and loadings

1.4.1 Modelings A and B

Nodes N1, N2, N3 are blocked in the directions Y and Z.

For Lbe modelingS With and B, nodes N1 and N3 are subjected to displacement $U(t)$ in the direction X.

For modeling B, the nodes N1 and N3 are subjected to displacement $U(t)$, speed $V(t)$ and acceleration $\gamma(t)$ in the direction X.
The condition in function displacement of time:

$U(t) = U_0 . \sin(2\pi . f.t)/(2\pi . f)$ with $f = 0.5\, Hz$ and U_0=6.0mm

The condition of speed function of time: $V(t) = \dot{U}(t)$
The condition in acceleration function of time: $\gamma(t) = \ddot{U}(t)$

1.4.2 Modelings C, D, E and F

Nodes N1, N2, N3 are blocked in Lhas direction X.

For Lbe modelingS C, D, E and F, nodes N1 and N3 are subjected with one displacement $U(t)$ in Lbe directionS Y and Z.

For modeling B, the nodes N1 and N3 are subjected to displacement $U(t)$, speed $V(t)$ and acceleration $\gamma(t)$ in Lbe directionS Y and Z.

Lbe conditionS in displacement are functionS time:

$$Depl = U_{1.} \sin(2\pi . f_1 . t) + U_{2.} \sin(2\pi . f_2 . t) + U_{3.} \sin(2\pi . f_3 . t)$$

According to the direction Y : $(u, f) = [(0.20, 0.80), (0.15, 1.50), (0.10, 3.00)]$
According to the direction Z : $(u, f) = [(-0.20, 0.90), (0.15, 2.00), (-0.10, 2.80)]$

The condition of speed function of time: $V(t) = \dot{U}(t)$
The condition in acceleration function of time: $\gamma(t) = \ddot{U}(t)$

2 Reference solutions

2.1 Method of calculating used for the reference solutions

2.1.1 Modeling A

Modeling A is useful Dreference solution for modeling has B .

2.1.2 Modeling B

The reference solution is that resulting from modeling A .

2.1.3 ModelingS C, D and E

Case testS of not-regression

2.2 Uncertainty on the solution

2.2.1 ModelingS With, B, C, D, E and F

Without object.

3 Modeling A

3.1 Characteristics of modeling

Modelings tested are DIS_T on meshs SEG2. The characteristics of stiffness of discrete are thus of the type: K_T_D_L, M_T_D_N.

3.2 Characteristics of the grid

Many nodes: 3, many meshs: 2, elements SEG2 : 2, elements POI1 : 1.

3.3 Boundary conditions and loadings

Nodes N1, N2, N3 are blocked in the directions Y and Z.

Nodes N1 and N3 are subjected to displacement $U(t)$ in the direction X.

$U(t) = U_0 . \sin(2\pi . f . t)/(2\pi . f)$ with $f = 0.5\, Hz$ and $U_0 = 6.0\, mm$

3.4 Sizes tested and results

The sizes are tested in not-regression, with the tolerances by default:

- the displacement of the node N2,
- effort with the node N2,
- power dissipated in the non-linear device,
- the unelastic displacement of the non-linear device,
- unelastic displacement cumulated of the non-linear device.

The moments appointed to test the various sizes are those where the effort reached a extrema.

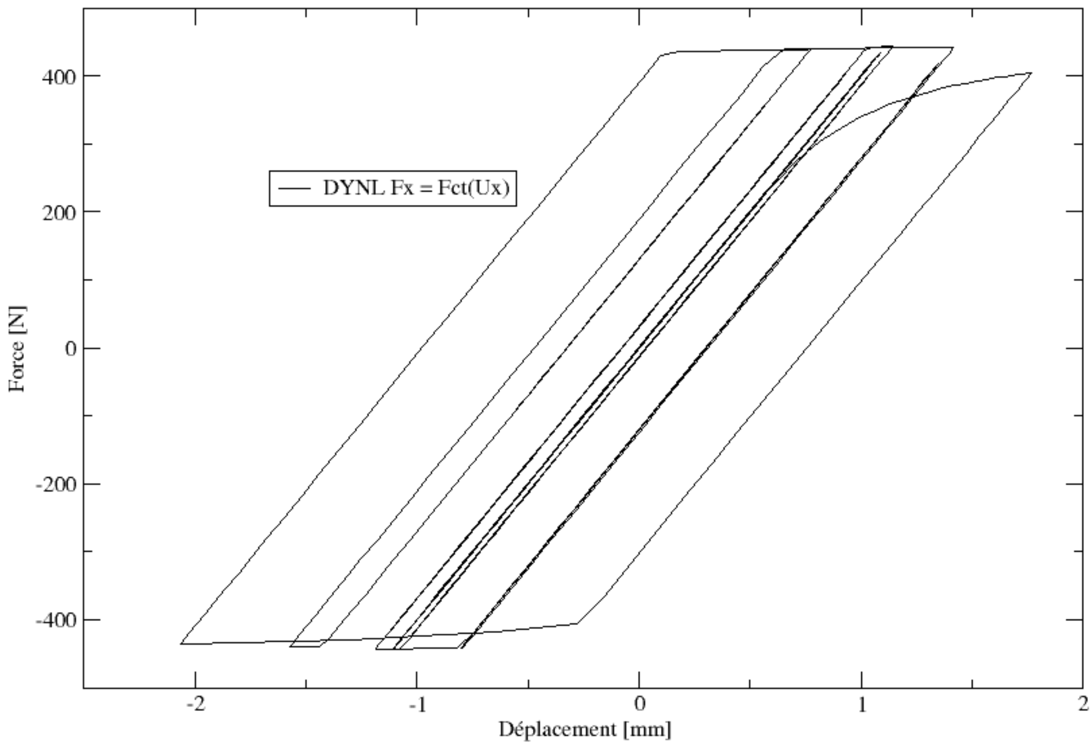

Figure 3.4-a **: Answer force-displacement to the node N2 .**

The following table gives the values of the internal variables related to the behavior DIS_ECRO_TRAC, at the moments when the force reaches a extrema.

INST	Force	Ux	Power	Up	p
1,275	4,0514895E+02	1,7698260E+00	2,7736499E+02	7,5695300E-01	1,2698160E+00
2,525	-4,3584585E+02	-2,0647460E+00	1,0140956E+03	-9,7513100E-01	3,0786590E+00
3,625	4,3921743E+02	7,7222800E-01	1,2982852E+03	-3,2581600E-01	3,7364570E+00
4,525	-9,1517870E+01	-5,5460400E-01	1,2982881E+03	-3,2580900E-01	3,7364630E+00
5,375	3,5606066E+02	5,6434300E-01	1,2982881E+03	-3,2580900E-01	3,7364630E+00
6,400	-4,3979664E+02	-1,5724580E+00	1,3629654E+03	-4,7296700E-01	3,8850760E+00
7,525	4,4218454E+02	1,4184290E+00	1,7096346E+03	3,1296800E-01	4,6769870E+00
8,550	-4,4221218E+02	-8,0345000E-01	1,7144548E+03	3,0208000E-01	4,6879540E+00
9,500	2,2752558E+02	8,7087900E-01	1,7144615E+03	3,0206500E-01	4,6879690E+00
10,450	-4,0783182E+02	-7,1751500E-01	1,7144615E+03	3,0206500E-01	4,6879690E+00
11,450	4,1833666E+02	1,3479060E+00	1,7144615E+03	3,0206500E-01	4,6879690E+00
12,525	-4,4304092E+02	-1,1860040E+00	1,8828698E+03	-7,8402000E-02	5,0705250E+00
13,525	4,0986344E+02	9,4625300E-01	1,8828717E+03	-7,8406000E-02	5,0705290E+00
14,500	-3,2997442E+02	-9,0334200E-01	1,8828717E+03	-7,8406000E-02	5,0705290E+00
15,475	3,8962561E+02	8,9565800E-01	1,8828717E+03	-7,8406000E-02	5,0705290E+00
16,475	-4,2729911E+02	-1,1466540E+00	1,8828717E+03	-7,8406000E-02	5,0705290E+00
17,500	4,4325666E+02	1,1421040E+00	1,9326673E+03	3,3962000E-02	5,1834430E+00
18,525	-4,2314598E+02	-1,0239020E+00	1,9326676E+03	3,3963000E-02	5,1834440E+00
19,500	3,6609776E+02	9,4920700E-01	1,9326676E+03	3,3963000E-02	5,1834440E+00
20,500	-3,7879652E+02	-9,1302900E-01	1,9326676E+03	3,3963000E-02	5,1834440E+00
21,475	4,0795131E+02	1,0538410E+00	1,9326676E+03	3,3963000E-02	5,1834440E+00
22,500	-4,4331859E+02	-1,1071190E+00	1,9472008E+03	1,1780000E-03	5,2163830E+00
23,525	4,3377501E+02	1,0856150E+00	1,9472010E+03	1,1770000E-03	5,2163840E+00
24,525	-3,9592010E+02	-9,8862300E-01	1,9472010E+03	1,1770000E-03	5,2163840E+00
25,500	3,7185745E+02	9,3082100E-01	1,9472010E+03	1,1770000E-03	5,2163840E+00
26,475	-3,9223062E+02	-9,7939900E-01	1,9472010E+03	1,1770000E-03	5,2163840E+00
27,475	4,3090550E+02	1,0784410E+00	1,9472010E+03	1,1770000E-03	5,2163840E+00
28,500	-4,4332341E+02	-1,1099060E+00	1,9484309E+03	-1,5970000E-03	5,2191710E+00
29,525	4,1639039E+02	1,0393790E+00	1,9484309E+03	-1,5970000E-03	5,2191710E+00
30,500	-3,7903620E+02	-9,4918800E-01	1,9484309E+03	-1,5970000E-03	5,2191710E+00
31,500	3,7762833E+02	9,4247400E-01	1,9484309E+03	-1,5970000E-03	5.2191710E+00

4 Modeling B

4.1 Characteristics of modeling

Modelings tested are DIS_T on meshs SEG2. The characteristics of stiffness of discrete are thus of the type: K_T_D_L, K_T_D_N, M_T_D_N.

4.2 Characteristics of the grid

Many nodes: 3, many meshs: 2, elements SEG2 : 1, elements POI1 : 1.

4.3 Boundary conditions and loadings

Nodes N1, N2, N3 are blocked in the directions Y and Z.
Nodes N1 and N3 are subjected to displacement $U(t)$, speed $V(t)$ and acceleration $\gamma(t)$ in the direction X.
The condition in function displacement of time:

$$U(t) = U_0 . \sin(2\pi . f.t)/(2\pi . f) \text{ with } f=0.5\,Hz \text{ and } U_0=6.0\text{mm}$$

The condition of speed function of time: $V(t) = \dot{U}(t)$
The condition in acceleration function of time: $\gamma(t) = \ddot{U}(t)$

4.4 Sizes tested and results

The sizes are tested in not-regression (with the tolerances by default) and compared to the values obtained with modeling A, a precision of 1.0E-02 .
The sizes tested are:

- the displacement of the node N2,
- effort with the node N2,
- power dissipated in the non-linear device,
- the unelastic displacement of the non-linear device,
- unelastic displacement cumulated of the non-linear device.

The moments appointed to test the various sizes are those where the effort reached a extrema.

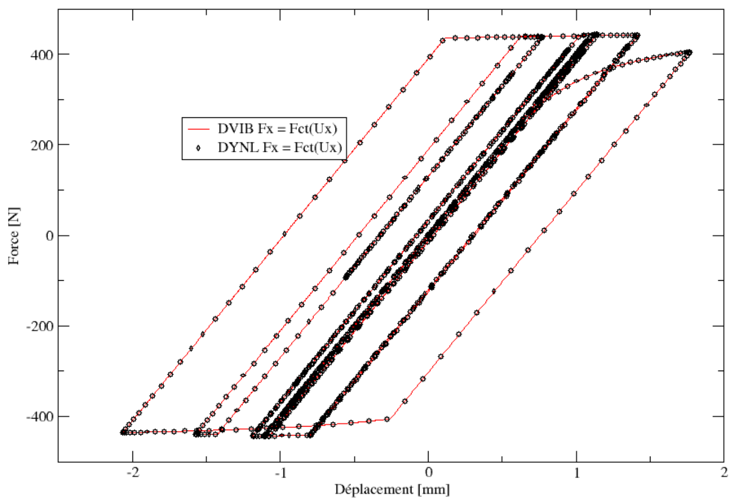

Figure 4.4-a **: Comparison of the answer force-displacement to the node N2 .**

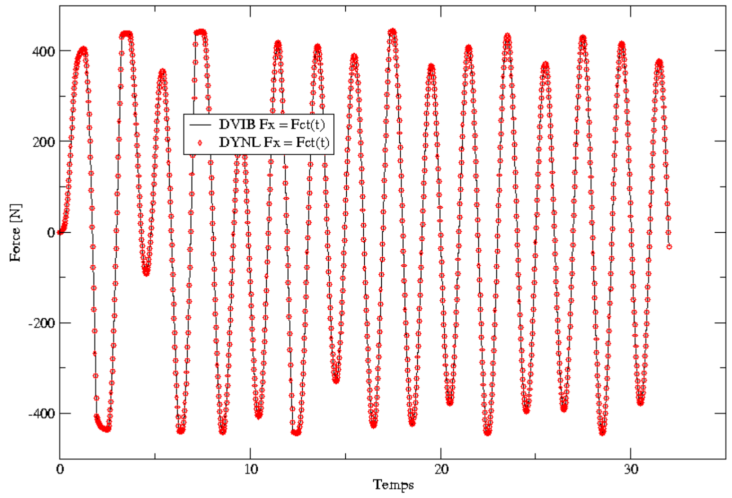

Figure 4.4-b **: Comparison forces vs time with the node** N2 **.**

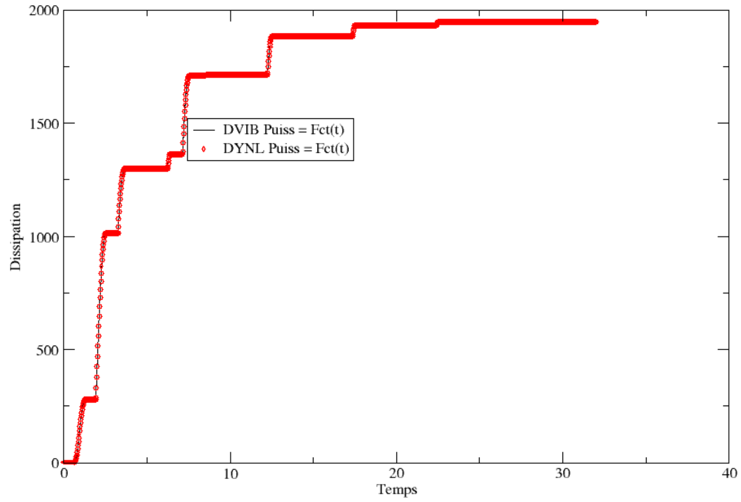

Figure 4.4-c **: Comparison of dissipation vs time.**

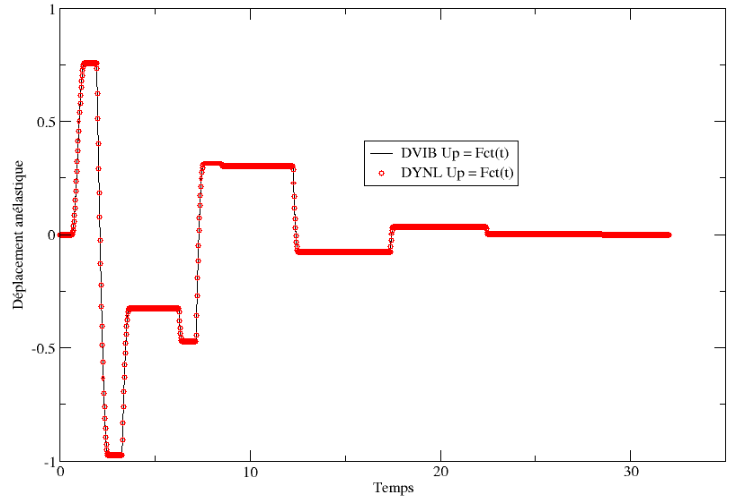

Figure 4.4-d **: Comparison of unelastic displacement vs time.**

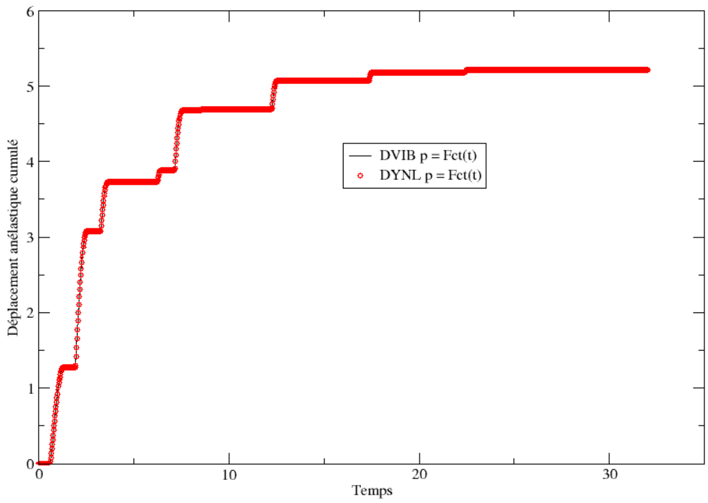

Figure 4.4-e **: Comparison of unelastic displacement cumulated vs time.**

5 Modeling C

5.1 Characteristics of modeling

Modelings tested are DIS_T on meshs SEG2. The characteristics of stiffness of discrete are thus of the type: K_T_D_L, M_T_D_N.

5.2 Characteristics of the grid

Many nodes: 3, many meshs: 2, elements SEG2 : 2, elements POI1 : 1.

5.3 Boundary conditions and loadings

Nodes N1, N2, N3 are blocked in Lhas direction X.
Lbe nodes N1 and N3 are subjected with one displacement $U(t)$ in Lbe directionS Y and Z.
Lbe conditionS in displacement are functionS time:

$$Depl=U_{1.}\sin(2\pi.f_1.t)+U_{2.}\sin(2\pi.f_2.t)+U_{3.}\sin(2\pi.f_3.t)$$

According to the direction Y : $(u,f)=[(0.20,0.80),(0.15,1.50),(0.10,3.00)]$
According to the direction Z : $(u,f)=[(-0.20,0.90),(0.15,2.00),(-0.10,2.80)]$

5.4 Sizes tested and results

The sizes tested are displacement, the effort, the internal variables.
The tolerances are those by default.

	Name of the variable	
V2	FORCEY	Force along the local axis there of the element.
V3	FORCEZ	Force along local axis Z of the element.
V5	DEPLY	Displacement along the local axis there of the element.
V6	DEPLZ	Displacement along local axis Z of the element.
V7	DISSTHER	Dissipation.
V8	PCUM	Plastic indicator.

INST	V2	V3	V5	V6	V7	V8
1.800E-01	-9,76339E+00	1,80384E+00	-9,76339E-03	1,80384E-03	0,00000E+00	0,00000E+00
6.400E-01	2,08219E+01	-5,12649E+01	2,08219E-02	-5,12649E-02	0,00000E+00	0,00000E+00
1.240E+00	4,16265E+01	5,06333E+01	4,16265E-02	5,06333E-02	0,00000E+00	0,00000E+00
1.700E+00	-3,22312E+01	-1,13996E+02	-8,31402E-02	-7,51778E-02	8,06801E+00	7,38608E-02
2.340E+00	2,25044E+01	1,19662E+02	4,79123E-02	1,64522E-01	2,56066E+01	2,19035E-01
2.780E+00	-1,22116E+02	-2,20447E+01	-2,77836E-01	-3,94050E-03	4,82341E+01	4,03111E-01
3.740E+00	-9,51943E+01	9,39456E-01	3,12024E-02	4,46006E-02	1,38843E+02	1,10796E+00
4.780E+00	-1,08950E+02	1,07265E+02	7,38362E-02	3,14078E-01	3,63344E+02	2,67843E+00
5.440E+00	-1,10535E+02	1,18431E+02	-3,51883E-01	1,62258E-01	4,76628E+02	3,39794E+00
6.140E+00	-1,61773E+02	-7,41718E+01	-1,50809E-01	2,55301E-02	6,91044E+02	4,65934E+00
7.220E+00	1,95538E+02	1,50800E+01	4,82129E-01	1,51968E-01	9,59268E+02	6,09336E+00
7.700E+00	-1,63715E+02	-1,14735E+02	-1,38211E-01	-1,24916E-01	1,01868E+03	6,39340E+00
8.120E+00	-8,05708E+01	-1,88355E+02	-9,04756E-02	1,47882E-02	1,09778E+03	6,78423E+00
8.560E+00	1,04084E+02	-1,85108E+02	5,26453E-01	-2,92965E-01	1,22140E+03	7,37678E+00
9.360E+00	-2,19232E+01	2,19598E+02	-6,71816E-02	3,17619E-01	1,36380E+03	8,03446E+00
9.860E+00	1,91398E+02	9,83585E+01	2,68841E-01	-1,88702E-01	1,45523E+03	8,44395E+00
1.038E+01	-7,39972E+01	2,19767E+02	-3,80882E-01	1,70281E-01	1,56404E+03	8,91932E+00
1.098E+01	1,87969E+02	-6,80061E+01	1,26836E-01	-4,24164E-01	1,65888E+03	9,32386E+00
1.168E+01	3,28009E+01	-2,44922E+02	-2,09901E-01	-3,55485E-01	1,85197E+03	1,01216E+01
1.206E+01	-1,91098E+01	-2,50444E+02	1,06192E-02	-3,65973E-01	1,93195E+03	1,04426E+01
1.278E+01	-2,57443E+02	-2,77486E+01	-4,68912E-01	1,02156E-01	2,08836E+03	1,10558E+01
1.374E+01	-1,68926E+02	2,14761E+01	7,50200E-02	6,93044E-02	2,31225E+03	1,19029E+01
1.456E+01	2,74928E+02	-7,14435E+01	6,05803E-01	-2,22692E-01	2,62723E+03	1,30406E+01
1.520E+01	-9,59737E+01	-2,71363E+02	5,17976E-02	-4,11527E-01	2,71254E+03	1,33390E+01
1.586E+01	2,28584E+02	1,88467E+02	4,12463E-01	4,28503E-01	2,90693E+03	1,40046E+01
1.636E+01	-2,32537E+02	-1,84267E+02	-7,16778E-02	3,04831E-02	2,91710E+03	1,40389E+01
1.722E+01	2,98724E+02	9,37164E+00	4,85259E-01	2,97521E-01	2,96829E+03	1,42108E+01
1.810E+01	-2,17087E+02	-1,55606E+02	-3,05520E-02	1,32544E-01	2,96829E+03	1,42108E+01
1.874E+01	-1,30978E+02	-1,37025E+02	5,55574E-02	1,51125E-01	2,96829E+03	1,42108E+01
1.962E+01	3,47285E+01	-5,24438E+01	2,21264E-01	2,35706E-01	2,96829E+03	1,42108E+01

6 Modeling D

6.1 Characteristics of modeling

Modelings tested are `DIS_T` on meshs `SEG2`. The characteristics of stiffness of discrete are thus of the type: `K_T_D_L`, `M_T_D_N`.

6.2 Characteristics of the grid

Many nodes: 3, many meshs: 2, elements `SEG2` : 2, elements `POI1` : 1.

6.3 Boundary conditions and loadings

Nodes `N1`, `N2`, `N3` are blocked in Lhas direction `X`.
Lbe nodes `N1` and `N3` are subjected to displacement $U(t)$, speed $V(t)$ and acceleration $\gamma(t)$ in Lbe directionS `Y` and `Z`.
Lbe conditionS in displacement are functionS time:

$$Depl=U_{1.}\sin(2\pi.f_1.t)+U_{2.}\sin(2\pi.f_2.t)+U_{3.}\sin(2\pi.f_3.t)$$

According to the direction Y : $(u,f)=[(0.20,0.80),(0.15,1.50),(0.10,3.00)]$
According to the direction Z : $(u,f)=[(-0.20,0.90),(0.15,2.00),(-0.10,2.80)]$
The condition of speed function of time: $V(t) = \dot{U}(t)$
The condition in acceleration function of time: $\gamma(t) = \ddot{U}(t)$

6.4 Sizes tested and results

The sizes tested are itS displacementS in the plan, Lbe effortS in the plan, dissipation.
The tolerances are those by default.

INST	FY	UY	FZ	UZ	DISSI
1,78500E-01	-9,52285E+00	-9,52285E-03	1,73773E+00	1,73773E-03	0,00000E+00
6,39500E-01	2,34800E+01	2,34800E-02	-5,42638E+01	-5,42638E-02	0,00000E+00
1,45225E+00	-1,03177E+02	-1,62113E-01	6,13078E+01	1,16245E-01	8,96451E+00
2,06700E+00	-9,23386E+00	1,55673E-02	-1,21557E+02	-1,52510E-01	2,70221E+01
2,77525E+00	-1,21363E+02	-2,71352E-01	-3,26937E+01	-3,65363E-02	6,40153E+01
3,74625E+00	-1,31646E+02	2,73299E-02	3,30076E+01	7,57833E-02	1,67592E+02
4,78900E+00	-1,22664E+02	1,01036E-02	9,77728E+01	3,89168E-01	4,11937E+02
5,42725E+00	-1,19938E+02	-4,83249E-01	1,16791E+02	1,15451E-01	5,47000E+02
6,38125E+00	-1,68193E+02	-1,67892E-01	-8,11705E+01	-1,68091E-01	8,17662E+02
7,48150E+00	-1,81713E+02	-1,39231E-01	-1,01454E+02	-1,55927E-01	1,15084E+03
8,12900E+00	-6,66188E+01	-2,22304E-01	-2,04507E+02	-2,21986E-02	1,27499E+03
8,54875E+00	1,07608E+02	4,10184E-01	-1,96228E+02	-3,94746E-01	1,41835E+03
9,34000E+00	3,63232E+01	-4,42223E-02	2,31439E+02	3,07575E-01	1,60789E+03
9,85900E+00	2,03147E+02	3,46661E-01	1,28415E+02	-1,57569E-01	1,72148E+03
1,03890E+01	-4,47134E+01	-3,12905E-01	2,43579E+02	3,16338E-01	1,86254E+03
1,09538E+01	2,41230E+02	2,67707E-01	-2,13434E+01	-2,37630E-01	1,96976E+03
1,16903E+01	2,09151E+01	-2,18357E-01	-2,64440E+02	-2,40384E-01	2,21945E+03
1,20625E+01	-3,54744E+01	5,86898E-03	-2,67467E+02	-3,32844E-01	2,31549E+03
1,27673E+01	-2,63252E+02	-5,27831E-01	-8,66062E+01	-5,14733E-02	2,47370E+03
1,37373E+01	-2,00470E+02	9,86344E-02	1,49167E+02	2,15190E-02	2,77046E+03
1,45615E+01	3,03132E+02	5,54386E-01	-1,74536E+01	-5,61822E-02	3,08165E+03
1,52145E+01	-1,03148E+02	-1,33764E-01	-2,91981E+02	-2,84559E-01	3,22775E+03
1,58820E+01	3,00718E+02	4,68026E-01	1,02959E+02	4,01976E-01	3,43094E+03
1,68698E+01	-7,90613E+01	3,51214E-02	3,09922E+02	5,03429E-01	3,48093E+03
1,76978E+01	-2,08598E+02	-1,23050E-01	-2,43347E+02	-9,42271E-02	3,49787E+03
1,85438E+01	1,43829E+02	2,29377E-01	-1,77043E+02	-2,79236E-02	3,49787E+03
1,99633E+01	-6,95902E+01	1,59582E-02	-1,53634E+02	-4,51478E-03	3,49787E+03

7 Modeling E

7.1 Characteristics of modeling

Modelings tested are DIS_T on meshs SEG2. The characteristics of stiffness of discrete are thus of the type: K_T_D_L, M_T_D_N.

7.2 Characteristics of the grid

Many nodes: 3, many meshs: 2, elements SEG2 : 2, elements POI1 : 1.

7.3 Boundary conditions and loadings

Nodes N1, N2, N3 are blocked in Lhas direction X. Lbe nodes N1 and N3 are subjected with one displacement $U(t)$ in Lbe directionS Y and Z.
Lbe conditionS in displacement are functionS time:

$$Depl=U_{1.}\sin(2\pi.f_1.t)+U_{2.}\sin(2\pi.f_2.t)+U_{3.}\sin(2\pi.f_3.t)$$

According to the direction Y : $(u,f)=[(0.20,0.80),(0.15,1.50),(0.10,3.00)]$
According to the direction Z : $(u,f)=[(-0.20,0.90),(0.15,2.00),(-0.10,2.80)]$

7.4 Sizes tested and results

The sizes tested are displacement, the effort, the internal variables.
The tolerances are those by default.

	Name of the variable	
V2	FORCEY	Force along the local axis there of the element.
V3	FORCEZ	Force along local axis Z of the element.
V5	DEPLY	Displacement along the local axis there of the element.
V6	DEPLZ	Displacement along local axis Z of the element.
V7	DISSTHER	Dissipation.
V8	PCUM	Plastic indicator.

INST	V2	V3	V5	V6	V7	V8
1.800E-01	-9,76339E+00	1,80384E+00	-9,76339E-03	1,80384E-03	0,00000E+00	0,00000E+00
8.000E-01	2,53060E-01	-7,35611E+00	2,53060E-04	-7,35611E-03	0,00000E+00	0,00000E+00
1.460E+00	-8,58652E+01	5,32350E+01	-1,46908E-01	1,09032E-01	8,32272E+00	8,32272E-02
1.960E+00	7,87737E+01	-6,10847E+01	6,50043E-02	-3,79406E-02	1,70069E+01	1,70069E-01
2.780E+00	-9,99401E+01	-2,07652E+01	-2,69018E-01	-1,32042E-02	5,46419E+01	5,46419E-01
3.840E+00	-1,24754E+01	-6,26107E+01	9,58159E-02	1,52981E-02	1,36801E+02	1,36801E+00
4.780E+00	-7,30022E+01	7,04884E+01	3,83950E-02	3,61531E-01	3,18056E+02	3,18056E+00
5.480E+00	-7,18446E+00	3,89847E+01	-3,27363E-01	1,41364E-01	4,08092E+02	4,08092E+00
6.120E+00	-9,50005E+01	-3,30017E+01	-1,53635E-01	-1,73728E-03	5,73654E+02	5,73654E+00
6.780E+00	-1,12429E+00	1,01463E+02	-3,60843E-01	2,21657E-01	6,30371E+02	6,30370E+00
7.480E+00	-7,40507E+01	-7,03572E+01	-1,59702E-01	-2,26515E-01	7,97467E+02	7,97467E+00
7.980E+00	-6,14530E+01	4,03704E+01	-2,16861E-02	3,00769E-01	8,45101E+02	8,45100E+00
8.320E+00	7,47458E+01	7,09416E+01	2,69892E-01	2,15605E-01	9,20405E+02	9,20404E+00
8.860E+00	-6,27574E+00	9,91193E+01	-1,68510E-01	3,65878E-02	1,03065E+03	1,03065E+01
9.600E+00	7,55581E+01	-7,11683E+01	1,94515E-01	-3,84419E-01	1,17399E+03	1,17399E+01
9.920E+00	2,80293E+01	5,19272E+01	2,37573E-01	-7,77343E-02	1,19545E+03	1,19545E+01
1.062E+01	-1,02555E+01	-1,03330E+02	5,19531E-02	-4,14710E-01	1,33898E+03	1,33898E+01
1.128E+01	-6,75099E+01	7,23910E+01	7,00008E-02	9,21129E-02	1,42899E+03	1,42899E+01
1.192E+01	9,72411E+01	-3,17902E+01	2,84795E-01	-4,46956E-02	1,56828E+03	1,56828E+01
1.258E+01	-2,72573E+01	2,05437E+01	1,96481E-01	2,23026E-01	1,65862E+03	1,65862E+01
1.310E+01	6,11234E+01	-8,34626E+01	1,07751E-01	-3,88817E-01	1,76770E+03	1,76770E+01
1.384E+01	-3,34017E+01	-7,42701E+01	1,13260E-01	1,06752E-01	1,87612E+03	1,87612E+01
1.456E+01	8,45984E+01	-5,86784E+01	3,80565E-01	-4,53619E-02	2,05557E+03	2,05557E+01
1.528E+01	-3,36578E+01	-1,72431E+01	-1,29200E-01	-2,12960E-01	2,14788E+03	2,14788E+01
1.582E+01	7,63334E+01	7,06393E+01	2,03655E-01	4,00961E-01	2,25968E+03	2,25968E+01
1.650E+01	-2,90055E+00	8,07580E+00	-4,03298E-02	-1,13798E-02	2,32072E+03	2,32072E+01
1.748E+01	-8,47817E+01	-5,09991E+01	5,32560E-03	-3,82677E-02	2,41827E+03	2,41827E+01
1.800E+01	-4,13652E+01	4,41497E+01	4,26800E-02	1,70033E-01	2,43016E+03	2,43016E+01
1.840E+01	8,03769E+01	-5,94173E+01	1,57075E-01	4,85477E-02	2,43316E+03	2,43316E+01
1.886E+01	-9,20692E+01	3,40421E+01	-2,56363E-02	3,25315E-02	2,45228E+03	2,45228E+01
1.960E+01	-6,22050E+00	-5,83337E+01	4,31556E-02	-4,71022E-02	2,45441E+03	2,45441E+01

8 Modeling F

8.1 Characteristics of modeling

Modelings tested are DIS_T on meshs SEG2. The characteristics of stiffness of discrete are thus of the type: K_T_D_L, M_T_D_N.

8.2 Characteristics of the grid

Many nodes: 3, many meshs: 2, elements SEG2 : 2, elements POI1 : 1.

8.3 Boundary conditions and loadings

Nodes N1, N2, N3 are blocked in Lhas direction X.
Lbe nodes N1 and N3 are subjected to displacement $U(t)$, speed $V(t)$ and acceleration $\gamma(t)$ in Lbe directionS Y and Z.
Lbe conditionS in displacement are functionS time:

$$Depl = U_{1.}\sin(2\pi.f_1.t) + U_{2.}\sin(2\pi.f_2.t) + U_{3.}\sin(2\pi.f_3.t)$$

According to the direction Y : $(u,f) = [(0.20, 0.80), (0.15, 1.50), (0.10, 3.00)]$
According to the direction Z : $(u,f) = [(-0.20, 0.90), (0.15, 2.00), (-0.10, 2.80)]$
The condition of speed function of time: $V(t) = \dot{U}(t)$
The condition in acceleration function of time: $\gamma(t) = \ddot{U}(t)$

8.4 Sizes tested and results

The sizes tested are itS displacementS in the plan, Lbe effortS in the plan, dissipation.
The tolerances are those by default.

INST	FY	UY	FZ	UZ	DISSIP
1,78500E-01	-9,52285E+00	-9,52285E-03	1,73773E+00	1,73773E-03	0,00000E+00
1,45100E+00	-8,83105E+01	-1,62217E-01	4,94879E+01	1,16656E-01	1,00979E+01
2,77425E+00	-9,81071E+01	-2,56739E-01	-2,78561E+01	-4,34820E-02	6,79684E+01
4,40475E+00	6,15594E+01	8,85626E-02	8,08338E+01	2,20000E-01	2,80220E+02
5,21475E+00	3,64047E+01	-3,32108E-02	-9,57140E+01	-3,26796E-01	4,14575E+02
5,82650E+00	8,73484E+01	3,41345E-01	5,88935E+01	4,41383E-01	5,54339E+02
6,67125E+00	-9,72060E+01	-1,81786E-01	-2,97775E+01	-2,07197E-01	6,49955E+02
7,47850E+00	-8,24549E+01	-1,66154E-01	-5,97317E+01	-1,89185E-01	8,67545E+02
8,07975E+00	-3,70270E+01	-2,89837E-01	-9,23438E+01	4,67886E-02	9,58962E+02
8,61150E+00	-6,02897E+01	2,95664E-01	-6,44423E+01	-3,58656E-01	1,06271E+03
9,59300E+00	7,82344E+01	2,51358E-01	-6,95014E+01	-4,29696E-01	1,28286E+03
1,01268E+01	-1,01830E+02	-3,72252E-01	1,85394E+01	7,85525E-02	1,37195E+03
1,09618E+01	5,79435E+01	2,41413E-01	-8,48922E+01	-2,26152E-01	1,52979E+03
1,16763E+01	1,94219E+01	-2,01469E-01	-9,92547E+01	-2,37830E-01	1,66580E+03
1,21353E+01	-5,53783E+01	5,35186E-02	6,32611E+01	-2,40125E-01	1,75090E+03
1,30893E+01	5,37249E+01	1,33765E-02	-8,90513E+01	-4,86920E-01	1,92774E+03
1,40900E+01	-5,35883E+01	-4,72384E-01	-9,03927E+01	-3,13451E-01	2,10573E+03
1,47685E+01	-7,72478E+01	-2,74588E-03	6,68629E+01	4,24219E-01	2,27596E+03
1,56093E+01	9,21142E+01	3,71403E-05	-3,76089E+01	-1,61524E-01	2,39968E+03
1,66685E+01	-9,95112E+01	-1,25825E-01	-1,44851E+01	-1,48023E-01	2,52738E+03
1,77000E+01	-9,72174E+01	-1,10377E-01	-2,44149E+01	-4,87330E-02	2,64239E+03
1,83155E+01	9,87313E+01	8,53027E-02	-1,37029E+01	7,16409E-02	2,66226E+03
1,89980E+01	-6,21933E+01	-5,04685E-02	7,77303E+01	4,14958E-02	2,68767E+03

9 Summary of the results

These tests make it possible to check the good performance of the discrete elements with the behavior DIS_ECRO_TRAC within the framework of a use with the order DYNA_NON_LINE and DYNA_VIBRA.

The behavior is tested:

- in the direction x local of discrete, with an isotropic work hardening.
- in the directions there and Z, tangent plan with discrete, with an isotropic and kinematic work hardening.

The order STAT_NON_LINE use an implicit algorithm and calculates 1281 pas de time, without adaptation of the step.
The order DYNA_VIBRA use an algorithm clarifies and adapts the step for the resolution of the diagram in time, that led to calculate 42796 steps of time.
Although the number of steps of time at the time of the study with DYNA_VIBRA that is to say 33 times more important than for the study with STAT_NON_LINE, the order DYNA_VIBRA is 10 times faster in time CPU that the order STAT_NON_LINE.

Note: kinematic work hardening is available in local direction X of discrete (no request and need to date).