

## SSND101 – Viscous constitutive law for discrete elements

---

### Summarized:

The problem is quasi-static nonlinear in structural mechanics. One distinguishes two elements in this test.

Initially, although it is about a viscous model, it is the operator `STAT_NON_LINE` who is employed for the validation. The velocity is then calculated on the base of displacements and the increment of selected time. One analyzes the response of discrete elements supporting a viscous nonlinear constitutive law under a harmonic loading.

In the second time and an aim of validating the viscous model strictly speaking, one carries out two computations `DYNA_NON_LINE`, one by means of the viscous model and the other by means of discrete defined in `AFFE_CARA_ELEM`. This test is carried out only in `3D`, in the frame of a linear damper, i.e  $\alpha=1$ .

The modelizations and discrete elements tested are:

- `3D` modelization `DIS_T` and `DIS_TR` with elementary characteristics: ( `K_T_D_L`, `K_TR_D_L`, `K_T_D_N`, `K_TR_D_N`, `A_T_D_L`, `M_T_D_L` );
- `2D` modelization `2D_DIS_T` and `2D_DIS_TR` with elementary characteristics: ( `K_T_D_L`, `K_TR_D_L`, `K_T_D_N`, `K_TR_D_N` ).

All the degrees of freedom are tested, the parameters of the loading in displacement and those of the viscous model are different for all the degrees of freedom in order to cover various situations.

The reference solutions are obtained in an analytical way.

## 1 Problem of reference

### 1.1 Geometry

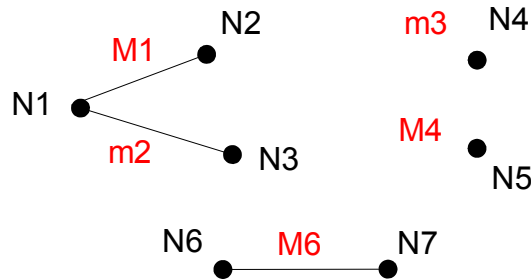


Figure 1.1.a: geometry.

	Modelization	3DModelisation	2D	GROUP_MA
Nets <i>M1</i> : Node <i>N1</i> with <i>N2</i>			DIS_T2D_DIS_TDL_T	
Nets <i>M2</i> : Node <i>N1</i> with <i>N3</i>			DIS_TR2D_DIS_TRDL_TR	
Nets <i>M3</i> : Node <i>N4</i>			DIS_T2D_DIS_TDN_T	
Nets <i>M4</i> : Node <i>N5</i>			DIS_TR2D_DIS_TRDN_TR	
Nets <i>M6</i> : Node <i>N6</i> with <i>N7</i>			DIS_T	DIS_T

### 1.2 Properties of the material

the constitutive law is form  $F = -CV^\alpha$  and thus requires 2 characteristics. Their units must be in agreement with those of the study.  $F$  is homogeneous with a force,  $V$  is homogeneous at a velocity.

$C$  : coefficient.

$\alpha$  : power of damping on the velocity.

### 1.3 Boundary conditions and loadings

The node is outside the field of definition with a right profile of the EXCLU type node: *N1* fixed support

Nodes *N2* *N3* *N4* *N5* : for all the degrees of freedom the signal in displacement is form  $A.\sin(2\pi.f.t)$ . The period of the loading is 5 seconds. The values of  $A$  and of  $f$  are different from one degree of freedom to another in order to sweep a broad range of behavior.

The node is outside the field of definition with a right profile of the EXCLU type node: *N6* fixed support

The node is outside the field of definition with a right profile of the EXCLU type node: *N7* loading crawls

## 2 Reference solution

### 2.1 Method of calculating used for the reference solution

the constitutive law is form  $F = -C V^\alpha$ , and the signal in displacement whatever the degree of freedom is form  $A \cdot \sin(2\pi \cdot f \cdot t)$ . One can thus calculate the maximum force  $F_{max} = -C \cdot (A \cdot 2\pi \cdot f)^\alpha$ . The maximum force is reached for  $\cos(2\pi \cdot f \cdot t) = 1$  and the minimal force is reached when  $\cos(2\pi \cdot f \cdot t) = -1$ .

Dissipated energy is  $W = C \cdot (A \cdot 2\pi \cdot f)^{\alpha+1} \int_0^t \cos(2\pi \cdot f \cdot x)^{\alpha+1} dx$ .

The analytical solution of the second phase of the benchmark, in the frame of a linear damper, i.e.  $\alpha=1$ , corresponds to the solution of the following differential equation:

$$\ddot{u}(t) + 100 \dot{u}(t) + u(t) = 10t$$

with the initial conditions:  $u(0) = 0$  and  $\dot{u}(0) = 0$  :

$$u(t) = 10t - 1000 - 0,000010004 e^{-99,98999t} + 1000,00001 e^{-0,010001t}$$

In particular, with  $t = 1,0$  one a:  $u(1,0) = 0,048853406$ .

### 2.2 Results of reference

the tests are carried out on:

- 1) forces maximum and minimal. For each degree of freedom several cycles are carried out; the minimal and maximum forces are thus reached several times. The test will be carried out for each cycle and on the 2 forces,
- 2) the energy dissipated at the end of the loading,
- 3) the displacement of the node *N7* at time  $t = 1,0$  for the validation of behavior `DIS_VISC` for the case  $\alpha=1$  in `STAT_NON_LINE` which is compared discrete with behavior of straight-line depreciation defined in `AFFE_CARA_ELEM`.

For the 2 modelizations a table presents the value of the forces and the dissipated energy which are used as reference.

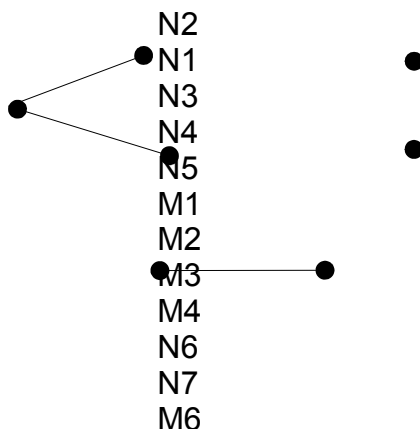
### 2.3 Uncertainty on the solution

No uncertainty, the solution is analytical.

## 3 Modelization A

### 3.1 Characteristic of the modelization

Modelization DISCRET (in 3D)



Appears 3.1.a: geometry.

Characteristics of the discrete elements:

Modelization into 3DGROUP\_MACaracteristic

Nets <i>M1</i>	DIS_TDL_TK_T_D_L
Nets <i>M2</i>	DIS_TRDL_TRK_TR_D_L
Nets <i>M3</i>	DIS_TDN_TK_T_D_N
Nets <i>M4</i>	DIS_TRDN_TRK_TR_D_N
Nets <i>M6</i>	DIS_TDIS_TK_T_D_L and
M_T_D_L	

### 3.2 Characteristic of the mesh

Many nodes: 7, Number of meshes: 5, Elements SEG2 : 3, Elements POI1 : 2

## 3.3 Properties of discrete and definition of the function of loading

the table below gives for all the requested directions the characteristics of the damper, the maximum force reached as well as corresponding energy dissipated for  $t$  in  $[0s, 5s]$ . The values of  $F_{max}$  and dissipated energy are calculated in an analytical way.

GROUP_ MA	Directions	Characteristics of the signal sines		Characteristic of damper			Dissipated Energy ( J )
		Frequency $f$ ( Hz )	$A$ ( m )	$\alpha$	$C$	$F_{max}$ ( N )	
DL_T	DX	0.800	4.00E-02	1.20	68549.48	10000	4842.77
	DY	1.900	5.00E-02	1.40	24712.48	12000	16663.54
	DZ	2.500	3.00E-02	2.25	43480.79	8000	7733.42
DL_TR	DX	1.350	4.00E-02	0.25	13102.57	10000	10053.44
	DY	1.650	3.50E-02	0.50	19921.19	12000	12113.91
	DZ	2.350	2.50E-02	0.60	27275.87	15000	15051.01
	DRX	3.000	1.50E-02	0.70	19369.36	8000	6013.35
	DRY	2.600	3.00E-02	0.80	15922.93	9000	11478.77
	DRZ	2.450	2.00E-02	0.90	21653.24	7500	5887.44
DN_T	DX	1.250	4.00E-02	1.25	42517.00	10000	7499.74
	DY	0.900	3.00E-02	1.40	143820.29	12000	4735.95
	DZ	1.150	3.50E-02	2.00	125083.06	8000	4293.33
DN_TR	DX	1.000	4.00E-02	0.25	14123.43	10000	7446.99
	DY	1.500	5.00E-02	0.45	16835.37	12000	15922.44
	DZ	2.000	6.00E-02	0.15	13562.48	13000	29852.93
	DRX	0.500	3.00E-02	0.30	16248.33	8000	2204.74
	DRY	0.750	2.00E-02	0.40	19290.91	7500	2014.92
	DRZ	1.250	7.00E-02	0.10	7431.55	7000	11889.99

Knowing the frequency of each signal in displacement, it is possible to calculate times when the maximum force is reached. This time is not necessarily in calculated times. The use of `RECU_FONCTION` makes it possible to extract the response from discrete and thus to know by interpolation the value of the force at this time.

## 3.4 Quantities tested and results

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code_Aster	Error
DN TR	N	1.000	-10000.000000	-9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	2.000	-10000.000000	-9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	3.000	-10000.000000	-9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	4.000	-10000.000000	-9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	5.000	-10000.000000	-9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	0.500	10000.000000	9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	1.500	10000.000000	9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	2.500	10000.000000	9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	3.500	10000.000000	9998.857646	1.1000 10 <sup>-4</sup>
DN TR	N	4.500	10000.000000	9998.857646	1.1000 10 <sup>-4</sup>
DN TR	VY	0.667	-12000.000000	-11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	1.333	-12000.000000	-11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	2.000	-12000.000000	-11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	2.667	-12000.000000	-11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	3.333	-12000.000000	-11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	4.000	-12000.000000	-11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	4.667	-12000.000000	-11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	0.333	12000.000000	11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	1.000	12000.000000	11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	1.667	12000.000000	11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	2.333	12000.000000	11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	3.000	12000.000000	11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	3.667	12000.000000	11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VY	4.333	12000.000000	11994.448490	4.6000 10 <sup>-4</sup>
DN TR	VZ	0.500	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	1.000	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	1.500	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	2.000	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	2.500	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	3.000	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	3.500	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	4.000	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	4.500	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	5.000	-13000.000000	-12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	0.250	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	0.750	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	1.250	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	1.750	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	2.250	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	2.750	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	3.250	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	3.750	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	4.250	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	VZ	4.750	13000.000000	12996.435161	2.7000 10 <sup>-4</sup>
DN TR	MFY	1.333	-7500.000000	-7499.228937	1.0000 10 <sup>-4</sup>
DN TR	MFY	2.667	-7500.000000	-7499.228937	1.0000 10 <sup>-4</sup>
DN TR	MFY	4.000	-7500.000000	-7499.228937	1.0000 10 <sup>-4</sup>
DN TR	MFY	0.667	7500.000000	7499.228937	1.0000 10 <sup>-4</sup>
DN TR	MFY	2.000	7500.000000	7499.228937	1.0000 10 <sup>-4</sup>
DN TR	MFY	3.333	7500.000000	7499.228937	1.0000 10 <sup>-4</sup>
DN TR	MFZ	0.800	-7000.000000	-6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	1.600	-7000.000000	-6999.500184	7.0000 10 <sup>-5</sup>

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

DN TR	MFZ	2.400	-7000.000000	-6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	3.200	-7000.000000	-6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	4.000	-7000.000000	-6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	4.800	-7000.000000	-6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	0.400	7000.000000	6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	1.200	7000.000000	6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	2.000	7000.000000	6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	2.800	7000.000000	6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	3.600	7000.000000	6999.500184	7.0000 10 <sup>-5</sup>
DN TR	MFZ	4.400	7000.000000	6999.500184	7.0000 10 <sup>-5</sup>

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code Aster	Error
DN T	N	0.800	-10000.000000	-9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	1.600	-10000.000000	-9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	2.400	-10000.000000	-9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	3.200	-10000.000000	-9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	4.000	-10000.000000	-9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	4.800	-10000.000000	-9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	0.400	10000.000000	9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	1.200	10000.000000	9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	2.000	10000.000000	9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	2.800	10000.000000	9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	3.600	10000.000000	9991.078369	8.9000 10 <sup>-4</sup>
DN T	N	4.400	10000.000000	9991.078369	8.9000 10 <sup>-4</sup>
DN T	VY	1.108	-11997.927477	-11985.497093	1.0400 10 <sup>-3</sup>
DN T	VY	2.225	-11997.927477	-11997.927528	4.2600 10 <sup>-9</sup>
DN T	VY	3.333	-12000.000000	-11993.783300	5.2000 10 <sup>-4</sup>
DN T	VY	4.442	-11997.927477	-11985.497093	1.0400 10 <sup>-3</sup>
DN T	VY	0.558	11997.927477	11997.927528	4.2600 10 <sup>-9</sup>
DN T	VY	1.667	12000.000000	11993.783300	5.2000 10 <sup>-4</sup>
DN T	VY	2.775	11997.927477	11985.497093	1.0400 10 <sup>-3</sup>
DN T	VY	3.892	11997.927477	11997.927528	4.2600 10 <sup>-9</sup>
DN T	VZ	0.867	-7996.491320	-7976.758013	2.4700 10 <sup>-3</sup>
DN T	VZ	1.742	-7997.313575	-7996.473209	1.1000 10 <sup>-4</sup>
DN T	VZ	2.608	-7999.945169	-7989.021433	1.3700 10 <sup>-3</sup>
DN T	VZ	3.475	-7995.559500	-7974.569438	2.6300 10 <sup>-3</sup>
DN T	VZ	4.350	-7998.026241	-7995.925127	2.6000 10 <sup>-4</sup>
DN T	VZ	0.433	7999.122734	7984.421179	1.8400 10 <sup>-3</sup>
DN T	VZ	1.308	7993.367266	7997.569449	5.3000 10 <sup>-4</sup>
DN T	VZ	2.175	7999.506530	7993.623454	7.4000 10 <sup>-4</sup>
DN T	VZ	3.042	7998.629300	7982.669166	2.0000 10 <sup>-3</sup>
DN T	VZ	3.917	7994.518139	7997.459821	3.7000 10 <sup>-4</sup>

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code Aster	Error
DL TR	N	0.742	-9999.922893	-9998.534947	1.4000 10 <sup>-4</sup>
DL TR	N	1.483	-9999.691567	-9998.997616	7.0000 10 <sup>-5</sup>
DL TR	N	2.225	-9999.306003	-9999.306042	3.8500 10 <sup>-9</sup>
DL TR	N	2.967	-9998.766173	-9999.460249	7.0000 10 <sup>-5</sup>
DL TR	N	3.700	-9998.766173	-9993.906296	4.9000 10 <sup>-4</sup>
DL TR	N	4.442	-9999.306003	-9995.140953	4.2000 10 <sup>-4</sup>
DL TR	N	0.367	9998.766173	9993.906296	4.9000 10 <sup>-4</sup>
DL TR	N	1.108	9999.306003	9995.140953	4.2000 10 <sup>-4</sup>
DL TR	N	1.850	9999.691567	9996.221069	3.5000 10 <sup>-4</sup>
DL TR	N	2.592	9999.922893	9997.146727	2.8000 10 <sup>-4</sup>

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

DL TR	N	3.333	10000.000000	9997.918000	2.1000 10 <sup>-4</sup>
DL TR	N	4.075	9999.922893	9998.534947	1.4000 10 <sup>-4</sup>
DL TR	VY	0.608	-11998.334466	-11996.977624	1.1000 10 <sup>-4</sup>
DL TR	VY	1.208	-11995.373326	-11977.729114	1.4700 10 <sup>-3</sup>
DL TR	VY	1.817	-11999.259772	-11987.724821	9.6000 10 <sup>-4</sup>
DL TR	VY	2.425	-11999.814944	-11994.387079	4.5000 10 <sup>-4</sup>
DL TR	VY	3.033	-11997.038997	-11997.717745	6.0000 10 <sup>-5</sup>
DL TR	VY	3.633	-11997.038997	-11981.431552	1.3000 10 <sup>-3</sup>
DL TR	VY	4.242	-11999.814944	-11990.315846	7.9000 10 <sup>-4</sup>
DL TR	VY	4.850	-11999.259772	-11995.867413	2.8000 10 <sup>-4</sup>
DL TR	VY	0.300	11997.038997	11981.431552	1.3000e-03
DL TR	VY	0.908	11999.814944	11990.315846	7.9000 10 <sup>-4</sup>
DL TR	VY	1.517	11999.259772	11995.867413	2.8000 10 <sup>-4</sup>
DL TR	VY	2.125	11995.373326	11998.087800	2.3000 10 <sup>-4</sup>
DL TR	VY	2.725	11998.334466	11984.763420	1.1300 10 <sup>-3</sup>
DL TR	VY	3.333	12000.000000	11992.536576	6.2000 10 <sup>-4</sup>
DL TR	VY	3.942	11998.334466	11996.977624	1.1000 10 <sup>-4</sup>
DL TR	VY	4.542	11995.373326	11977.729114	1.4700 10 <sup>-3</sup>
DL TR	VZ	0.425	-14999.722417	-14972.670066	1.8000 10 <sup>-3</sup>
DL TR	VZ	0.850	-14998.889665	-14967.489550	2.0900 10 <sup>-3</sup>
DL TR	VZ	1.275	-14997.501733	-14961.753745	2.3800 10 <sup>-3</sup>
DL TR	VZ	1.700	-14995.558605	-14955.462578	2.6700 10 <sup>-3</sup>
DL TR	VZ	2.125	-14993.060256	-14948.615970	2.9600 10 <sup>-3</sup>
DL TR	VZ	2.550	-14990.006655	-14941.213834	3.2600 10 <sup>-3</sup>
DL TR	VZ	2.975	-14986.397765	-14933.256077	3.5500 10 <sup>-3</sup>
DL TR	VZ	3.408	-14983.683322	-14994.315058	7.1000 10 <sup>-4</sup>
DL TR	VZ	3.833	-14987.662430	-14993.945087	4.2000 10 <sup>-4</sup>
DL TR	VZ	4.258	-14991.086219	-14993.020156	1.3000 10 <sup>-4</sup>
DL TR	VZ	4.683	-14993.954732	-14991.540253	1.6000 10 <sup>-4</sup>
DL TR	VZ	0.217	14985.071396	14994.253396	6.1000 10 <sup>-4</sup>
DL TR	VZ	0.642	14988.865393	14993.698439	3.2000 10 <sup>-4</sup>
DL TR	VZ	1.067	14992.104085	14992.588519	3.0000 10 <sup>-5</sup>
DL TR	VZ	1.492	14994.787514	14990.923622	2.6000 10 <sup>-4</sup>
DL TR	VZ	1.917	14996.915713	14988.703728	5.5000 10 <sup>-4</sup>
DL TR	VZ	2.342	14998.488708	14985.928808	8.4000 10 <sup>-4</sup>
DL TR	VZ	2.767	14999.506519	14982.598828	1.1300 10 <sup>-3</sup>
DL TR	VZ	3.192	14999.969157	14978.713748	1.4200 10 <sup>-3</sup>
DL TR	VZ	3.617	14999.876630	14974.273519	1.7100 10 <sup>-3</sup>
DL TR	VZ	4.042	14999.228935	14969.278084	2.0000 10 <sup>-3</sup>
DL TR	VZ	4.467	14998.026065	14963.727383	2.2900 10 <sup>-3</sup>
DL TR	MFY	0.383	-8998.420886	-8965.942963	3.6100 10 <sup>-3</sup>
DL TR	MFY	0.767	-8993.683823	-8950.960412	4.7500 10 <sup>-3</sup>
DL TR	MFY	1.150	-8985.789639	-8932.829184	5.8900 10 <sup>-3</sup>
DL TR	MFY	1.542	-8990.131297	-8993.553273	3.8000 10 <sup>-4</sup>
DL TR	MFY	1.925	-8996.447059	-8989.608079	7.6000 10 <sup>-4</sup>
DL TR	MFY	2.308	-8999.605217	-8982.507456	1.9000 10 <sup>-3</sup>
DL TR	MFY	2.692	-8999.605217	-8972.252647	3.0400 10 <sup>-3</sup>
DL TR	MFY	3.075	-8996.447059	-8958.845448	4.1800 10 <sup>-3</sup>
DL TR	MFY	3.458	-8990.131297	-8942.288198	5.3200 10 <sup>-3</sup>
DL TR	MFY	3.850	-8985.789639	-8994.342346	9.5000 10 <sup>-4</sup>
DL TR	MFY	4.233	-8993.683823	-8991.975161	1.9000 10 <sup>-4</sup>
DL TR	MFY	4.617	-8998.420886	-8986.452131	1.3300 10 <sup>-3</sup>
DL TR	MFY	5.000	-9000.000000	-8977.774225	2.4700 10 <sup>-3</sup>
DL TR	MFY	0.192	8999.605217	8972.252647	3.0400 10 <sup>-3</sup>
DL TR	MFY	0.575	8996.447059	8958.845448	4.1800 10 <sup>-3</sup>
DL TR	MFY	0.958	8990.131297	8942.288198	5.3200 10 <sup>-3</sup>
DL TR	MFY	1.350	8985.789639	8994.342346	9.5000 10 <sup>-4</sup>

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.



DL TR	MFY	1.733	8993.683823	8991.975161	1.9000 10 <sup>-4</sup>
DL TR	MFY	2.117	8998.420886	8986.452131	1.3300 10 <sup>-3</sup>
DL TR	MFY	2.500	9000.000000	8977.774225	2.4700 10 <sup>-3</sup>
DL TR	MFY	2.883	8998.420886	8965.942963	3.6100 10 <sup>-3</sup>
DL TR	MFY	3.267	8993.683823	8950.960412	4.7500 10 <sup>-3</sup>
DL TR	MFY	3.650	8985.789639	8932.829184	5.8900 10 <sup>-3</sup>
DL TR	MFY	4.042	8990.131297	8993.553273	3.8000 10 <sup>-4</sup>
DL TR	MFY	4.425	8996.447059	8989.608079	7.6000 10 <sup>-4</sup>
DL TR	MFY	4.808	8999.605217	8982.507456	1.9000 10 <sup>-3</sup>
DL TR	MFZ	0.408	-7499.976868	-7482.608605	2.3200 10 <sup>-3</sup>
DL TR	MFZ	0.817	-7499.907473	-7483.671565	2.1600 10 <sup>-3</sup>
DL TR	MFZ	1.225	-7499.791814	-7484.688347	2.0100 10 <sup>-3</sup>
DL TR	MFZ	1.633	-7499.629892	-7485.658944	1.8600 10 <sup>-3</sup>
DL TR	MFZ	2.042	-7499.421709	-7486.583352	1.7100 10 <sup>-3</sup>
DL TR	MFZ	2.450	-7499.167264	-7487.461568	1.5600 10 <sup>-3</sup>
DL TR	MFZ	2.858	-7498.866560	-7488.293586	1.4100 10 <sup>-3</sup>
DL TR	MFZ	3.267	-7498.519597	-7489.079403	1.2600 10 <sup>-3</sup>
DL TR	MFZ	3.675	-7498.126378	-7489.819016	1.1100 10 <sup>-3</sup>
DL TR	MFZ	4.083	-7497.686904	-7490.512419	9.6000 10 <sup>-4</sup>
DL TR	MFZ	4.492	-7497.201177	-7491.159611	8.1000 10 <sup>-4</sup>
DL TR	MFZ	4.900	-7496.669200	-7491.760587	6.5000 10 <sup>-4</sup>
DL TR	MFZ	0.200	7486.679102	7441.045179	6.1000 10 <sup>-3</sup>
DL TR	MFZ	0.608	7487.765820	7443.260386	5.9400 10 <sup>-3</sup>
DL TR	MFZ	1.017	7488.806334	7445.429607	5.7900 10 <sup>-3</sup>
DL TR	MFZ	1.425	7489.800637	7447.552833	5.6400 10 <sup>-3</sup>
DL TR	MFZ	1.833	7490.748725	7449.630053	5.4900 10 <sup>-3</sup>
DL TR	MFZ	2.242	7491.650594	7451.661256	5.3400 10 <sup>-3</sup>
DL TR	MFZ	2.650	7492.506240	7453.646434	5.1900 10 <sup>-3</sup>
DL TR	MFZ	3.058	7493.315657	7455.585577	5.0400 10 <sup>-3</sup>
DL TR	MFZ	3.467	7494.078843	7457.478675	4.8800 10 <sup>-3</sup>
DL TR	MFZ	3.875	7494.795794	7459.325720	4.7300 10 <sup>-3</sup>
DL TR	MFZ	4.283	7495.466506	7461.126702	4.5800 10 <sup>-3</sup>
DL TR	MFZ	4.692	7496.090976	7462.881614	4.4300 10 <sup>-3</sup>

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code Aster	Error
DL T	N	1.250	-10000.000000	-9996.491218	3.5000 10 <sup>-4</sup>
DL T	N	2.500	-10000.000000	-9996.491218	3.5000 10 <sup>-4</sup>
DL T	N	3.750	-10000.000000	-9996.491218	3.5000 10 <sup>-4</sup>
DL T	N	5.000	-10000.000000	-9996.491218	3.5000 10 <sup>-4</sup>
DL T	N	0.625	10000.000000	9996.491218	3.5000 10 <sup>-4</sup>
DL T	N	1.875	10000.000000	9996.491218	3.5000 10 <sup>-4</sup>
DL T	N	3.125	10000.000000	9996.491218	3.5000 10 <sup>-4</sup>
DL T	N	4.375	10000.000000	9996.491218	3.5000 10 <sup>-4</sup>
DL T	VY	0.525	-11997.927477	-11957.139588	3.4000 10 <sup>-3</sup>
DL T	VY	1.050	-11991.711032	-11937.844841	4.4900 10 <sup>-3</sup>
DL T	VY	1.575	-11981.354041	-11914.437431	5.5900 10 <sup>-3</sup>
DL T	VY	2.108	-11988.718531	-11991.635073	2.4000 10 <sup>-4</sup>
DL T	VY	2.633	-11996.315644	-11986.112298	8.5000 10 <sup>-4</sup>
DL T	VY	3.158	-11999.769710	-11976.450648	1.9400 10 <sup>-3</sup>
DL T	VY	3.683	-11999.078855	-11962.655368	3.0400 10 <sup>-3</sup>
DL T	VY	4.208	-11994.243454	-11944.733950	4.1300 10 <sup>-3</sup>
DL T	VY	4.733	-11985.266131	-11922.696124	5.2200 10 <sup>-3</sup>
DL T	VY	0.267	11985.266131	11992.555665	6.1000 10 <sup>-4</sup>
DL T	VY	0.792	11994.243454	11988.413292	4.9000 10 <sup>-4</sup>
DL T	VY	1.317	11999.078855	11980.130796	1.5800 10 <sup>-3</sup>

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

DL T	VY	1.842	11999.769710	11967.712671	2.6700 10 <sup>-3</sup>
DL T	VY	2.367	11996.315644	11951.165661	3.7600 10 <sup>-3</sup>
DL T	VY	2.892	11988.718531	11930.498752	4.8600 10 <sup>-3</sup>
DL T	VY	3.425	11981.354041	11993.015975	9.7000 10 <sup>-4</sup>
DL T	VY	3.950	11991.711032	11990.254254	1.2000 10 <sup>-4</sup>
DL T	VY	4.475	11997.927477	11983.351410	1.2100 10 <sup>-3</sup>
DL T	VZ	0.400	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	0.800	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	1.200	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	1.600	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	2.000	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	2.400	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	2.800	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	3.200	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	3.600	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	4.000	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	4.400	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	4.800	-8000.000000	-7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	0.200	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	0.600	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	1.000	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	1.400	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	1.800	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	2.200	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	2.600	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	3.000	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	3.400	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	3.800	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	4.200	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>
DL T	VZ	4.600	8000.000000	7948.731403	6.4100 10 <sup>-3</sup>

GROUP_MA	Direction	Time ( s )	Energy Reference	Energy Code_Aster	Error
DN TR	DX	5.0	7446.992455	7446.226532	1.0000 10 <sup>-4</sup>
DN TR	DY	5.0	15922.438890	15917.165692	3.3000 10 <sup>-4</sup>
DN TR	DZ	5.0	29852.929010	29845.435719	2.5000 10 <sup>-4</sup>
DN TR	X-ray	5.0	2204.743155	2204.675540	3.0000 10 <sup>-5</sup>
DN TR	RY	5.0	2014.924218	2014.762898	8.0000 10 <sup>-5</sup>
DN TR	RZ	5.0	11889.988830	11889.103440	7.0000 10 <sup>-5</sup>
DN T	DX	5.0	7499.743876	7496.726061	4.0000 10 <sup>-4</sup>
DN T	DY	5.0	4735.953639	4734.902012	2.2000 10 <sup>-4</sup>
DN T	DZ	5.0	4293.333333	4291.387918	4.5000 10 <sup>-4</sup>
DL TR	DX	5.0	10053.439810	10050.829423	2.6000 10 <sup>-4</sup>
DL TR	DY	5.0	12113.905900	12108.257062	4.7000 10 <sup>-4</sup>
DL TR	DZ	5.0	15051.011140	15035.825198	1.0100 10 <sup>-3</sup>
DL TR	X-ray	5.0	6013.348235	6003.266460	1.6800 10 <sup>-3</sup>
DL TR	RY	5.0	11478.773220	11462.826914	1.3900 10 <sup>-3</sup>
DL TR	RZ	5.0	5887.444214	5879.778101	1.3000 10 <sup>-3</sup>
DL T	DX	5.0	4842.766985	4841.989352	1.6000 10 <sup>-4</sup>
DL T	DY	5.0	16663.540580	16647.055440	9.9000 10 <sup>-4</sup>
DL T	DZ	5.0	7733.415243	7715.476835	2.3200 10 <sup>-3</sup>

### C linear $\alpha=1$ aces damper: Comparison NON-regression

GROUP_MA	Behavior	Urgent	Displacement	DX Reference	DX Code_Aster	Error
DIS T	"DIS VISC"	DX	1.000	0.0491083	0.0490831	3.2 10 <sup>-5</sup>

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

DIS_T	"ELAS" + carac. élém.	DX	1.000	0.0488534	0.0488534	$1.2 \cdot 10^{-3}$
-------	-----------------------	----	-------	-----------	-----------	---------------------

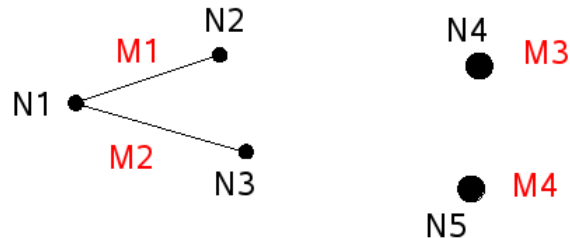
### C linear $\alpha=1$ aces damper: Analytical comparison

GROUP_MA	Behavior	Urgent	Displacement	$DX$ Analytical	$DX$ Code_Aster	Error
DIS_T	"DIS_VISC"	DX	1.000	0.0488534	0.0490831	$6.0 \cdot 10^{-3}$
DIS_T	"ELAS" + carac. élém.	DX	1.000	0.0488534	0.0488534	$1.0 \cdot 10^{-5}$

## 4 Modelization B

### 4.1 Characteristic of the modelization

Modelization 2D\_DISCRET



Appear 5.1.a: geometry.

Characteristics of the discrete elements:

Modelization in 2D GROUP\_MACaractéristiques

Nets *M1* 2D\_DIS\_TDL\_TK\_T\_D\_L  
Nets *M2* 2D\_DIS\_TRDL\_TRK\_TR\_D\_L  
Nets *M3* 2D\_DIS\_TDN\_TK\_T\_D\_N  
Nets *M4* 2D\_DIS\_TRDN\_TRK\_TR\_D\_N

### 4.2 Characteristic of the mesh

Many nodes: 5, Number of meshes: 4, Elements SEG2 : 2, Elements POI1 : 2.

### 4.3 Properties of discrete

the table below gives, for all the requested directions, the characteristics of the damper the maximum force reached as well as corresponding energy dissipated for  $t$  in  $[0, 5s]$ .

GROUP_M A	Directions	Characteristics of the signal sines		Characteristic of damper			Dissipated Energy ( J )
		Frequency $f$ ( Hz )	$A$ ( m )	$\alpha$	$C$	$F_{max}(N)$	
DL_T	DX	0.800	4.00E-02	1.20	68549.48	10000	4842.77
	DY	1.900	5.00E-02	1.40	24712.48	12000	16663.54
DL_TR	DX	1.350	4.00E-02	0.25	13102.57	10000	10053.44
	DY	1.650	3.50E-02	0.50	19921.19	12000	12113.91
	DRZ	2.450	2.00E-02	0.90	21653.24	7500	5887.44
DN_T	DX	1.250	4.00E-02	1.25	42517.00	10000	7499.74
	DY	0.900	3.00E-02	1.40	143820.29	12000	4735.95
DN_TR	DX	1.000	4.00E-02	0.25	14123.43	10000	7446.99
	DY	1.500	5.00E-02	0.45	16835.37	12000	15922.44
	DRZ	1.250	7.00E-02	0.10	7431.55	7000	11889.99

Knowing the frequency of each signal, it is possible to calculate times when the maximum force is reached. This time is not necessarily in calculated times. The use of RECU\_FONCTION makes it

possible to extract the response from discrete and thus to know by interpolation the value of the force at this time.

## 4.4 Quantities tested and results

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code_Aster	Error
DN_TR	N	1.000	-10000.000000	-9998.947209	1.1000 10 <sup>-4</sup>
DN_TR	N	2.000	-10000.000000	-9998.947209	1.1000 10 <sup>-4</sup>
DN_TR	N	3.000	-10000.000000	-9998.947209	1.1000 10 <sup>-4</sup>
DN_TR	N	4.000	-10000.000000	-9998.947209	1.1000 10 <sup>-4</sup>
DN_TR	N	5.000	-10000.000000	-9998.947209	1.1000 10 <sup>-4</sup>
DN_TR	N	0.504	9999.210380	9999.736808	5.0000 10 <sup>-5</sup>
DN_TR	N	1.504	9999.210380	9999.736808	5.0000 10 <sup>-5</sup>
DN_TR	N	2.504	9999.210380	9999.736808	5.0000 10 <sup>-5</sup>
DN_TR	N	3.504	9999.210380	9999.736808	5.0000 10 <sup>-5</sup>
DN_TR	N	4.504	9999.210380	9999.736808	5.0000 10 <sup>-5</sup>
DN_TR	VY	0.664	-11998.294474	-11988.060589	8.5000 10 <sup>-4</sup>
DN_TR	VY	1.336	-11998.294474	-11998.294582	8.9800 10 <sup>-9</sup>
DN_TR	VY	2.000	-12000.000000	-11994.883718	4.3000 10 <sup>-4</sup>
DN_TR	VY	2.664	-11998.294474	-11988.060589	8.5000 10 <sup>-4</sup>
DN_TR	VY	3.336	-11998.294474	-11998.294582	8.9800 10 <sup>-9</sup>
DN_TR	VY	4.000	-12000.000000	-11994.883718	4.3000 10 <sup>-4</sup>
DN_TR	VY	4.664	-11998.294474	-11988.060589	8.5000 10 <sup>-4</sup>
DN_TR	VY	0.336	11998.294474	11998.294582	8.9800 10 <sup>-9</sup>
DN_TR	VY	1.000	12000.000000	11994.883718	4.3000 10 <sup>-4</sup>
DN_TR	VY	1.664	11998.294474	11988.060589	8.5000 10 <sup>-4</sup>
DN_TR	VY	2.336	11998.294474	11998.294582	8.9800 10 <sup>-9</sup>
DN_TR	VY	3.000	12000.000000	11994.883718	4.3000 10 <sup>-4</sup>
DN_TR	VY	3.664	11998.294474	11988.060589	8.5000 10 <sup>-4</sup>
DN_TR	VY	4.336	11998.294474	11998.294582	8.9800 10 <sup>-9</sup>
DN_TR	MFZ	0.800	-7000.000000	-6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	1.600	-7000.000000	-6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	2.400	-7000.000000	-6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	3.200	-7000.000000	-6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	4.000	-7000.000000	-6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	4.800	-7000.000000	-6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	0.400	7000.000000	6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	1.200	7000.000000	6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	2.000	7000.000000	6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	2.800	7000.000000	6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	3.600	7000.000000	6999.539373	7.0000 10 <sup>-5</sup>
DN_TR	MFZ	4.400	7000.000000	6999.539373	7.0000 10 <sup>-5</sup>

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code_Aster	Error
DN_T	N	0.800	-10000.000000	-9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	1.600	-10000.000000	-9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	2.400	-10000.000000	-9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	3.200	-10000.000000	-9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	4.000	-10000.000000	-9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	4.800	-10000.000000	-9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	0.400	10000.000000	9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	1.200	10000.000000	9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	2.000	10000.000000	9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	2.800	10000.000000	9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	3.600	10000.000000	9991.777629	8.2000 10 <sup>-4</sup>
DN_T	N	4.400	10000.000000	9991.777629	8.2000 10 <sup>-4</sup>

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

DN T	VY	1.112	-11999.787765	-11995.968035	3.2000 10 <sup>-4</sup>
DN T	VY	2.224	-11999.151072	-11997.241190	1.6000 10 <sup>-4</sup>
DN T	VY	3.336	-11998.089956	-11998.089999	3.6200 10 <sup>-9</sup>
DN T	VY	4.448	-11996.604476	-11998.514416	1.6000 10 <sup>-4</sup>
DN T	VY	0.552	11996.604476	11983.240381	1.1100 10 <sup>-3</sup>
DN T	VY	1.664	11998.089956	11986.633730	9.5000 10 <sup>-4</sup>
DN T	VY	2.776	11999.151072	11989.603323	8.0000 10 <sup>-4</sup>
DN T	VY	3.888	11999.787765	11992.148996	6.4000 10 <sup>-4</sup>

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code Aster	Error
DL T	N	1.248	-9999.393620	-9993.735110	5.7000 10 <sup>-4</sup>
DL T	N	2.504	-9997.574577	-9999.191504	1.6000 10 <sup>-4</sup>
DL T	N	3.752	-9999.393620	-9998.585172	8.0000 10 <sup>-5</sup>
DL T	N	5.000	-10000.000000	-9996.766277	3.2000 10 <sup>-4</sup>
DL T	N	0.624	9999.848403	9995.402201	4.4000 10 <sup>-4</sup>
DL T	N	1.872	9998.635667	9991.765071	6.9000 10 <sup>-4</sup>
DL T	N	3.128	9998.635667	9999.039919	4.0000 10 <sup>-5</sup>
DL T	N	4.376	9999.848403	9997.827281	2.0000 10 <sup>-4</sup>
DL T	VY	0.528	-11996.604476	-11987.200624	7.8000 10 <sup>-4</sup>
DL T	VY	1.056	-11986.420924	-11993.139176	5.6000 10 <sup>-4</sup>
DL T	VY	1.576	-11989.602798	-11935.938745	4.4800 10 <sup>-3</sup>
DL T	VY	2.104	-11998.089956	-11960.496202	3.1300 10 <sup>-3</sup>
DL T	VY	2.632	-11999.787765	-11978.295684	1.7900 10 <sup>-3</sup>
DL T	VY	3.160	-11994.694715	-11989.321358	4.5000 10 <sup>-4</sup>
DL T	VY	3.688	-11982.815336	-11993.563417	9.0000 10 <sup>-4</sup>
DL T	VY	4.208	-11992.360779	-11942.710577	4.1400 10 <sup>-3</sup>
DL T	VY	4.736	-11999.151072	-11965.580354	2.8000 10 <sup>-3</sup>
DL T	VY	0.264	11999.151072	11981.687634	1.4600 10 <sup>-3</sup>
DL T	VY	0.792	11992.360779	11991.018087	1.1000 10 <sup>-4</sup>
DL T	VY	1.312	11982.815336	11921.132370	5.1500 10 <sup>-3</sup>
DL T	VY	1.840	11994.694715	11949.060995	3.8000 10 <sup>-3</sup>
DL T	VY	2.368	11999.787765	11970.241821	2.4600 10 <sup>-3</sup>
DL T	VY	2.896	11998.089956	11984.656002	1.1200 10 <sup>-3</sup>
DL T	VY	3.424	11989.602798	11992.290717	2.2000 10 <sup>-4</sup>
DL T	VY	3.944	11986.420924	11928.745876	4.8100 10 <sup>-3</sup>
DL T	VY	4.472	11996.604476	11954.989647	3.4700 10 <sup>-3</sup>

GROUP_MA	Urgent	Force	$F_{max}$ Reference	$F_{max}$ Code Aster	Error
DL TR	N	0.744	-9999.044546	-9999.470984	4.0000 10 <sup>-5</sup>
DL TR	N	1.480	-9999.802605	-9996.817553	3.0000 10 <sup>-4</sup>
DL TR	N	2.224	-9999.715749	-9999.076203	6.0000 10 <sup>-5</sup>
DL TR	N	2.960	-9999.210380	-9995.158563	4.1000 10 <sup>-4</sup>
DL TR	N	3.704	-9999.992104	-9998.286562	1.7000 10 <sup>-4</sup>
DL TR	N	4.448	-9998.862914	-9999.502566	6.0000 10 <sup>-5</sup>
DL TR	N	0.368	9999.494655	9995.869615	3.6000 10 <sup>-4</sup>
DL TR	N	1.112	9999.928938	9998.649810	1.3000 10 <sup>-4</sup>
DL TR	N	1.848	9998.665481	9993.973288	4.7000 10 <sup>-4</sup>
DL TR	N	2.592	9999.968417	9997.623183	2.3000 10 <sup>-4</sup>
DL TR	N	3.336	9999.360416	9999.360448	3.2700 10 <sup>-9</sup>
DL TR	N	4.072	9999.613099	9996.201410	3.4000 10 <sup>-4</sup>
DL TR	VY	0.608	-11998.787203	-11996.911403	1.6000 10 <sup>-4</sup>
DL TR	VY	1.216	-11995.148565	-11998.275608	2.6000 10 <sup>-4</sup>
DL TR	VY	1.816	-11998.465046	-11985.957996	1.0400 10 <sup>-3</sup>
DL TR	VY	2.424	-11999.981050	-11992.477381	6.3000 10 <sup>-4</sup>

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

DL TR	VY	3.032	-11999.071456	-11996.570344	2.1000 10 <sup>-4</sup>
DL TR	VY	3.640	-11995.736078	-11998.237714	2.1000 10 <sup>-4</sup>
DL TR	VY	4.240	-11998.104986	-11984.972404	1.0900 10 <sup>-3</sup>
DL TR	VY	4.848	-11999.924201	-11991.795175	6.8000 10 <sup>-4</sup>
DL TR	VY	0.304	11999.696804	11995.319766	3.6000 10 <sup>-4</sup>
DL TR	VY	0.912	11997.271148	11997.896667	5.0000 10 <sup>-5</sup>
DL TR	VY	1.512	11996.797368	11981.788000	1.2500 10 <sup>-3</sup>
DL TR	VY	2.120	11999.526256	11989.521062	8.3000 10 <sup>-4</sup>
DL TR	VY	2.728	11999.829453	11994.827102	4.2000 10 <sup>-4</sup>
DL TR	VY	3.336	11997.707020	11997.707196	1.4600 10 <sup>-8</sup>
DL TR	VY	3.936	11996.285679	11980.650645	1.3000 10 <sup>-3</sup>
DL TR	VY	4.544	11999.317806	11988.687185	8.9000 10 <sup>-4</sup>
DL TR	MFZ	0.408	-7499.978682	-7481.884175	2.4100 10 <sup>-3</sup>
DL TR	MFZ	0.816	-7499.914727	-7480.776804	2.5500 10 <sup>-3</sup>
DL TR	MFZ	1.224	-7499.808136	-7479.626886	2.6900 10 <sup>-3</sup>
DL TR	MFZ	1.632	-7499.658908	-7478.434426	2.8300 10 <sup>-3</sup>
DL TR	MFZ	2.040	-7499.467046	-7477.199431	2.9700 10 <sup>-3</sup>
DL TR	MFZ	2.448	-7499.232550	-7475.921906	3.1100 10 <sup>-3</sup>
DL TR	MFZ	2.856	-7498.955420	-7474.601855	3.2500 10 <sup>-3</sup>
DL TR	MFZ	3.264	-7498.635658	-7473.239285	3.3900 10 <sup>-3</sup>
DL TR	MFZ	3.672	-7498.273266	-7471.834203	3.5300 10 <sup>-3</sup>
DL TR	MFZ	4.080	-7497.868244	-7470.386613	3.6700 10 <sup>-3</sup>
DL TR	MFZ	4.488	-7497.420595	-7468.896524	3.8000 10 <sup>-3</sup>
DL TR	MFZ	4.896	-7496.930321	-7467.363940	3.9400 10 <sup>-3</sup>
DL TR	MFZ	0.208	7487.723239	7495.729902	1.0700 10 <sup>-3</sup>
DL TR	MFZ	0.616	7488.724793	7495.687289	9.3000 10 <sup>-4</sup>
DL TR	MFZ	1.024	7489.683761	7495.602065	7.9000 10 <sup>-4</sup>
DL TR	MFZ	1.432	7490.600137	7495.474228	6.5000 10 <sup>-4</sup>
DL TR	MFZ	1.840	7491.473918	7495.303780	5.1000 10 <sup>-4</sup>
DL TR	MFZ	2.248	7492.305101	7495.090722	3.7000 10 <sup>-4</sup>
DL TR	MFZ	2.656	7493.093681	7494.835054	2.3000 10 <sup>-4</sup>
DL TR	MFZ	3.064	7493.839654	7494.536778	9.0000 10 <sup>-5</sup>
DL TR	MFZ	3.472	7494.543018	7494.195895	5.0000 10 <sup>-5</sup>
DL TR	MFZ	3.880	7495.203770	7493.812405	1.9000 10 <sup>-4</sup>
DL TR	MFZ	4.288	7495.821906	7493.386312	3.2000 10 <sup>-4</sup>
DL TR	MFZ	4.696	7496.397424	7492.917617	4.6000 10 <sup>-4</sup>

GROUP_MA	Direction	Time	Energy Reference	Energy Code_Aster	Error
DN TR	DX	5.0	7446.992455	7446.069540	-1.2000 10 <sup>-4</sup>
DN TR	DY	5.0	15922.438890	15916.906995	-3.5000 10 <sup>-4</sup>
DN TR	RZ	5.0	11889.988830	11889.167409	-7.0000 10 <sup>-5</sup>
DN T	DX	5.0	7499.743876	7496.962917	-3.7000 10 <sup>-4</sup>
DN T	DY	5.0	4735.953639	4734.984481	-2.0000 10 <sup>-4</sup>
DL TR	DX	5.0	10053.439810	10051.029314	-2.4000 10 <sup>-4</sup>
DL TR	DY	5.0	12113.905900	12108.698784	-4.3000 10 <sup>-4</sup>
DL TR	RZ	5.0	5887.444214	5880.378840	-1.2000 10 <sup>-3</sup>
DL T	DX	5.0	4842.766985	4842.049192	-1.5000 10 <sup>-4</sup>
DL T	DY	5.0	16663.540580	16648.347389	-9.1000 10 <sup>-4</sup>



## 5 Summary of the results

---

These tests make it possible to check the correct operation of discrete elements 2D and 3D with behavior DIS\_VISC with the use of STAT\_NON\_LINE.

Certain variations (remainder weak) come from the rather coarse discretization in time of the process of loading.