PLEXU08 - Validation of the new features of CALC_EUROPLEXUS

Summary:

At the time of the building site of recasting of CALC_EUROPLEXUS new features were added to the macro-order. The list of these additions is the following one:

- new law of behavior: VMIS_ISOT_TRAC,
- new loading: imposed displacements (DDL_IMPO) others that blockings,
- new modeling: 3D on meshs support HEXA8 and TETRA4.

Other features were also added since:

- loading of pressure on the faces of elements 3D (PRES_REP/PRES)
- loading FORCE_NODALE
- new modeling: 3D_IF on mesh support HEXA8.

The purpose of this test is to validate the good performance of these additional features.

1 Modeling A

1.1 Goal

The goal of this test is to validate the use of the behavior VMIS_ISOT_TRAC in CALC_EUROPLEXUS.

1.2 Description

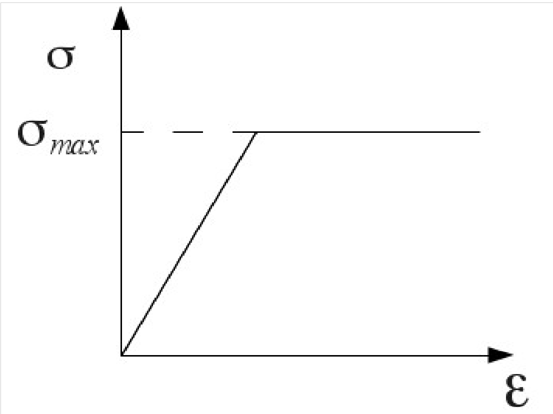
One takes again the elementary grid, model, characteristics and the loadings of the test plexu03a. Only the affected material with the elements of BAR is modified to activate the law VMIS_ISOT_TRAC. One keeps an elastic behavior for the hulls.

One points out the elastic properties of materials:

Material	Concrete	Steel
Young modulus	$E_b=3.0^{10}\ Pa$	$E_a=2.1.10^{11}\ Pa$
Poisson's ratio	$\nu_b=0.3$	$\nu_a=0.3$
Density	$m_b=2500\ Kg/m^3$	$m_a=7500\ Kg/m^3$

and the surface of the cross-section of the cable: $S_a=1{,}5.10^{-4} m^2$.

The forced curve/deformation induced by the material Steel and behavior VMIS_ISOT_TRAC is following form:



With $\sigma_{max}=1E6$.

1.3 Principle of validation

With the behavior ELAS on all the model, the constraint exceeds the ultimate stress σ_{max} during the application of the loading. To make sure of the good taking into account of the law VMIS_ISOT_TRAC during the execution of CALC_EUROPLEXUS, it is checked that the constraint in the elements of BAR do not exceed this ultimate stress.

For that one prints in a table using the keyword CURVE of CALC_EUROPLEXUS the value of the constraint on the 3rd element of BAR. One proceeds then to one TEST_TABLE/TYPE_TEST=' MAX', to check that the maximum value is well the ultimate stress.

One also wishes to validate the good recovery of the internal variables. On the 5 internal variables of law EPX, only the 3rd component with a direct correspondence in those of Aster. It thus should be checked that this 3rd variable is well placed in the component V1 of VARI_ELGA (EPSPEQ). For that one prints, using the keyword CURVE, the component V3 internal variables of the 3rd element of BAR in the same table as previously. One checks then by one TEST_RESU that this value is well that found in the field VARI_ELGA result of exit.

Note: the V2 component (INDIPLAS) is left to zero because it is too complicated to rebuild it (it also depends on moment T-1).

1.4 Values tested

The first test is carried out on the values resulting from the table, i.e. the values given by EPX without Forced transformation/effort.

Mesh	NUME_ORDRE	Component	Type of reference	Value of reference	Tolerance
SG001003	MAX	N	'ANALYTICAL'	$1.\ 10^{6}$	0.1 %
SG001003	100	$V1$	'AUTRE_ASTER'	1.6214E-05	0.1 %

2 Modeling B

2.1 Goal

The goal of this test is to validate the use of the displacements imposed (others that blockings) in CALC_EUROPLEXUS.

2.2 Description

One takes again the test plexu03a by preserving only the cable in the model.

Degrees of freedom DY and DZ of the 5 nodes present are blocked. Displacements are imposed in DX on the 5 nodes also so that there is no dynamic effect (what makes it possible to have a reference solution with STAT_NON_LINE).

Node	DX
NC001001	0
NC001002	0.025
NC001003	0.05
NC001004	0.075
NC001005	0.1

2.3 Principle of validation

One tests displacements in DX on several nodes at the end of the loading.

2.4 Values tested

Node	Component	Type of reference	Value of reference	Tolerance
NC001005	DX	'AUTRE_ASTER'	0.1	0.1 %
NC001003	DX	'AUTRE_ASTER'	0.05	0.1 %

Mesh	Component	Type of reference	Value of reference	Tolerance
SG001003	N	'AUTRE_ASTER'	1428571.42857	2.5 %

One obtains expected displacements well what means that the loading was correctly taken into account. The difference on the level as of constraints is due unlike kinematics between Code_Aster and EPX. Indeed Code_Aster does not have kinematics GROT_GDEP for modeling BAR, one thus uses PETIT_REAC.

3 Modeling C

3.1 Goal

The goal of this test is to validate the use of modeling 3D on mesh support HEXA8 in CALC_EUROPLEXUS. It is already possible in EPX not to read a state of initial stress on the elements corresponding. One will use and validate thus also this functionality which was immediately activated in CALC_EUROPLEXUS.

3.2 Description

This test is the equivalent of CAS-test EPX bm_cub8_ini_med_cont.

It is about a cube formed by only one element. The lower face is embedded and one applies a loading (imposed displacement) to the higher face. This calculation is done with the operator STAT_NON_LINE in order to produce an initial state for calculation EPX.

One launches then CALC_EUROPLEXUS with this initial state (displacements + forced) and without additional loading that those having allowed to obtain the initial state. One then expects that EPX obtains a balanced initial state. A hundred steps of time are carried out. One recovers the result and one checks that nothing moved compared to the initial state.

3.3 Principle of validation

Comparison with the initial state.

3.4 Values tested

Node	Component	Type of reference	Value of reference	Tolerance
N8	*DX*	'AUTRE_ASTER'	2.15537139042198E-03	1E-6
N7	*DY*	'AUTRE_ASTER'	-2.15537139042198E-03	1E-6
N6	*DZ*	'AUTRE_ASTER'	1.E-02	1E-6

Mesh	Component	Not	Type of reference	Value of reference	Tolerance
M1	*SIXX*	1	'AUTRE_ASTER'	1.20270859098697E+08	1E-6
M1	*SIYY*	2	'AUTRE_ASTER'	-2.15863269903220E+07	1E-6
M1	*SIZZ*	3	'AUTRE_ASTER'	3.78842807394021E+08	1E-6
M1	*SIXY*	4	'AUTRE_ASTER'	-3.58270324318444E+04	1E-6
M1	*SIXZ*	5	'AUTRE_ASTER'	-1.48252765464761E+07	1E-6
M1	*SIYZ*	6	'AUTRE_ASTER'	1.47199039729651E+07	1E-6

4 Modeling D

4.1 Goal

The goal of this test is to validate the use of modeling 3D on mesh support TETRA4 in CALC_EUROPLEXUS. It is already possible in EPX not to read a state of initial stress on the elements corresponding. One will use and validate thus also this functionality which was immediately activated in CALC_EUROPLEXUS.

4.2 Description

This test is the equivalent of CAS-test EPX bm_tetr_ini_med_cont.

Same stages as modeling C.

4.3 Principle of validation

Comparison with the initial state.

4.4 Values tested

Node	Component	Type of reference	Value of reference	Tolerance
N2	*DX*	'AUTRE_ASTER'	2.19188002660453E-033	1E-6
N5	*DY*	'AUTRE_ASTER'	5.81721432580442E-04	1E-6
N5	*DZ*	'AUTRE_ASTER'	-2.43970568218930E-03	1E-6

Mesh	Component	Not	Type of reference	Value of reference	Tolerance
M1	*SIXX*	1	'AUTRE_ASTER'	1.33476658397901E+07	1E-6
M1	*SIYY*	1	'AUTRE_ASTER'	1.32759870309648E+07	1E-6
M1	*SIZZ*	1	'AUTRE_ASTER'	3.09327863977736E+07	1E-6
M2	*SIXY*	1	'AUTRE_ASTER'	1.20735966805089E+07	1E-6
M2	*SIXZ*	1	'AUTRE_ASTER'	2.29556551673508E+07	1E-6
M2	*SIYZ*	1	'AUTRE_ASTER'	-7.54657118237435E+06	1E-6

5 Modeling E

5.1 Goal

The goal of this test is to validate the use of the surface loading of pressure on faces of elements 3D (PRES_REP/PRES).

5.2 Description

A cube of with dimensions $1m$ composed of 27 meshs HEXA8 is embedded on its lower face and one applies a pressure to the higher face like to a side face.

Except what has just been specified one follows the same stages as modeling C.

5.3 Principle of validation

Comparison with the initial state.

5.4 Values tested

Node	Component	Type of reference	Value of reference	Tolerance
GRN1	DX	'AUTRE_ASTER'	-9.07102694457E-06	5th-5
GRN1	DY	'AUTRE_ASTER'	-6.54472368612E-07	5th-5
GRN1	DZ	'AUTRE_ASTER'	-6.2234063541E-06	5th-5

Mesh	Component	Not	Type of reference	Value of reference	Tolerance
M93	$SIXX$	1	'AUTRE_ASTER'	-90491.3795116	5th-5
M93	$SIYY$	1	'AUTRE_ASTER'	-4495.07212071	1E-4
M93	$SIZZ$	1	'AUTRE_ASTER'	-92662.5352308	5th-5

6 Modeling F

6.1 Goal

The goal of this test is to validate the use of the loading of nodal forces (FORCE_NODALE).

6.2 Description

A cube of with dimensions $1\mathrm{m}$ composed of 27 meshs HEXA8 is embedded on its lower face and one applies forces to the nodes of the face higher (according to Z) like than the nodes of a side face (according to X).

Except what has just been specified one follows the same stages as modeling C.

6.3 Principle of validation

Comparison with the initial state.

6.4 Values tested

Node	Component	Type of reference	Value of reference	Tolerance
GRN1	DX	'AUTRE_ASTER'	-8.6090494774E-05	1E-6
GRN1	DY	'AUTRE_ASTER'	-1.86758056933E-05	1E-6
GRN1	DZ	'AUTRE_ASTER'	-0.000110181067659	1E-6

Mesh	Component	Not	Type of reference	Value of reference	Tolerance
M93	$SIXX$	1	'AUTRE_ASTER'	-1220186.68329	1E-6
M93	$SIYY$	1	'AUTRE_ASTER'	-71707.7384702	1E-6
M93	$SIZZ$	1	'AUTRE_ASTER'	-2036191.89547	1E-6

7 Modeling G

7.1 Goal

The goal of this test is to validate the use of elements 3D_SI on mesh support HEXA8 with an initial state of displacement and constraint and with a loading of pressure applied (PRES_REP/PRES).

7.2 Description

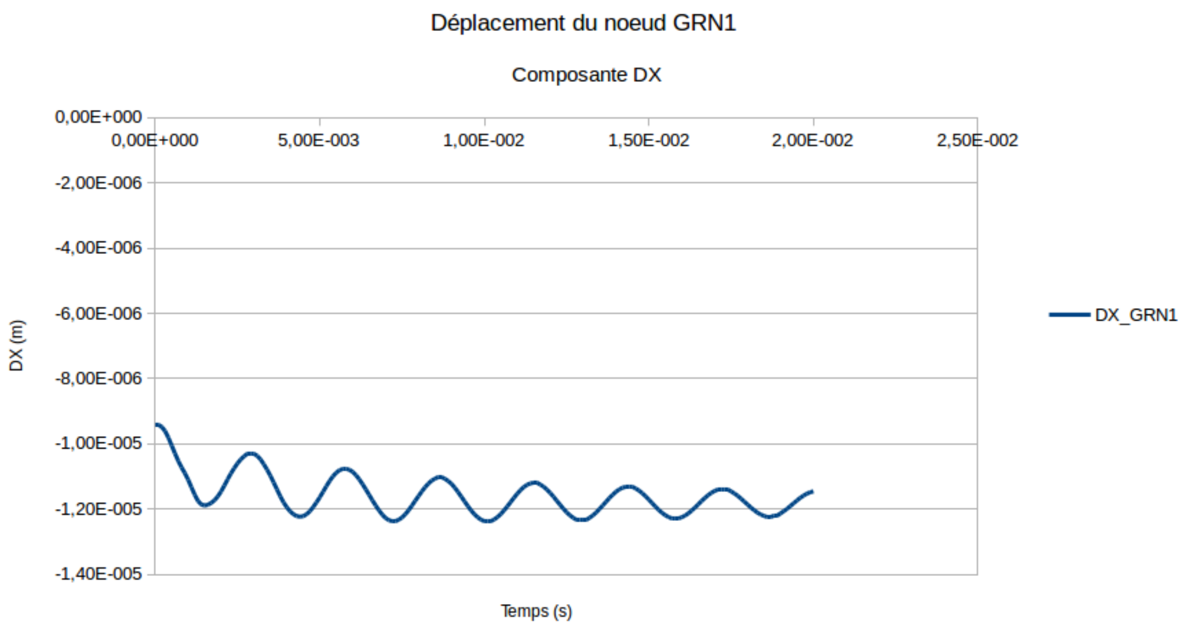
This modeling is a copy of the modeling E in which one replaced modeling 3D by 3D_SI.

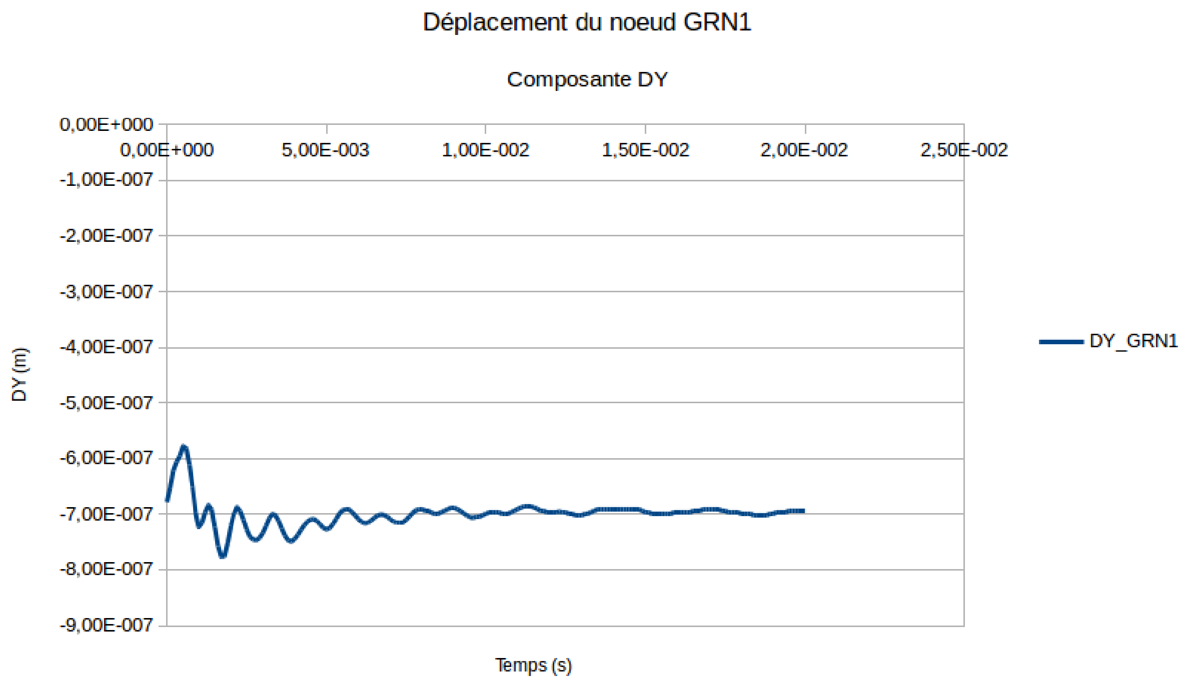
However for modeling 3D_SI, differences exist between Code_Aster and EPX. That causes that the static initial state to send to EPX (with only loading that already applied) does not give a state balanced in EPX. The validation is thus a little different.

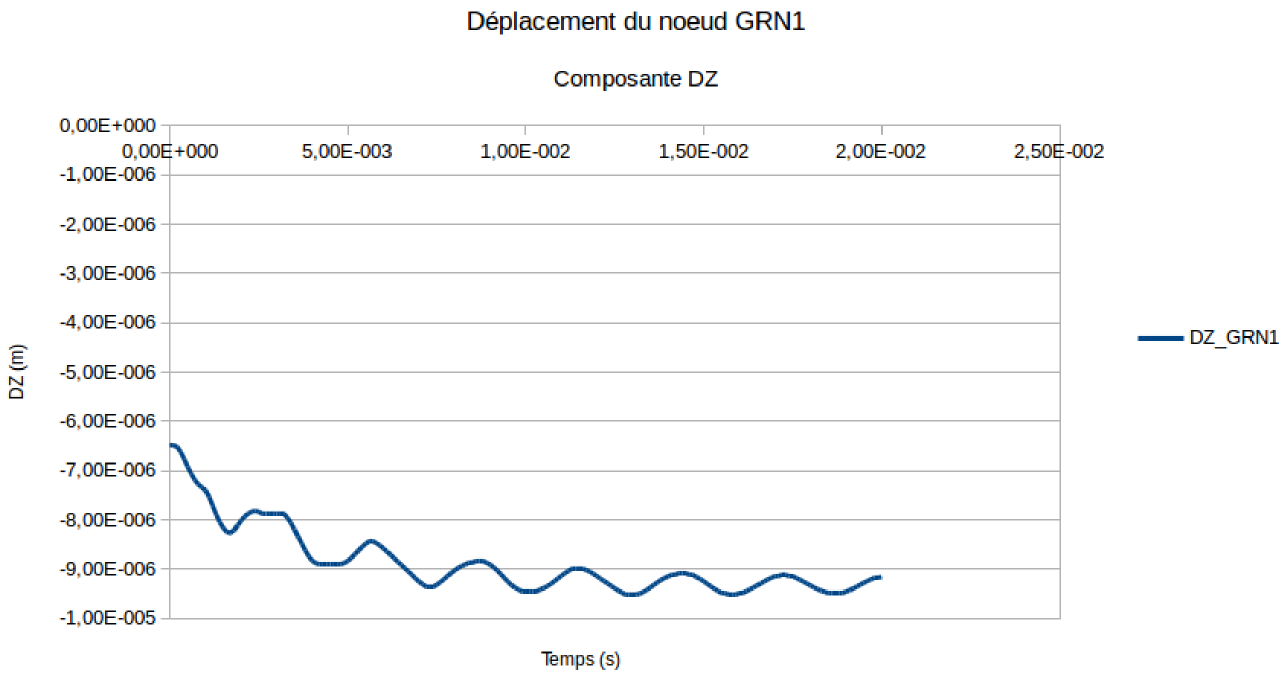
One launches the first calculation by activating balancing (EQUI=' OUI'). So at the exit of this calculation one finds the values of displacement and of constraint of entry then the good taking into account of the initial state will be shown for 3D_SI.

One launches then one second calculation without activating balancing (EQUI=' NON'). One visualizes the curves of displacement of node GRN1 in order to note that imbalance is limited enough. This calculation makes it possible qualitatively to validate the good taking into account of the loading of pressure and to note that models Code_Aster and EPX are not too distant one from the other and that it is thus coherence to use a Code_Aster-EPX chaining with these elements if balancing is activated.

The following figures show displacements of node GRN1 in the 3 directions of space:







7.3 Principle of validation

Comparison with the initial state.

7.4 Values tested

Calculation with EQUI=' OUI':
Final moment 4th-3

Node	Component	Type of reference	Value of reference	Tolerance
GRN1	*DX*	'AUTRE_ASTER'	-9.42600991306E-06	5th-5
GRN1	*DY*	'AUTRE_ASTER'	-6.78188286688E-07	5th-5
GRN1	*DZ*	'AUTRE_ASTER'	-6.47139874604E-06	5th-5

Mesh	Component	Not	Type of reference	Value of reference	Tolerance
M93	*SIXX*	1	'AUTRE_ASTER'	-88191.2920113	5th-5
M93	*SIYY*	1	'AUTRE_ASTER'	-4298.28256544	1E-4
M93	*SIZZ*	1	'AUTRE_ASTER'	-89716.486396	5th-5

Calculation with EQUI=' NON':
Final moment 2nd2

Node	Component	Type of reference	Value of reference	Tolerance
GRN1	*DX*	'AUTRE_ASTER'	-9.42600991306E-06	22 %
GRN1	*DY*	'AUTRE_ASTER'	-6.78188286688E-07	2,5 %
GRN1	*DZ*	'AUTRE_ASTER'	-6.47139874604E-06	42 %

Mesh	Component	Not	Type of reference	Value of reference	Tolerance
M93	*SIXX*	1	'AUTRE_ASTER'	-88191.2920113	0.015 %
M93	*SIYY*	1	'AUTRE_ASTER'	-4298.28256544	100 %
M93	*SIZZ*	1	'AUTRE_ASTER'	-89716.486396	2,5 %

8 Conclusion

The tests show that the various features are well taken into account by CALC_EUROPLEXUS.

Attention however with the use of modeling 3D_SI with an initial state, because modeling EPX is not completely equivalent to the modeling of Code_Aster. It is necessary to put the keyword EQUI with YES in this case.