PLEXU09 – Validation of VMIS_JOHN_COOK in CALC_EUROPLEXUS

Summary:

This test validates the use of the law of behavior VMIS_JOHN_COOK in CALC_EUROPLEXUS. It also validates the functionality VARI_INT = ' OUI' of ETAT_INIT and the use apart from CALC_EUROPLEXUS macro-order LIRE_EUROPLEXUS.

Modeling a: reproduction of the test EPX bm_ini_med_ecro_vmjc which validates the taking into account of internal variables in initial state (resulting from Code_Aster) for the law VMIS_JOHN_COOK (VMJC of EPX).

Modeling b: test of nonregression to validate the good translation of the parameters materials.

1 Details on the transformations of the internal variables for law VMIS_JOHN_COOK

1.1 Description

One notes the internal variables of Code_Aster with the suffix V and the internal variables of EPX with followed suffix ECR by the number of component.

1.1.1 Code_Aster

The law VMIS_JOHN_COOK in Code_Aster has 5 internal variables.

V1	EPSPEQ	Equivalent plastic deformation (deviatoric) cumulated
V2	INDIPLAS	Indicator of plasticity (0: threshold unfulfilled, 1 or > 1: threshold reached)
V3	DEPSPEQ	Increment of equivalent plastic deformation
V4	DINSTM	Increment of time
V5	DDISSM	Speed of dissipation mechanical

1.1.2 EPX

Law VMJC of EPX has 8 internal variables. Here information resulting from the documentation of EPX:

ECR1	current hydrostatic presses
ECR2	current equivalent stress (Von Mises)
ECR3	current equivalent plastic strain
ECR4	current yield stress
ECR5	sound speed
ECR6	disastrous strain equivalent (Von Mises)
ECR7	failure flag (0=virgin Gauss Not, 1=failed Gauss Not)
ECR8	ramming parameter for the Johnson-Cook criterion

1.2 Passage Code_Aster towards EPX

1.2.1 ECR1

One calculates the trace of the matrix of the constraints thanks to CALC_CHAMP/CHAM_UTIL/CRITERE = 'TRACE'at once SIEF_ELGA. The value obtained for each point of Gauss is then divided by 3 to obtain $ECR1$.

1.2.2 ECR2

$ECR2$ corresponds to the component $VMIS$ field SIEQ_ELGA.

1.2.3 ECR3

$ECR3$ corresponds to the component $V1$ field VARI_ELGA.

1.2.4 ECR4

$ECR4$ corresponds to the component $VMIS$ field SIEQ_ELGA, value to which one adds one $epsilon$ equal to $10\text{E-}6$. This choice was made within the framework of the thesis of Emricka Julan. It allows that calculations with law VMJC of EPX functions with the initial state given.

1.2.5 ECR5

$ECR5$: value put at $0.$ because calculated completely by EPX at every moment.

1.2.6 ECR6

This value corresponds at a speed of deformation which is always worthless at exit of a static calculation. It is thus put at $0.$ because it is not envisaged to give an initial state resulting from a dynamic calculation to CALC_EUROPLEXUS.

1.2.7 ECR7 and ECR8

These two variables relate to only the breaking process. They are put at $0.$.

1.3 Passage EPX towards Code_Aster

The transformations at the time of this passage can be made only starting from values present in the field of internal variables resulting from EPX.

For this law, the transformation only consists in putting the component $ECR3$ in $V1$ and to put the 4 other components at $0.$.

2 Modeling A

2.1 Goal

The goal of this test is to validate sends it and the transformation (for law VMIS_JOHN_COOK) of a field of internal variables into initial state of a calculation EPX via CALC_EUROPLEXUS. It also validates the transformation of the internal variables in direction EPX towards Code_Aster for the law VMIS_JOHN_COOK and the use of LIRE_EUROPLEXUS apart from CALC_EUROPLEXUS.

2.2 Description

This test is the equivalent of “bench” EPX bm_ini_med_ecro_vmjc.

It is about a cube formed by only one element. The lower face is embedded and one applies a loading (displacement imposed according to X) 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 + variable interns) and without additional loading that those having allowed to obtain the initial state.

It is checked whereas the initial internal variables and in final state are well the same ones as in bm_ini_med_ecro_vmjc thanks to the keyword CURVE (and with TEST_TABLE) and that the internal variables recovered by Code_Aster at the end of the calculation are well those expected.

The internal variables should not normally evolve since that no additional loading was added. However, certain components which do not depend on the computed values are recomputed completely by EPX with each iteration. It is the case of ECR5.

2.3 Principle of validation

Comparison with the case analytical test EPX or references.

2.4 Values tested

In this first table of the numbers of the internal variables are those of EPX.

Mesh	Moment	Component	Not	Value of reference	Tolerance
M1	0.	$V1=ECR1$	1	4.078819E+2	1E-4
M1	0.	$V2=ECR2$	2	1.420337E+2	1E-4
M1	0.	$V3=ECR3$	3	5.773488E-3	1E-4
M1	0.	$V4=ECR4$	4	1.561430E+2	1E-4
M1	0,004	$V1=ECR1$	1	4.078819E+2	1E-4
M1	0,004	$V2=ECR2$	2	1.420337E+2	1E-4
M1	0,004	$V3=ECR3$	3	5.773488E-3	1E-4
M1	0,004	$V4=ECR4$	4	1.561430E+2	1E-4
M1	0,004	$V5=ECR5$	5	4019.1847623425019	1E-4

One tests then the value of the internal variables in the Aster result at exit of CALC_EUROPLEXUS.

Mesh	Moment	Component	Not	Value of reference	Tolerance
M1	0.	$V1$	3	5.773488E-3	1E-4
M1	0,004	$V1$	3	5.773488E-3	1E-4

Finally one tests the value of the internal variables in the Aster result at exit of LIRE_EUROPLEXUS.

Mesh	Moment	Component	Not	Value of reference	Tolerance
M1	0.	$V1$	3	5.773488E-3	1E-4
M1	0,004	$V1$	3	5.773488E-3	1E-4

3 Modeling B

3.1 Goal

Modeling A does not make it possible to make sure that the parameters materials were translated correctly. The goal of this test is to supplement that.

3.2 Description

On the same model which modeling A, one applies a pressure to the higher face of the cube sufficiently strong to leave the elastic part of the law. Calculation is launched without initial state.

3.3 Principle of validation

After having checked that the translation of the parameters materials was well made in the command file EPX created, one applies tests of not-regression to this calculation.

3.4 Values tested

Mesh	Component	Not	Value of reference	Tolerance
M1	*SIXX*	1	-150717574.84	1E-6
M1	*SIYY*	3	-150717574.84	1E-6
M1	*SIZZ*	5	-150729740.85	1E-6

4 Conclusion

The tests made it possible to show that:

- the law VMIS_JOHN_COOK was well taken into account,
- a field of internal variables could be sent besides the fields of displacements and constraints in the initial state,
- the transformation of the internal variables of Code_Aster towards EPX was in conformity with the request,
- the transformation of the internal variables of EPX towards Code_Aster also,
- the use of LIRE_EUROPLEXUS apart from CALC_EUROPLEXUS is operational.