
Procedure TEST_COMPOR

1 Drank

This macro-command makes it possible to test the mechanical constitutive laws from the point of view of the robustness and reliability:

- in the mechanical case, the test implements a simulation of a way of multiaxial loading on a material point, with an aim of checking the robustness of the numerical integration of the behaviors tested, of their insensitivity compared to a change of units, invariance of result compared to a total rotation applied to the problem, the accuracy of the tangent matrix;
- in the case as of command variables (temperature,...) this test checks the good taking into account of the command variables whose the coefficients depend on the model, as well as the terms of strain which result from it.

2 Syntax

```

TEST_COMPOR (
  ◊OPTION=/          "THER",
  [DEFAULT]
                    /"MECA",
  ◊/COMP_INCR       =_F (see the document [U4.51.11] ),
    /COMP_ELAS      =_F (see the document [U4.51.11] ),

  ◊ NEWTON           =_F ( see the document [U4.51.03]),

  ◊ CONVERGENCE     =_F ( see the document [U4.51.03]),

  if OPTION = "THER" tion

    ◊MATER=mater          ,                               [to
subdue]
    ◊LISTE_MATER=mater    ,
[l_mater]
    ◊ ALPHA=alpha        ,
[function]
    ◊ YOUNG=young        ,
[function]
    ◊          TEMP_INIT=temp_init      ,               [R]
    ◊          TEMP_FIN=temp_fin      ,               [R]
    ◊          NB_VARI=nb_vari      ,               [I]
  ◊ SUPPORT              = "POINT"      [DEFAULT]
                                /"ELEMENT"

    ◊INST_FIN=temp_fin      ,               [R]
    ◊VARI_TEST=vari_test    ,               [kN]
    ◊D_SIGM_EPSI=d_sigm_epsi      ,

[function]
    ◊C_PRAG=c_prag        ,

[function]

  if OPTION = "MECA"
    ◊LISTE_MATER=mater      ,
    ◊ POISSON=poisson      ,                               [R]
    ◊ YOUNG=young          ,                               [R]
    ◊LISTE_NPAS=liste_npas    ,               [l_I]
    ◊LISTE_TOLE=liste_tole    ,               [l_R]
    ◊PREC_ZERO=prec_zero     ,               [l_R]
    ◊VARI_TEST=vari_test     ,               [kN]
  ◊ SUPPORT                = /"POINT"
[DEFAULT]
                                /"ELEMENT"
  ◊ MODELISATION=/        "3D"
  [DEFAULT]
                                /"C_PLAN"
  ◊MASSIF                  = "ANGL_REP"      [R]
                                /"ANGL_EULER"  [R]
  ◊ ANGLE                    =angz ,          [R]
  ◊ VERI_MATR_OPTION=_F (
    ◊ VALE_PERT_RELA=      [R]
    ◊ PRECISION=          [R]
    ◊ PREC_ZERO=          [R]
  ),

```

◇INFO =/1 /2 , ' [DEFAULT]
)

3 Operands

3.1 Key words COMP_INCR/COMP_ELAS/NEWTON/CONVERGENCE

the syntax of these key keys is described in the document [U4.51.11].

3.2 OPTION= ' THER''

thermomechanical Test allowing to validate the taking into account of the variation in temperature in the constitutive laws (cf V6.07.108). These tests make it possible to check the two following points:

- Thermal thermal expansion is well calculated (with taking into account of the variation of thermal thermal expansion with the temperature)
- the variation of the coefficients material with the temperature is correct, in particular in the incremental resolution of the behavior.

It is about a double simulation, the first in thermomechanics, the second in pure mechanics. The first will be validated in comparison with the second, by supposing of course that the behavior tested provides a correct solution in pure mechanics.

The first simulation (solution which one seeks to validate) consists in applying a temperature variation to a material point, by blocking for example the strains according to $\varepsilon_{xx} = 0$. The imposed temperature is increasing linearly according to time.

The second simulation (which must be equivalent to the first) consists in applying to the same material point a strain imposed according to $\varepsilon_{xx} = -\varepsilon^{th} = -\alpha(T)(T - T_{ref})$, in pure mechanics. Indeed, for any behavior (while supposing the additive decomposition of the strains):

$$\sigma_{xx} = E(T)(\varepsilon_{xx} - \varepsilon^{th} - \varepsilon_{xx}^p)$$

in the first case $\sigma_{xx} = E(T)(0 - \varepsilon^{th} - \varepsilon_{xx}^p)$, and the second: $\sigma_{xx} = E(T)(\varepsilon - \varepsilon_{xx}^p)$.

It is thus enough, at every moment to apply, for mechanical computation $\varepsilon_{xx} = -\varepsilon^{th} = -\alpha(T)(T - T_{ref})$.

Moreover, to get the same results in both cases, it is necessary, with each time step of the second simulation, to carry out pure mechanical computation with coefficients whose values are interpolated according to the temperature at time running (operand list_mater).

3.2.1 Operand MATER

◆ `MATER =mater,`

This key word makes it possible to inform the name of the material (to subdue) definite by `DEFI_MATERIAU` [U4.43.01], where are provided the parameters necessary to the behavior chosen, functions of the temperature.

3.2.2 Operand LIST_MATER

◆ `LIST_MATER =liste_mater,`

This key word makes it possible to inform a list of materials (`liste_mater`), defined by `DEFI_MATERIAU` [U4.43.01], whose constant parameters correspond to those of subduing, interpolated according to the temperature.

3.2.3 Operands ALPHA/YOUNG

- ◆ ALPHA=alpha , [function]
- ◆ YOUNG=young , [function]

These key word make it possible to inform the Young modulus and the thermal coefficient of thermal expansion functions of the temperature, in order to calculate the corresponding thermal strains and the forced.

3.2.4 Operands TEMP_INIT /TEMP_FIN / INST_FIN

- ◆ TEMP_INIT=temp_init , [R]
- ◆ TEMP_FIN=temp_fin , [R]
- ◇ INST_FIN=temp_fin , [R]

These key word make it possible to inform the temperatures initial and final, as well as the instant final one transient (corresponding with temp_fin), being worth 1. by default.

3.2.5 Operands NB_VARI/VARI_TEST

- ◆ NB_VARI=nb_vari , [I]
- ◇ VARI_TEST=vari_test , [kN]

These key word make it possible to inform the number of local variables of the behavior chosen, as well as the local variables to be tested (by default, all the local variables are tested).

3.2.6 Operands D_SIGM_EPSI /C_PRAG

- ◇ D_SIGM_EPSI=d_sigm_epsi , [function]
- ◇ C_PRAG=c_prag , [function]

In the cas particulier of behaviors with linear kinematic hardening, these key keys make it possible to define the hardening slope kinematical according to the temperature. This slope is worth:

- d_sigm_epsi for the behavior VMIS_CINE_LINE,
- c_prag for behaviors VMIS_ECMI_LINE, VMIS_ECMI_TRAC.

3.2.7 Operand SUPPORT

- ◇ SUPPORT = "POINT" [DEFAULT]
/ "ELEMENT"

See [U4.51.12]

3.3 OPTION = "MECA"

mechanical Test pure, which implements a simulation of a way of loading in strains in a material point, i.e. on a model such as the stress states and of strains are homogeneous at any moment. It thus makes it possible to test a certain number of models of behavior, with an aim of checking the robustness of their numerical integration, their insensitivity compared to a change of units, invariance compared to a total rotation applied to the problem, the accuracy of the tangent matrix. This test proceeds, for each modelization, with an intercomparison between the reference solution (obtained with one time step very fine), the solution with a fairly coarse discretization, the solution with effect of the temperature (or another command variable), the solution by changing the system of units (Pa into MPa), and that obtained after rotation or symmetry (see the document [v6.07.101]).

3.3.1 Operand LIST_MATER

◆ LIST_MATER =liste_mater ,

This key word makes it possible to inform a list of 2 materials (`liste_mater`), defined by `DEFI_MATERIAU [U4.43.01]`, whose constant parameters are evaluated either in *Pa* , or in *Mpa* .

3.3.2 Operands POISSON /YOUNG

◆ POISSON=poisson , [R]
◆ YOUNG=young , [R]

These key word make it possible to inform the Young modulus and the Poisson's ratio.

3.3.3 Operands LIST_NPAS/LIST_TOLE

◇LISTE_NPAS=liste_npas , [l_I]
◇LISTE_TOLE=liste_tole , [l_R]

These key word make it possible to inform the discretization in time and the corresponding tolerances.

By default, `list_npas=[1,1,1,1,1,5,25]` (4 problems "equivalent" with the coarsest discretization, is 1 increment by segment of loading, then variation of the discretization: 1 then 5 then 25 increments per segment).

By default `list_tole=4×[1.E-10]+[1.E-1]+2*[1.E-2]+[1.E-8]` . The accuracy necessary for the problems equivalent is voluntarily very small (if not there is a risk of bug). The following precise details are looser, since the comporements are in general sensitive to the discretization in time. The denière value is the tolerance on the tangent matrix.

3.3.4 Operand PREC_ZERO

◇PREC_ZERO=prec_zero , [l_R]

This key word make it possible to provide one zero "numerical" for each variable tested, in order to calculate a significant relative error. `prec_zero` thus has the same length as `vari_test`. By default this list is worth: $3 \times 1.E-10$.

3.3.5 Operand VARI_TEST

◇VARI_TEST=vari_test , [kN]

List of the components tested, presumedly invariant in the problem equivalents (rotation, change of unit). By default `vari_test = ("V1", VMIS', "TRACE")` .

3.3.6 Operand SUPPORT

◇ SUPPORT = "POINT" [DEFAULT]
/ "ELEMENT"

See [U4.51.12]

3.3.7 Key word MODELISATION

key word `MODELISATION` allows, in case `SUPPORT=' ELEMENT'` , 3D to carry out computation on an element or an element 2D, in plane stresses. It is not available in case `SUPPORT=' POINT'` , because it is enough to zero impose a value on the components corresponding to the plane stresses or the plane strains to obtain the same one result.

3.3.8 Key word ANGLE

This key word makes it possible to specify an angle (in degrees) to carry out an overall rotation around Z applied at the same time to the loading, the mesh, and the examination. This especially makes it possible to check the reliability of the integration of the behavior, as in tests COMP001, COMP002. By default, rotation is identically null.

In the case of materials having an intrinsic directional sense (orthotropy, behaviors crystalline), it is advisable to also use key word MASSIF, with a first value of angle identical to that provided under ANGLE.

3.3.9 Key word MASSIF / ANGL_EULER/ANGL_REP

These key word make it possible to lay down an intrinsic directional sense in the material (orthotropy, behaviors crystalline), and make it possible to appeal to the key word in macro-command MASSIF of AFFE_CARA_ELEM [U4.42.01].

By default, the directional sense is null, and one does not call on AFFE_CARA_ELEM.

3.3.10 Key word VERI_MATR_OPTION

This key word is used to gather the operands which manage the behavior of TEST_COMPOR during the checking of the analytical tangent matrix with that obtained by numerical disturbance.

3.3.11 Operand VALE_PERT_RELA

◇ VALE_PERT_RELA= [R]

Makes it possible to define the value of the numerical relative disturbance which intervenes in the computation of the disturbed matrix. For more detail to refer to [U4.51.11].

3.3.12 Operand accuracy

◇ PRECISION= [R]

the operand accuracy makes it possible to define the value in the top of which it is considered that the analytical matrix and the disturbed matrix are different.

3.3.13 Operand PREC_ZERO

◇ PREC_ZERO= [R]

Below PREC_ZERO, one does not compare the values of the terms of the tangent matrix. That makes it possible to manage the situations where the terms of the disturbed tangent matrix are very close to zero.

3.4 Operand INFO

Specifies the detail of the information printed in the message file.

In mode INFO=2, one prints all the arrays produced by SIMU_POINT_MAT.

4 Example

4.1 OPTION=' MECA '

See tests COMP001 [V6,07,101] , COMP002 [V6,07,102]

Titre : Procédure TEST_COMPOR
Responsable : Jean-Michel PROIX

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```
#unities out of Pa
ACIER [0] =DEFI_MATERIAU (ELAS=_F (E=YOUNG_Pa,
                                NU=POISSON,
                                ALPHA=11.8e-6),
                        ECRO_LINE=_F (D_SIGM_EPSI=pente_Pa,
                                      SY=SY_Pa,,));

#unities in MPaACIER
[1] =DEFI_MATERIAU (ELAS=_F (E=YOUNG,
                                NU=POISSON,
                                ALPHA=11.8e-6),
                        ECRO_LINE=_F (D_SIGM_EPSI=pente,
                                      SY=SY,,))

compor='
VMIS_ISOT_LINE'tabresu=TEST_COMPOR (OPTION=' MECA',
                                COMP_INCR=_F (RELATION=compor,,),
                                NEWTON=_F (REAC_ITER=1),
                                LIST_MATER=ACIER,
                                VARI_TEST= ("v1", "VMIS", "TRACE"),
                                YOUNG=YOUNG, POISSON=POISSON,
                                )
```

4.2 OPTION=' THER '

```
See tests COMP008*
TREF = 0.
Tmax = 500.
YOUN=DEFI_FONCTION (NOM_PARA=' TEMP', VALE= (TREF, 200000. ,
                                             Tmax, 100000. ,
                                             ),);
ALPH=DEFI_FONCTION (NOM_PARA=' TEMP', VALE= (TREF, 1.E-5,
                                             Tmax, 2.E-5,
                                             ),);
SIGY=DEFI_FONCTION (NOM_PARA=' TEMP', VALE= (TREF, 100. ,
                                             Tmax, 50. ,
                                             ),);
DSDE=DEFI_FONCTION (NOM_PARA=' TEMP', VALE= (TREF, 10000. ,
                                             Tmax, 5000. ,
                                             ),);
MATERI=DEFI_MATERIAU (ELAS_FO=_F (E=YOUN, NU=ZERO,
                                TEMP_DEF_ALPHA=TREF,
                                ALPHA=ALPH),
                    ECRO_LINE_FO=_F (D_SIGM_EPSI=DSDE,
                                      SY=SIGY,))
);
LMAT2 = [Nun] * (NCAL)
time=0.
for I in arranges (NCAL):
    timem = time
    time = timem + tfin/NCAL
    Ti = T0 + time /tfin * (Tmax - T0)
    LMAT2 [I] =DEFI_MATERIAU (ELAS =_F (E=YOUN (Ti),
                                        NU=0.,
                                        ALPHA=0.),
                            ECRO_LINE=_F (D_SIGM_EPSI=DSDE (Ti),
                                          SY=SIGY (Ti)),)

compor=' VMIS_ISOT_LINE'

tabresu=TEST_COMPOR (
    MATER=MATERI, COMP_INCR=_F (RELATION=compor),
```

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.

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```
LIST_MATER=LMAT2, ALPHA=ALPH, YOUNG=YOUN, TEMP_INIT=TREF,  
TEMP_FIN=Tmax,  
NEWTON=_F (REAC_ITER=1),  
NB_VARI=2, VARI_TEST= ("V1", "V2"),  
)
```