Code_Aster

Version default

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Responsable : Sylvie MICHEL-PONNELLE

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Macro-command `CALC_PRECONT`

Summarized

This macro-command makes it possible to put in tension the cables in a structure, so that, at the conclusion of this computation, the structure is in equilibrium and the tension is equal to the tension given by rules BPEL91, calculated by the command DEFI_CABLE_BP.
It also allows:

•   to apply prestressing in a progressive way, in order to be able to treat the case where the concrete will plasticize or be damaged according to the model behavior selected,
•   to practice the phasage of setting in prestressing, i.e. the setting in tension of the cables in a sequential way.

For more details on the model implemented by the command, consult documentation entitled: "Modelization of the cables of prestressed" [R7.01.02].

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1 Syntax

```
statnl  [evol_noli] = CALC_PRECONT


(  ◊   reuse=statnl              ,
   ♦   MODEL       =mo        ,                              [model]
   ♦   CHAM_MATER   =chmat       ,                        [cham_mater]
   ♦   CARA_ELEM    =carac        ,                        [cara_elem]

   ♦   EXCIT        = (_F (    ♦  CHARGE=chi/
[char_meca]
                                             /   [char_cine_meca]
              ),),
   ♦COMP_INCR              =   ( see the document [U4.51.11]   )
   ♦INCREMENT=_F     (
        ♦LISTE_INST=/litpsr8              ,                  [listr8]
                    /litps,                  [list_inst]
        ◊INST_INIT=instini          ,            [R]
        ◊INST_FIN=instfin          ,            [R]
        ◊   PRECISION=/1.0E-6         ,              [DEFAULT]
                    /prec,                  [R]

   ♦CABLE_BP=cabl_pr              ,
[cable_precont]

   ◊CABLE_BP_INACTIF=cabl_pr         ,
[cable_precont]

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

   ◊METHODE=/NEWTON                  ,                 [DEFAULT]
                    /IMPLEX    ,

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

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

   ◊SOLVEUR         =   ( see the document [U4.50.01]   ),

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

   ◊INFO            =/1   ,                 [DEFAULT]
                    /2  ,

   ◊TITER=tx                            [kN]
   ),
```

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2   Operands

2.1   Operands MODELS / CHAM_MATER / CARA_ELEM

♦MODELE   = Mo

Name of the model whose elements are the object of mechanical computation.

♦CHAM_MATER   = chmat

Name of the affected material field on the mesh. Attention, all meshes of the model must be associated with a material.

♦CARA_ELEM   = carac

Name of the characteristics of the shell elements, beam, pipe, bar, cable and discrete elements affected on the model Mo.

2.2   Key word EXCIT

♦EXCIT =

This factor key word makes it possible to describe a load for each occurrence. It is necessary to provide the boundary conditions for structure, possibly of the instantaneous loadings like gravity as well as kinematical connections related to the cables having already been put in tension by a preceding call to CALC_PRECONT. To in no case, one should not include the loading of () the cable (S) which one wants to put in tension by the call to this macro-command, nor loadings related to (X) the cable (S) declared (S) inactive (S).

2.2.1 Operands CHARGE

♦CHARGE   = chi

chi is the mechanical loading specified with the ième occurrence of EXCIT.

2.3   Key word COMP_INCR

the syntax of this key word common to command STAT_NON_LINE is described in the document [U4.51.11].

2.4   Key word INCREMENT

♦INCREMENT   =

Defines the intervals of time taken in the incremental method.

2.4.1 Operands LIST_INST

♦ LIST_INST=/litpsr8   ,   [listr8]
                 /litps,   [list_inst]

♦ If LIST_INST = litpsr8   [listr8]

times of computation are those defined in the concept litpsr8 by the operator DEFI_LIST_REEL [U4.34.01].

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♦ If LIST_INST = litps   [list_inst]

times of computation are those defined in the concept `litps` by the operator DEFI_LIST_INST [U4.34.03].

> **Note:**
>> *Even if computation is carried out with several time step, only the last time step is stored in the result concept.*
>> *During the process of setting in tension of the cables, times are generated automatically besides those provided by the user. It is thus completely normal to see appearing in the file of message of computations with* STAT_NON_LINE *at times that the user did not specify. These times are not stored in the result concept.*

2.4.2   Operands INST_INIT/INST_FIN

◊INST_INIT=   instini

the initial time of the computation (which thus (Re) is not calculated) must be indicated by its value.

If this initial time is not specified, the default is calculated in the following way:

- if an initial state is specified (operand ETAT_INIT) and if it defines one corresponding time then (by EVOL_NOLI or INST_ETAT_INIT) initial time is that defined by the initial state,
- if there is no initial state or that it does not define time corresponding (the fields are given in ETAT_INIT without specifying INST_ETAT_INIT), then one takes the first time of the list of times litps (NUME_INST_INIT =0).

◊INST_FIN=   instfin

final moment (last calculated step) is indicated same way as initial time, except that it is not possible to refer to the time of the initial state.

2.4.3   Operand accuracy

◊PRECISION   = prec

2.5   Key word CABLE_BP

♦CABLE_BP = cabl_pr

It acts here by the operator to provide a list of the concepts of the type cabl_precont produced DEFI_CABLE_BP [U4.42.04]. All the cables concerned will be tended at the conclusion of this computation.

2.6   Key word CABLE_BP_INACTIF

◊CABLE_BP_INACTIF   = cabl_pr

It acts here by the operator to provide a list of the concepts of the type cabl_precont produced DEFI_CABLE_BP [U4.42.04]. The macro-command is given the responsibility to generate kinematical connections related to these inactive cables, and does not take into account the stiffness of these cables.

2.7   Key word METHODE

◊METHODE   =/NEWTON   ,   [DEFAULT]

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/IMPLEX,

This key word makes it possible to define the method of resolution of the problem. By default, it is the exact iterative method of Newton which is used. If the user wishes it, it can use the robust method but approximate IMPLEX.

2.8 Key word NEWTON

the syntax of this key word common to command STAT_NON_LINE is described in the document [U4.51.03]. It is usable only if the required method is NEWTON.

2.9 Key word ETAT_INIT

the syntax of this key word common to command STAT_NON_LINE is described in the document [U4.51.03].

2.10 Key word RECH_LINEAIRE

the syntax of this key word common to command STAT_NON_LINE is described in the document [U4.51.03].

2.11 Key word solver

the syntax of this key word common to several commands is described in the document [U4.50.01].

2.12 Key word CONVERGENCE

the syntax of this key word common to command STAT_NON_LINE is described in the document [U4.51.03].

2.13 Operand INFO

the syntax of this key word common to command STAT_NON_LINE is described in the document [U4.51.03].

2.14 Operand TITER

◊TITER = tx

tx is the title of computation. It will be printed at the top of the results. See [U4.03.01].

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3   Example

One details here the main steps of a structural analysis containing of the cables of prestressed (benchmark SSNV164)

3.1   Before using the macro-command

- **Definition of the cables**

In the event of setting in NON-simultaneous tension of all the cables, it is necessary to make (at least) as much DEFI_CABLE_BP than of stages of loading.

```
CAB_BP1=DEFI_CABLE_BP (MODELE=MO,
                    CHAM_MATER=CMAT,
                    CARA_ELEM=CE,
                    GROUP_MA_BETON=' VOLTOT',
                    DEFI_CABLE= (_F (GROUP_MA=' CAB1',
                                  GROUP_NO_ANCRAGE= ("PC1D", "PC1F",),
                                  TYPE_ANCRAGE= ("ACTIF", "PASSIF",),),
                                _F (GROUP_MA=' CAB2',
                                  GROUP_NO_ANCRAGE= ("PC2D", "PC2F",),
                                  TYPE_ANCRAGE= ("ACTIF", "PASSIF",),),),
                    TENSION_INIT=3.750000E6,
                    RECUL_ANCRAGE=0.001,)


CAB_BP3=DEFI_CABLE_BP (MODELE=MO,
                     CHAM_MATER=CMAT,
                     CARA_ELEM=CE,
                     GROUP_MA_BETON=' VOLTOT',
                     DEFI_CABLE= (_F (GROUP_MA=' CAB3',
                                   GROUP_NO_ANCRAGE= ("PC3D", "PC3F",),
                                   TYPE_ANCRAGE= ("ACTIF", "PASSIF",),),
                                 _F (GROUP_MA=' CAB4',
                                   GROUP_NO_ANCRAGE= ("PC4D", "PC4F",),
                                           TYPE_ANCRAGE= ("ACTIF",
"PASSIF",),),),
                     TENSION_INIT=3.750000E6,
                     RECUL_ANCRAGE=0.001,)


CAB_BP5=DEFI_CABLE_BP (MODELE=MO,
                    CHAM_MATER=CMAT,
                    CARA_ELEM=CE,
                    GROUP_MA_BETON=' VOLTOT',
                    DEFI_CABLE=_F (GROUP_MA=' CAB5',
                            GROUP_NO_ANCRAGE= ("PC5D", "PC5F",),
                            TYPE_ANCRAGE= ("ACTIF", "ACTIF",),),
                    TENSION_INIT=3.750000E6,
                    RECUL_ANCRAGE=0.001,
                    )
```

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- **Definition of the loadings**

It is necessary to distinguish:
- *loadings related to the boundary conditions plus the possible instantaneous loadings,*
- *the loading related to the cables containing only kinematical connections,*
- *the NON-instantaneous loadings posterior with the setting in tension of the cables.*

```
AIR CONDITIONING =AFFE_CHAR_MECA (MODELE=MO,
                    DDL_IMPO= (
                        _F (GROUP_NO=' PP',
                           DX=0.0, DY=0.0,),
                        _F (GROUP_NO=' PX',
                           DY=0.0,),
                        _F (GROUP_NO=' PY',
                           DX=0.0,),
                        _F (GROUP_NO=' SU3',
                           DZ=0.0,),),
                    PESANTEUR= (9.81, 0.0, 0.0, - 1.0,),)


CMCAB1=AFFE_CHAR_MECA (MODELE=MO,
                    RELA_CINE_BP=_F (CABLE_BP=CAB_BP1,
                                SIGM_BPEL=' NON',
                                RELA_CINE=' OUI',),)
CMCAB3=AFFE_CHAR_MECA (MODELE=MO,
                    RELA_CINE_BP=_F (CABLE_BP=CAB_BP3,
                                SIGM_BPEL=' NON',
                                RELA_CINE=' OUI',),)
CMCAB5=AFFE_CHAR_MECA (MODELE=MO,
                    RELA_CINE_BP=_F (CABLE_BP=CAB_BP5,
                                SIGM_BPEL=' NON',
                                RELA_CINE=' OUI',),)


CHMECA =AFFE_CHAR_MECA (MODELE=MO,
                    DDL_IMPO=_F (GROUP_NO='SU2',
                             DZ=1.0,),)
```

- **preliminary Computation before setting in tension of the cables (optional)**

It acts here to take into account the loadings which apply to structure before the setting in tension of the cables. Not to take into account the stiffness of the cables, and not to introduce a loading on the cables, it is necessary to carry out computation either on a model not containing the cables or in their affecting a constitutive law SANS, which imposes that the stress remains null in these elements.

```
RES1 = STAT_NON_LINE (MODELE=MO,
                    CHAM_MATER=CMAT,
                    CARA_ELEM=CE,
                    COMP_INCR= (_F (RELATION = "ELAS",),
                            _F (RELATION = "SANS",
                                GROUP_MA= ("CAB1", "CAB3", "CAB5"),),),
                    EXCIT  = (_F (CHARGE = Air conditioning,),
                            _F (CHARGE = CMCAB1),
                            _F (CHARGE = CMCAB3),
                            _F (CHARGE = CMCAB5),),
                    INCREMENT=_F (LIST_INST = LINST,
                            INST_FIN = 150.),)
```

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3.2 Use of the macro-command: setting in successive tension of the 5 cables

One calls on the macro-command as many times as necessary.

```
RES1 = CALC_PRECONT (reuse=RES1,
                        ETAT_INIT=_F (EVOL_NOLI=RES1),
                        MODELE=MO,
                        CHAM_MATER=CMAT,
                        CARA_ELEM=CE,
                        COMP_INCR= (_F (RELATION = "ELAS",),),
                        EXCIT   = (_F (CHARGE = Air conditioning,),),
                        CABLE_BP  = (CAB_BP1,),
                        CABLE_BP_INACTIF = (CAB_BP3, CAB_BP5,),
                        INCREMENT=_F (LIST_INST = LINST,
                                      INST_FIN  = 300. ,
                                      ),)
RES1 = CALC_PRECONT (reuse=RES1,
                        ETAT_INIT=_F (EVOL_NOLI=RES1),
                        MODELE=MO,
                        CHAM_MATER=CMAT,
                        CARA_ELEM=CE,
                        COMP_INCR= (_F (RELATION = "ELAS",),),
                        EXCIT   = (_F (CHARGE = Air conditioning,),
                                   _F (CHARGE = CMCAB1,),
                        CABLE_BP  = (CAB_BP3,),
                        CABLE_BP_INACTIF = (CAB_BP5,),
                        INCREMENT=_F (LIST_INST = LINST,
                                      INST_FIN  = 450. ,
                                      ),)
RES1 = CALC_PRECONT (  reuse=RES1,
                        ETAT_INIT=_F (EVOL_NOLI=RES1),
                        MODELE=MO,
                        CHAM_MATER=CMAT,
                        CARA_ELEM=CE,
                        COMP_INCR= (_F (RELATION = "ELAS",),),
                        EXCIT   = (_F (CHARGE = Air conditioning,),
                                    _F (CHARGE = CMCAB1,),
                                    _F (CHARGE = CMCAB3,),
                        CABLE_BP  = (CAB_BP5,),
                        INCREMENT=_F (LIST_INST = LINST,
                                      INST_FIN = 600. ,
                                      ),)
```

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3.3 Poursuite of the loading after setting in tension of the cables

the cables being tended, it does not have there any more but to continue computation by always including kinematical connections binding the nodes of the cable to the concrete.

```
RES1 = STAT_NON_LINE (reuse = RES1,
                      ETAT_INIT=_F (EVOL_NOLI=RES1),
                      MODELE=MO,
                      CHAM_MATER=CMAT,
                      CARA_ELEM=CE,
                      COMP_INCR=_F (RELATION = "ELAS"),
                      EXCIT   = (_F (CHARGE = Air conditioning,),
                                 _F (CHARGE = CMCAB1),
                                 _F (CHARGE = CMCAB3),
                                 _F (CHARGE = CMCAB5),
                                 _F (CHARGE=CHMECA,
                                    FONC_MULT = FONCTION,),
                      INCREMENT=_F (LIST_INST = LINST,),)
```