SSNV228 – Setting in pre-tensioning of a pin

Summary:
This test illustrates the setting in pre-tensioning of a pin in Code_Aster. Methodology selected consists in applying a relative displacement between a group of elements of the pin and a group of elements of the nut (between the two faces which are normally threaded). Two modelings are proposed:

- Modeling a: manual determination of displacement.
- Modeling b: determination automated of displacement using `MACR_RECAL`.

1 Problem of reference

1.1 Methodology

The setting in pre-tensioning consists in imposing a relative displacement between nodes of the nut and nodes of the pin. This relative displacement is imposed in line with pin and must correspond to the desired clamping force. This relative displacement is imposed via the keyword `LIAISON_GROUP` order `AFFE_CHAR_MECA_F`.

For the user, it is thus a question of determining displacement to force to find the clamping force wished. For that, it is necessary to play again the study several times by modifying the value of relative displacement until reaching the required clamping force.

This CAS-test proposes two modelings:

- Modeling a: a modeling to illustrate a manual retiming.
- Modeling b: a modeling to illustrate an automated retiming.

Notice :
This method applies only to small displacements.
It makes the assumption that the difference in displacements between the nut and the pin is constant on all the zone.

1.2 Geometry

Geometry, presented to the figure 1.2-a, is generated by the tool trade "Calculation of support" of SALOME-MECA-2012.1. Dimensions, in millimetres are indicated in figure 1.2-b, they are the values suggested by default in the tool.

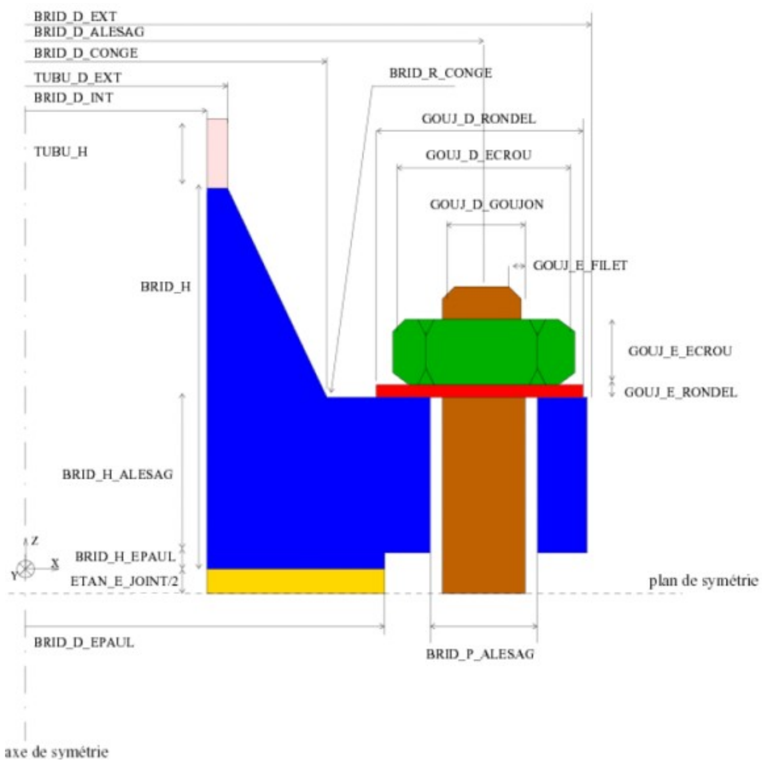

Figure 1.2-a : Geometry of the support and the pin.

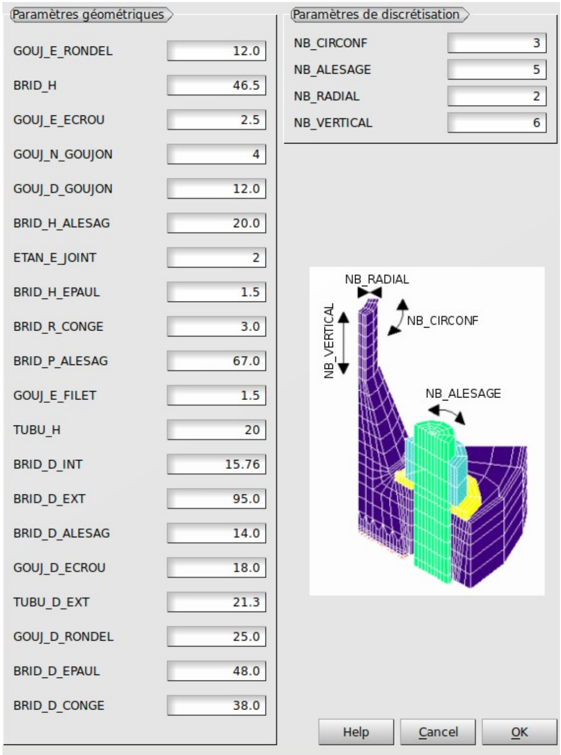

Figure 1.2-b : Parameters of the geometry.

1.3 Grid

Grid, presented to the figure 1.3-a, by the tool trade "Calculation of support is also generated" of SALOME-MECA-2012.1. It linear and is composed of 1108 hexahedrons and 70 prisms for 1821 nodes.

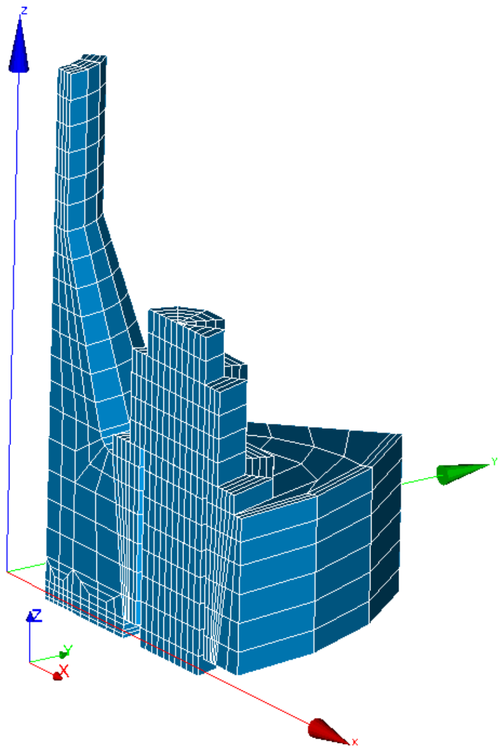

Figure 1.3-a : Grid of the support and the pin.

1.4 Materials

The material is elastic and its properties are: $E=200\,000\,MPa$ and $\nu=0.3$.

1.5 Boundary conditions, of contact and loading

The boundary conditions of blockings are the following ones:

- blocking of the degree of freedom DZ on the faces of the lower part of the pin and joint,
- conditions of symmetry via the blocking of the normal displacement of the side face with boring,
- conditions of symmetry via the blocking of the normal displacement of the side face without boring,
- condition of flatness of the face of cut of the tube in the plan XY by imposing an identical value for the degree of freedom DZ with all the nodes of the face,
- condition of tightening via one worthless difference between the degrees of freedom DX and DY nodes of the nut and pin in opposite,
- pressure of $1.0\text{E-}06\,Pa$ inside the tube.
- condition of contact between the flange facings of the joint and.

The loading corresponds to a relative displacement imposed on the nodes nut and pin. It is null at moment zero and is worth DEPL_R at the moment 1.0 .

Notice :
LE displacement is named DEPL_R so as to re-use the command file of modeling A directly with MACR_RECAL in modeling B. Indeed, the macro-order requires the presence of ''at the end of the name of the parameters to be readjusted.

1.6 Modeling

Modeling is 3D.

1.7 Required effort

One seeks to apply a displacement DEPL_R correspondent with a average constraint of $30\ MPa$ in the stem of the pin, that is to say an effort resulting from:

$F^{résultant}=\sigma^{pré-tension}.\pi.R_{goujon}^{2}/2=1695.6\text{N}$. Division by 2 takes account of symmetry.

2 Modeling A

2.1 Characteristics of modeling

This modeling illustrates the methodology of tightening of a pin. It is a question of imposing one displacement relative between nodes nut and pin and to calculate the resulting effort. Calculation is realized in modifying the value of DEPL_R until the resulting effort corresponds to the required effort.

2.2 Sizes tested and results

Retiming carried out is considered to be satisfactory when DEPL_R is of $8.0\text{E-}3\,mm$. This value makes it possible to put the pin in pre-tensioning with a constraint average of $30\,MPa$ in the stem of the pin.

The resulting effort is compared to the required effort.

Result	Reference	Value of reference	Tolerance
Resulting effort on the nut	ANALYTICAL	$-1695.6\,N$	1.0E-02

Tests of not-regression with a tolerance of $1.0\text{E-}6$ are realized on the efforts resulting from the following faces:

- face of the nut in contact with the pin,
- face of the pin in contact with the nut,
- face of the lower part of the pin,
- face of the joint in contact with the support,
- flange facing in contact with the joint.

Notice : the resulting effort calculated on each face is identical.

3 Modeling B

3.1 Characteristics of modeling

This modeling illustrates the methodology of the setting in tension of a pin by carrying out an automatic retiming of the value of relative displacement between the nodes nut and pin. For that, the macro-order is used MACR_RECAL in a file Master and modeling A like file slave.

The function of the effort targets to reach:

```
TARGET=DEFI_FONCTION (
   NOM_PARA='INST',
   NOM_RESU='DZ',
   VALE=( 0.0 , 0.0 ,
          1.0 , F_RESULT,),
)
```

The call to the ordering of retiming:

```
RECAL=MACR_RECAL (
   PARA_OPTI = _F (NOM_PARA='DEPL_R',
                   VALE_INI=0,004, VALE_MIN=0,004, VALE_MAX=0,012,),
   CURVE     = _F (FONC_EXP=TARGET, NOM_FONC_CALC='REACF',
                   PARA_X='INST', PARA_Y='DZ'),
)
```

In the file slave the calculation of REACF :

```
REACF=POST_RELEVE_T (
   ACTION=_F (INTITULE='FZ_CEG',
             OPERATION='EXTRACTION',
             RESULTAT=RESU,
             NOM_CHAM='REAC_NODA',
             RESULTANTE='DZ',
             GROUP_NO='N_SCEG',),
)
```

3.2 Sizes tested and results

Retiming carried out makes it possible to determine a value of DEPL_R_ near to $8.0\text{E-}3\ mm$. This value makes it possible to put the pin in tension with a average constraint of $30\ MPa$ in its stem.

The only size which it is possible to recover in the concept MARC_RECAL is the value of the parameter. TEST_RESU is thus realized on this value, and it is a test of not-regression.

Result	Reference	Value of reference	Tolerance
Resulting effort on the nut	NOT REGRESSIO N	0.0079595	5.0E-06

__Notice__ : in the file slave an impression of REACF is carried out. The value of the effort corresponding to the parameter is $-1.69560\text{E+}03$ *, which corresponds to the value of the target effort.*

4 Summary of the results

The two methods make it possible to get the same result, that is to say a relative displacement to impose near to $8.0\text{E-}3\,mm$ to obtain a average constraint of $30\,MPa$ in the pin.