SSNV228 – Setting in pre-tensioning of a Summarized

pin:
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 sides which are normally threaded). Two modelizations are proposed:
- Modelization a: manual determination of displacement.
- Modelization 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 key word LIAISON_GROUP of the command AFFE_CHAR_MECA_F.

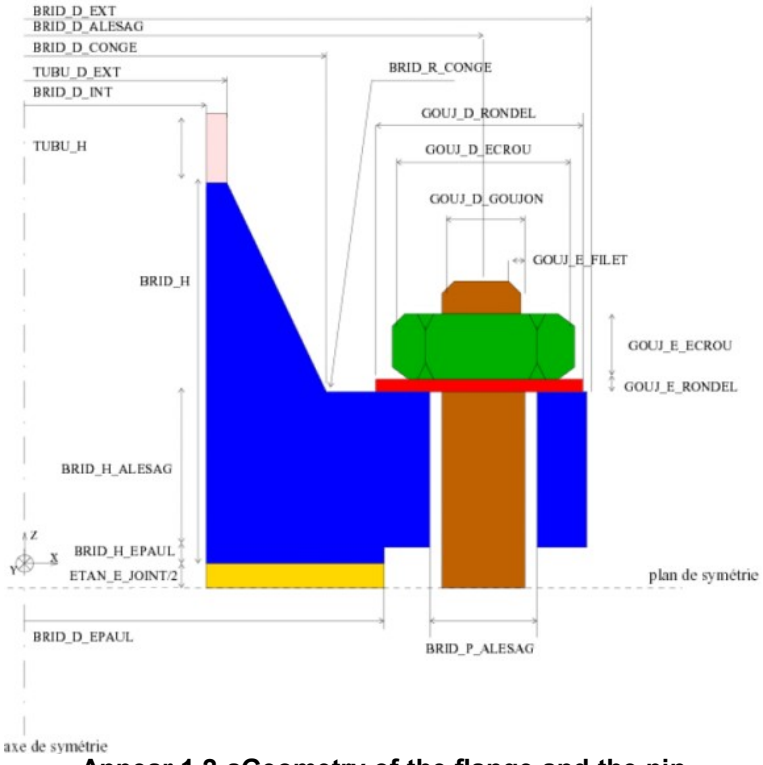
For the user, it is thus a question of determining displacement to force to find the clamping force wished. For that, it is necessary to play again the study several times by modifying the value of relative displacement until reaching the required clamping force.

This benchmark proposes two modelizations:
- Modelization a: a modelization to illustrate a manual retiming.
- Modelization b: a modelization to illustrate an automated retiming.

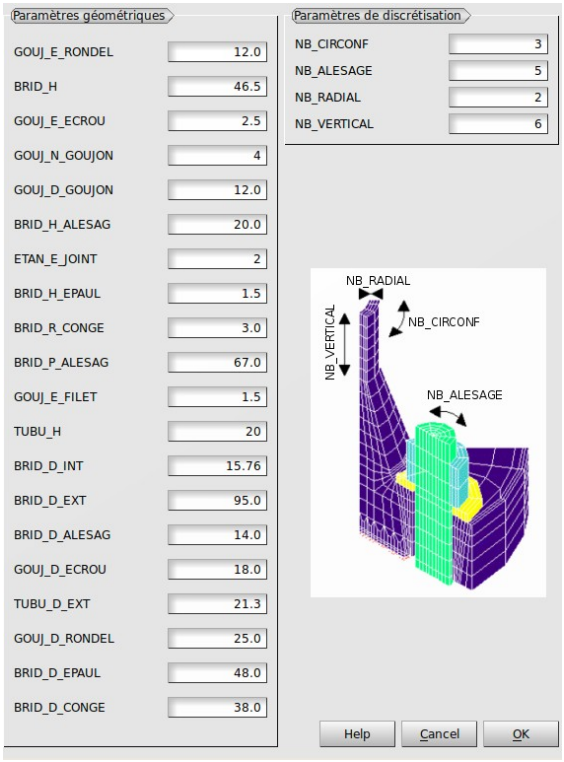
Note:
This method applies only to small displacements.
It makes the assumption that the difference in displacements between the nut and the pin is constant on all the zone.

1.2 Geometry

the geometry, presented to the figure1.2-a, is generated by the dedicated tools "Computation of flange" of SALOME-MECA-2012.1. Dimensions, in millimetres are indicated in figure1.2-b, they are the values suggested by default in the tools.



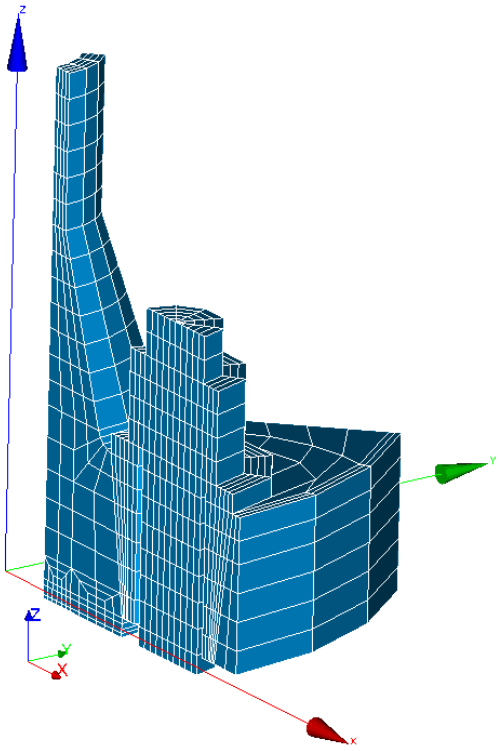
Appear 1.2-aGeometry of the flange and the pin.



Appear1.2-b

1.3 Mesh

The mesh, presented to the figure1.3-a, is also generated by the dedicated tools "Computation of flange" of SALOME-MECA-2012.1. It linear and is composed of 1108 hexahedrons and 70 prisms for 1821 nodes.



Appear :

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 sides of the lower part of the pin and the 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 plane XY by imposing a value identical for the degree of freedom DZ to all the nodes of the face,
- condition of tightening via a difference null between the DX degrees of freedom and DY of the nodes of the nut and of the pin in opposite,
- pressure of $1.0\text{E-}06\,Pa$ inside the tube.
- condition of contact between the sides of the joint and the flange.

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

Note:
Displacement is named DEPL_R so as to A re-use the command file of the modelization directly with MACR_RECAL in the modelization B. Indeed, the macro-command requires the presence of "" at the end of the name of the parameters to be readjusted.

1.6 Modelization

The modelization is 3D.

1.7 Required force

One seeks to apply a displacement DEPL_R corresponding to a average constraint of $30\ MPa$ in the rod of the pin, that is to say a force resulting from:

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

2 Modelization A

2.1 Characteristic of the modelization

This modelization illustrates the methodology of tightening of a pin. It is a question of imposing a relative displacement between the nodes of the nut and the pin and of calculating the resulting force. The computation is realized by modifying the value of DEPL_R until the resulting force corresponds to the required force.

2.2 Quantities 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 average constraint of $30\,MPa$ in the rod of the pin.

The resulting force is compared to the required force.

Result	Reference	Value of reference	Tolerance
Force resulting on nut	ANALYTIQUE	$-1695.6\,N$	1.0E-02

From the tests of NON-regression with a tolerance from $1.0\text{E-}6$ are carried out on the forces resulting from the following sides:

- 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 flange,
- face of the flange in contact with the joint.

Note: the resulting force calculated on each side is identical.

3 Modelization B

3.1 Characteristic of the modelization

This modelization 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 of the nut and the pin. For that, one uses macro-command MACR_RECAL in a master file and the modelization A like slave file.

The function of the force targets to reach:

```
CIBLE=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,),
   COURBE    = _F (FONC_EXP=CIBLE, NOM_FONC_CALC=' REACF",
                   PARA_X=' INST', PARA_Y=' DZ'),
)
```

In slave file the computation 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 Quantities tested and results

retiming carried out makes it possible to determine a value of DEPL_R_ close 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 rod.

The only quantity which it is possible to recover in concept MARC_RECAL is the value of the parameter. THE TEST_RESU is thus carried out on this value, and it is a test of NON-regression.

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

Note : in slave file printing of REACF is carried out. The value of the force corresponding to the parameter is $-1.69560\text{E+}03$, which corresponds to the value of the target force.

4 Summary of the results

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