SSNP126 - Validation of the law of behavior JOINT_BA (steel-concrete connection) in 2D plan

Summary:

Validation of the law of behavior JOINT_BA steel-concrete connection by using the element of joint $2D$ plan. This joined element is embedded in two nodes and bound to an element cubes with the characteristics of an unspecified elastic material. By applying a monotonous loading in slip to the cubic element, one checks the degradation of the interface, as well as the passage of the small deformations at the beginning of the experiment, with the great observable slips starting from the peak of the resistance of the connection. In this case test, the parameters used do not correspond to the data of a particular experimental case. However, the validation is carried out by comparison with results got with code FEAP of Professeur Taylor, of Berkeley, software in which this formulation was established.

1 Problem of reference

1.1 Geometry

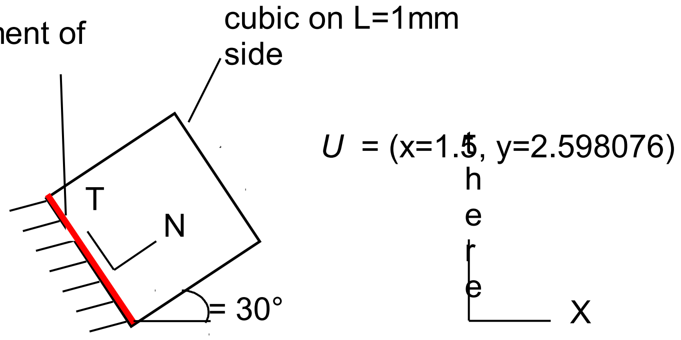

Figure 1.1-a: Geometry and boundary conditions

1.2 Properties of material

Cubic *:* rubber band

$$E=2,1\cdot10^{6}\quad MPa\ ,\ \nu=0$$

Element of joint :

- law of behavior `ELAS` with the following parameters:

$$E=2,1\cdot10^{6}\quad MPa\ ,\ \nu=0$$

- law of behavior `JOINT_BA` with the following parameters:

  - Initial parameters:

coefficient of penetration:	$Hpen=0.64\text{mm}$	(keyword: `HPEN`)
module of rigidity:	$G_{lia}=6.65\times10^{+3\text{MPa}}$	(keyword: `GTT`)

  - Parameters of tangential damage:

threshold of elastic strain:	$\varepsilon_{\gamma}^{0}=5\times10^{-4}$	(keyword: `GAMD0`)
coefficient of damage area 1:	$Ad_{1}=1.0$	(keyword: `AD1`)
coefficient of damage area 1:	$Bd_{1}=0.5$	(keyword: `BD1`)
threshold of the great slips:	$\varepsilon_{\gamma}^{2}=9.6\times10-1$	(keyword: `GAMD2`)
coefficient of damage area 2:	$Ad_{2}=6\times10^{-5}\ MPa^{-1}$	(keyword: `AD2`)
coefficient of damage area 2:	$Bd_{2}=1.0$	(keyword: `BD2`)

- Parameters for the friction of the cracks and containment:

friction:	$\gamma=10.0\,MPa$	(keyword: `VIFROT`)
kinematic work hardening:	$\alpha=4\times10^{-1}\,MPa^{-1}$	(keyword: `F`)
containment:	$c=1.0$	(keyword: `FC`)

- Parameters of normal damage:

normal deformation criticizes (opening):	$\varepsilon_N^0=9\times10^{-1}$	(keyword: `EPSTR0`)
coefficient of normal damage:	$Ad_N=1\times10^{-9}\,MPa^{-1}$	(keyword: `DNA`)
coefficient of normal damage:	$Bd_N=1.5$	(keyword: `BDN`)

1.3 Boundary conditions and loadings

Worthless displacements imposed on the left face of the element of joint.
The mechanical loading is imposed in the form of displacements imposed on the right face of the cube in increments of $0.01\times U$ with each step of time, 0 to 300.

1.4 Notice

The law of behavior of the element of joint is locally given (reference mark (n,t)), calculations of the system are carried out in the total reference mark (x,y) . The basic change was taken into account in calculations. The case test was developed with a rotation of $30°$ with an aim of validating this basic change.

2 Reference solution

It is about a comparison code-code. The reference used is code FEAP version 7.4 of Professeur R.L. Taylor, of the University of California, Berkeley. The results were got with the same geometrical and material parameters, as well as the same discretization in time.

2.1 Bibliographical references

[1] TAYLOR R.L. – FEAP: In Finite Element Analysis Program version 7.4. To use, Theory, To program & Example Manuals - University Of California At Berkeley, the USA, December 2000.

3 Modeling A

3.1 Characteristics of modeling

Modeling in plane deformations (keyword D_PLAN) for the cube on side 1.
Modeling fissures planes (keyword PLAN_JOINT) for the element of joint.

The cube is one $QUAD4$.
The element of joint is one $QUAD4$ degenerated (confused nodes).

3.2 Characteristics of the grid

Many nodes: 6
Number and type of meshs: 2 $QUAD4$.

4 Results of modeling A

4.1 Sizes tested and results

The components are tested yy and xy element which corresponds to the components normal and tangential of the local law of behavior in the interface, starting from the stress field SIEF_ELGA as well as the value of the damage D_T (which corresponds to the second variable of the field VARI_ELGA). The values are tested at the point of Gauss 1 of the element joint, with 4 pas de different times: at the beginning of loading, during the phase of growth of the damage, after the peak of the maximum resistance of the connection and at the end of the loading.

Field SIEF_ELGA component SIGN

Identification	Reference	*Code_Aster*	% difference
For an imposed displacement $U_{TT} = 0.2\,mm$	-9.94080 E-02	-1.00976 E-01	1,577
For an imposed displacement $U_{TT} = 0.8\,mm$	-1.54560 E-01	-1.52328 E-01	-1,444
For an imposed displacement $U_{TT} = 1.2\,mm$	-1.44060 E-01	-1.47200 E-01	2,180
For an imposed displacement $U_{TT} = 3.0\,mm$	-1.06920 E-01	-1.06914 E-01	-0,006

Field SIEF_ELGA component SITX

Identification	Reference	*Code_Aster*	% difference
For an imposed displacement $U_{TT} = 0.2\,mm$	-7.58900 E+00	-7.65768 E+00	0,905
For an imposed displacement $U_{TT} = 0.8\,mm$	-1.17960 E+01	-1.15521 E+01	-2,068
For an imposed displacement $U_{TT} = 1.2\,mm$	-1.09950 E+01	-1.11632 E+01	1,530
For an imposed displacement $U_{TT} = 3.0\,mm$	-8.15940 E+00	-8.10802 E+00	-0,630

Field VARI_ELGA component V2 (variable of tangential damage)

Identification	Reference	*Code_Aster*	% difference
For an imposed displacement $U_{TT} = 0.2\,mm$	9.97203 E-01	9.97203 E-01	-2 . 19 E-05
For an imposed displacement $U_{TT} = 0.8\,mm$	9.98948 E-01	9.98915 E-01	-0,003
For an imposed displacement $U_{TT} = 1.2\,mm$	9.99369 E-01	9.99309 E-01	-0,006
For an imposed displacement $U_{TT} = 3.0\,mm$	9.99854 E-01	9.99821 E-01	-0,003

5 Summary of the results

The comparison of the results resulting from *Code_Aster* and those obtained numerically by code FEAP of Professeur Taylor de Berkeley are satisfactory (the maximum change is of 2.18% on the constraints).

The objective of modeling is to test the stability of the law of behavior by using the already existing elements joined in *Code_Aster* : one can consider that the establishment of the law is correct. However, since the maximum resistance of the connection between the steel reinforcements and the concrete is reached beyond the framework of the small deformations, it is necessary to pay attention to the choice of the increments of time in particular when `JOINT_BA` is used in combination with other nonlinear laws of behavior (law MAZARS, for example).