SSNL127 - Traction test with the model CORR_ACIER

Summarized:

This test of nonlinear quasi-static mechanics makes it possible to validate elastoplastic endommageable CORR_ACIER the model.

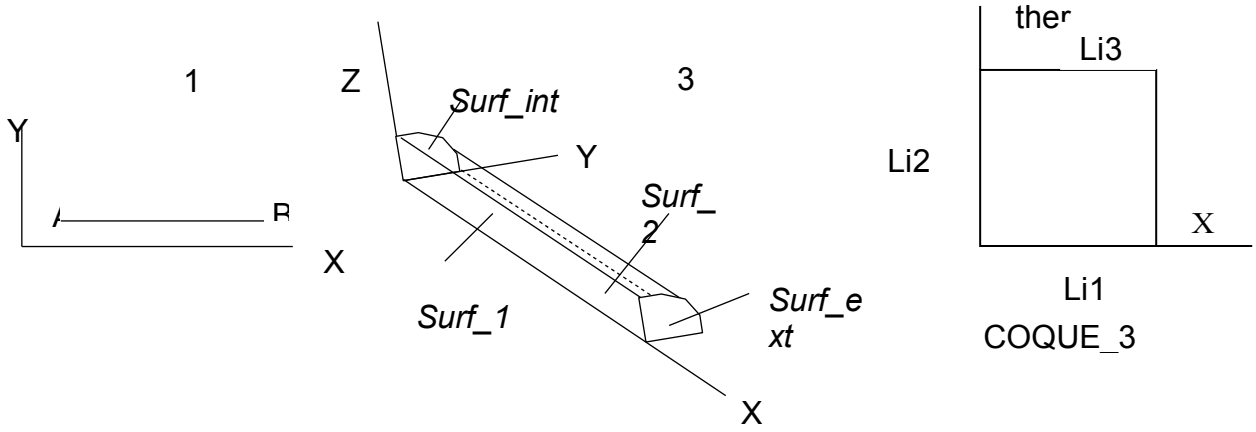
5 modelizations make it possible to validate the behavior:

1) the modelizations A, B, C in 1D for the elements BARS, POU_D_EM, POU_D_TGM;
2) the modelization D in 3D in the case of an axisymmetric test-tube (stress state and of homogeneous strain) subjected to a simple traction test; the modelization 3D of the test-tube is carried out with elements CU20 ;
3) the modelization E in COQUE_3D in the case of a plate subjected to a simple tension, with a mesh QUAD9.

1 Problem of reference

1.1 Geometry

the geometry is selected voluntarily simple, to translate a stress state and strains homogeneous, as it is the case in uniaxial tension. In the case $1D$ and $3D$, it is here about a bar of diameter $\phi=6\ mm$ and length. In $3D$, one nets only one quarter of the bar. The tension is done with displacement imposed in $1D$ and $3D$ with the length of the test-tube. In the case COQUE_3D, the plate is square on side, and thickness $\pi\frac{\phi^2}{4}$ (so that the forces are identical to the case $1D$).



1.2 Properties of the material

Modulates YOUNG = $2.E11\ Pa$
Poisson's ratio $\nu=0.33$

Key word CORR_ACIER :
Coefficient of damage D_CORR = 0.2
Hardening parameters ECRO_K = $500\ MPa$
Elastic limit ECRO_M = 2.781
SY = $500.\ MPa$

the degree of corrosion is given using command CREA_CHAM :
NOM_CMP = "CORR" VALE = 0.0,2.5,13 (in for hundred)

1.3 Boundary conditions and loadings

Modelization 1D
Displacements DX DZ and DY blocked at the point A
Displacement DX and DZ imposed on the point B

Modelization 3D
Displacement DX prevented on $Surf_{\text{int}}$
Displacement DY prevented on $Surf_1$
Displacement DZ prevented on $Surf_2$
Displacement DX imposed on $Surf_{ext}$

Modelization COQUE_3D :

Displacement DX prevented on $Li4$
Displacement DY prevented on $Li1$
Displacement DX imposed on $Li3$

1.4 Forced

Initial conditions and null strains.

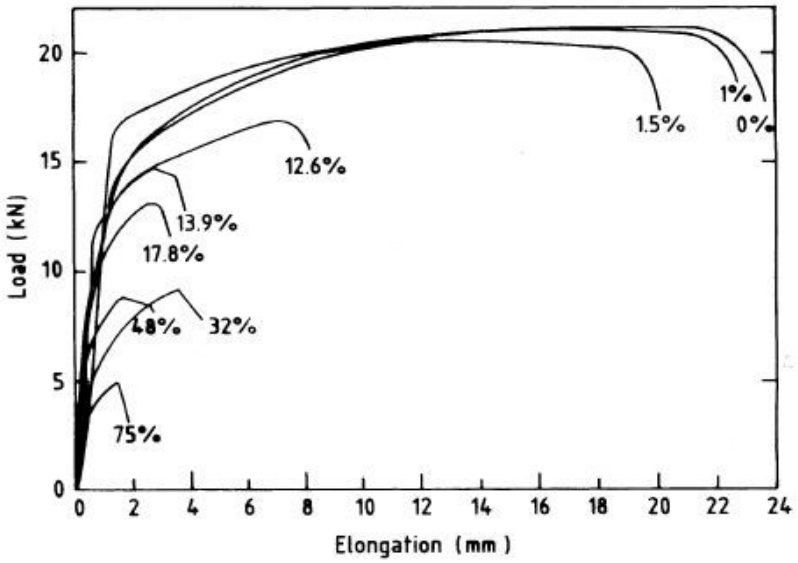
2 Reference solution

2.1 Method of calculating

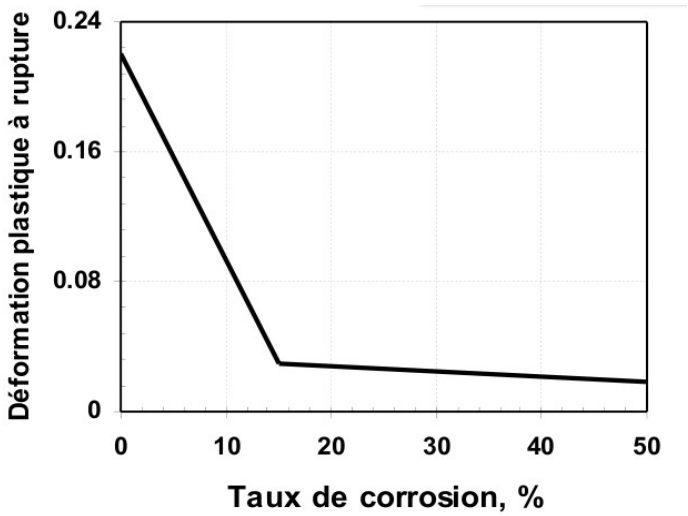
the reference solution is consisted the results of the traction tests carried out on corroded bars (the initial diameter is $6mm$). Following these tests, one notes the reduction in the plastic strain with fracture with increase in the degree of corrosion.

2.2 Results of reference

Evolution of the plastic strain with fracture of the corroded bars according to the degree of corrosion (the reduction of the diameter of bars or the thickness of flat reinforcement compared to those not corroded) is presented on [Figure 2.2-a] and it [Figure 2.2-b].



Appear 2.2.a Influence of corrosion on the reaction of steel according to the rate of corrosion



Is reproduced 2.2.b Evolution of the plastic strain in fracture according to the rate of corrosion

2.3 Uncertainties on the solution

Accuracy of the codes.

2.4 Bibliographical references

1) A.A. ALMUSALLAM: “Effect of dismantles of corrosion one the properties of reinforcing steel bars”, Construction and Building Materials 15,2001.

2) A. OUGLOVA, Y. BERTHAUD, I. PETRE-LAZAR: “Experimental Characterization of the corrosion of steels in the concrete on old analogues. First approach of modelization “, HT 2/25/030 /A, EDF, 2002.

3 Modelization A

3.1 Characteristic of the modelization

It acts of an element BARS. Maximum displacement at the point B is of $0.021\mathrm{m}$, it is reached in 50 increments.

3.2 Characteristics of the mesh

Many nodes: 10
Number of meshes and type: 10 (SEG2)

3.3 Quantities tested and results

the forces maximum (in N) are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.019	21857.1
2.5% of corrosion	0.0164	21451.6
13% of corrosion	the 0.0075	19610.1

forces corresponding to maximum displacement to the point B are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	21193.7
2.5% of corrosion	0.018	20557.6
13% of corrosion	0.008	18758.6

the maximum cumulated equivalent plastic strain is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	0.19625
2.5% of corrosion	0.018	0.17636
13% of corrosion	the 0.008	0.07668

damage is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.0192	0.00229
2.5% of corrosion	0.0164	0.01371
13% of corrosion	0.0075	0.01188

4 Modelization B

4.1 Characteristic of the modelization

It acts of an element POU_D_EM (beam multifibre). Maximum displacement at the point B is of $0.021\mathrm{m}$, it is reached in 50 increments.

4.2 Characteristics of the mesh

Many nodes: 10
Number of meshes and type: 10 (SEG2)

4.3 Quantities tested and results

the forces maximum (in N) are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.019	21857.1
2.5% of corrosion	0.0164	21451.6
13% of corrosion	the 0.0075	19610.1

forces corresponding to maximum displacement to the point B are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	21193.7
2.5% of corrosion	0.018	20557.6
13% of corrosion	0.008	18758.6

the maximum cumulated equivalent plastic strain is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	0.19625
2.5% of corrosion	0.018	0.17636
13% of corrosion	the 0.008	0.07668

damage is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.0192	0.00229
2.5% of corrosion	0.0164	0.01371
13% of corrosion	0.0075	0.01188

5 Modelization C

5.1 Characteristic of the modelization

It acts of an element POU_D_TGM (beam multifibre). Maximum displacement at the point B is of $0.021\mathrm{m}$, it is reached in 50 increments.

5.2 Characteristics of the mesh

Many nodes: 10
Number of meshes and type: 10 (SEG2)

5.3 Quantities tested and results

the forces maximum (in N) are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.019	21857.1
2.5% of corrosion	0.0164	21451.6
13% of corrosion	the 0.0075	19610.1

forces corresponding to maximum displacement to the point B are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	21193.7
2.5% of corrosion	0.018	20557.6
13% of corrosion	0.008	18758.6

the maximum cumulated equivalent plastic strain is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	0.19625
2.5% of corrosion	0.018	0.17636
13% of corrosion	the 0.008	0.07668

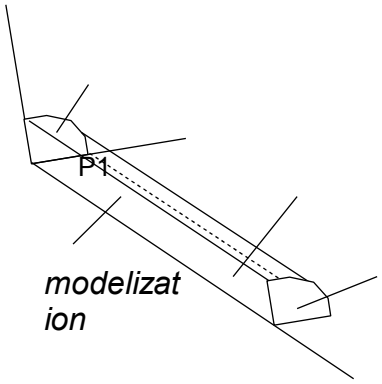
damage is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.0192	0.00229
2.5% of corrosion	0.0164	0.01371
13% of corrosion	0.0075	0.01188

6 Modelization D

6.1 Characteristic of the XSurf_intSurf_extSurf_1Surf_2ZYll

acts of a modelization 3D.



modelizat ion

6.2 Characteristics of the mesh

Many nodes: 39
Number of meshes and type: 3 (HEXA20)

6.3 Quantities tested and results

the forces maximum (in N) are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.019	7.730 10 8
2.5% of corrosion	0.0164	7.588 10 8
13% of corrosion	the 0.0075	6.936 108

forces corresponding to maximum displacement to the point B are:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	7.487 10 8
2.5% of corrosion	0.018	7.261 108
13% of corrosion	0.008	6.612 108

the maximum cumulated equivalent plastic strain is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.02	0.19625
2.5% of corrosion	0.018	0.17636
13% of corrosion	the 0.008	0.07668

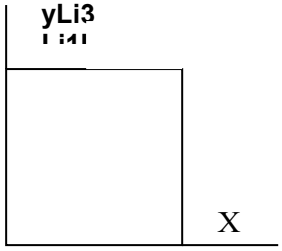
damage is worth:

Identification	Displacement imposed (m)	Reference
0% of corrosion	0.0192	0.00345
2.5% of corrosion	0.0164	0.01505
13% of corrosion	0.0075	0.015

7 Modelization E

7.1 of the modelization

It acts of a modelization COQUE_3D.



7.2 Characteristics of the mesh

Many nodes: 9
Number of meshes and type: 1 (QUAD9)

7.3 Quantities tested and results

the forces maximum (in N) are:

Identification	Displacement imposed (m)	Reference	Tolerance
0% of corrosion	0.019	21857.1	4.00%
2.5% of corrosion	0.0164	21451.6	7.00%
13% of corrosion	0.0075	19610.1	4.00%

the forces corresponding to maximum displacement to the point B are:

Identification	Displacement imposed (m)	Reference	Tolerance
0% of corrosion	0.02	21193.7	2.00%
2.5% of corrosion	0.018	20557.6	1.00%
13% of corrosion	0.008	18758.6	0.5%

8 Summary of the results

For the modelizations A, B, C, D, E the results correspond well to those obtained in experiments.

The curves force-displacement obtained for 3 rates of corrosion tested are the following ones: