SSNS112 – Test of compression and alternate tensile of a reinforced concrete post

Summary:

The objective of this test is to validate the alternate uniaxial answer of a reinforced concrete beam, on the basis of experimental test, modelled by the laws:

- GLRC_DM , [R7.01.32] , reinforced concrete law generalized used with elements DKTG .
- MAZARS_GC , [R5.03.09] , concrete 1D law, associated with a non-linear law for steel VMIS_CINE_GC on a multifibre model of beam POU_D_EM .

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1 Problem of reference

1.1 Geometry

One considers a reinforced concrete post length $0{,}7\,m$, according to the axis Ox, of square section of height and width equalizes with $0{,}15\,m$.

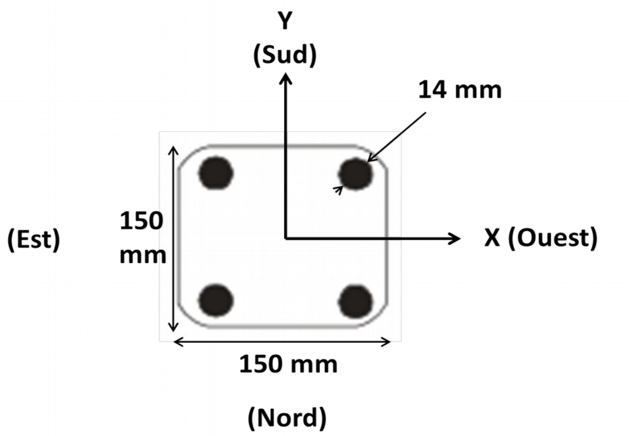

Figure 1: section of the post out of reinforced concrete.

The longitudinal reinforcements are four $HA14$.

The transverse reinforcements are not taken into account in modelings hereafter.

1.2 Properties of material

For modeling a:
The law of behavior of `GLRC_DM` has the following parameters for the concrete:

- Young modulus: $E=28\,500\,MPa$
- Poisson's ratio $\nu=0.2$
- Maximum constraint in compression $\sigma_c=25\,MPa$
- Maximum constraint in traction $\sigma_t=1{,}6\,MPa$
- Slope post-peak in traction $E_t=-28500\,MPa$

The parameters for steel are:

- Young modulus $E=195\,000\,MPa$
- Poisson's ratio $\nu=0.3$
- Elastic limit $\sigma_y=610\,MPa$
- Tangent module (plastic slope) $E_t=19{,}5\,MPa$

The operator is used `DEFI_GLRC` for obtaining the parameters of the law. The parameters are also fixed $\gamma_c=0{,}35$ and $\alpha_c=60$ for non-linear behaviour in compression.

The elastic module are equivalent out of membrane, cf [R7.01.32], page 21/36, is worth with these data material: $E_{eq}^m=34021.0\,MPa$, that is to say a membrane stiffness according to the direction Ox : $E_{eq}^m * S=765.393\,MN$.

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For modeling A, one uses two beds of reinforcements X and Y of $2{,}053\ 10^{-3} m^2/m$.

For modeling b:

The law of behavior of MAZARS_GC has the following parameters for the concrete:

- Young modulus: $E=28\,500\,MPa$
- Poisson's ratio $\nu=0.2$
- Maximum constraint in compression $\sigma_c=25\,MPa$
- Maximum constraint in traction $\sigma_t=1{,}6\,MPa$
- Deformation with the peak in compression $\epsilon_c=2{,}3\,.\,10^{-3}$

Parameters for the steel, modelled with the law VMIS_CINE_GC, are:

- Young modulus $E=195\,000\,MPa$
- Elastic limit $\sigma_y=610\,MPa$

For modeling B, one uses only one steel fibre of section $6{,}15\,mm^2$.

1.3 Boundary conditions and loadings

An end of the beam, edge A , is blocked and one imposes at the other end, edge B , an effort distributed of resultant $FX=1\,kN$ according to the direction X .

The cycles of loading are defined by:

t	Multiplying coefficient on the force FX
0,0	0,0
1,0	−250
3,0	55
5,0	−365
7,0	176
9,0	−490
11,0	298
13,0	−675
15,0	368
17,0	−790
19,0	376

1.4 Initial conditions

Nothing.

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2 Reference solution

The reference solution is given by experimental results, acquired on the test named test QJ5TC, provided in [1]. On the basis of cycle forces – deformation measured on average on the post, one identifies, cf Figure 1:

- a range of deformations ranging between -0.002 and 0.003, i.e. not causing general plastic deformations of steels within sight of the characteristics of steel, except potentially locally on the way of the cracks,
- an elastic equivalent axial stiffness of $743,7 MN$,
- an equivalent axial stiffness post-damage in traction of $120,1 MN$, that is to say a relationship between the two of $0,161$.

2.1 Bibliographical references

[1] BENMANSOUR M.B. Modeling of the alternate cyclic behavior of the reinforced concrete. Application to various static tests of posts.
Doctorate of the National school of the Bridges and Fitted. January 6th, 1997.

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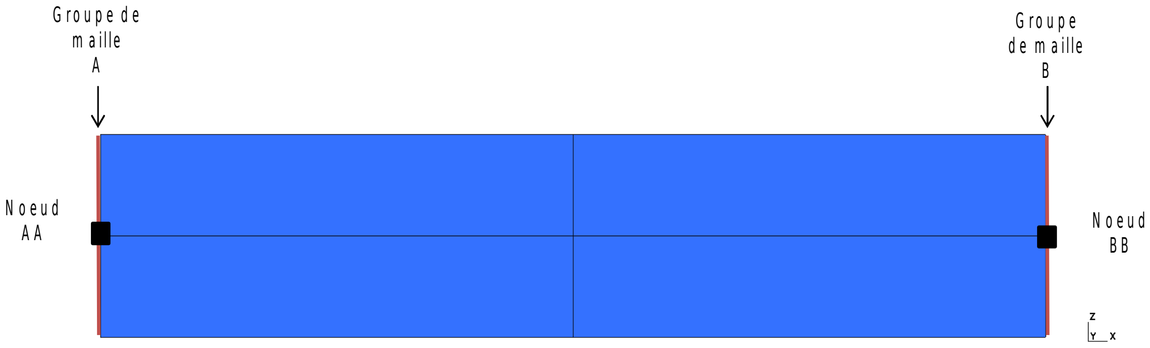
3 Modeling A

3.1 Characteristics of modeling

A modeling is used DKTG. The law of behavior is GLRC_DM.

3.2 Characteristics of the grid

The grid contains 4 elements of the type QUAD4.



3.3 Sizes tested and results

The displacement of the edge is tested B. The node BB is located at the center of the edge B.

Identification	Moment	Type of reference 'NON_REGRESSION'	Type of reference 'SOURCE_EXTERNE'	
		Tolerance	Value of reference	Tolerance
Not BB - DX	1,0	0.0001%	-2.436805E-04	4,00%
Not BB - DX	3,0	0.0001%	1.689212E-04	40,00%
Not BB - DX	5,0	0.0001%	-3.891909E-04	1,00%
Not BB - DX	7,0	0.0001%	9.398004E-04	20,00%
Not BB - DX	9,0	0.0001%	-5.599223E-04	25,00%
Not BB - DX	11,0	0.0001%	1.5470623E-03	3,00%
Not BB - DX	13,0	0.0001%	-1.1283811E-03	5,00%
Not BB - DX	15,0	0.0001%	1.9670126E-03	1,00%
Not BB - DX	17,0	0.0001%	-1.3747783E-03	8,00%
Not BB - DX	19,0	0.0001%	1.9887658E-03	2,50%

The axial answer of the beam and the experimental results are presented Figure 2.

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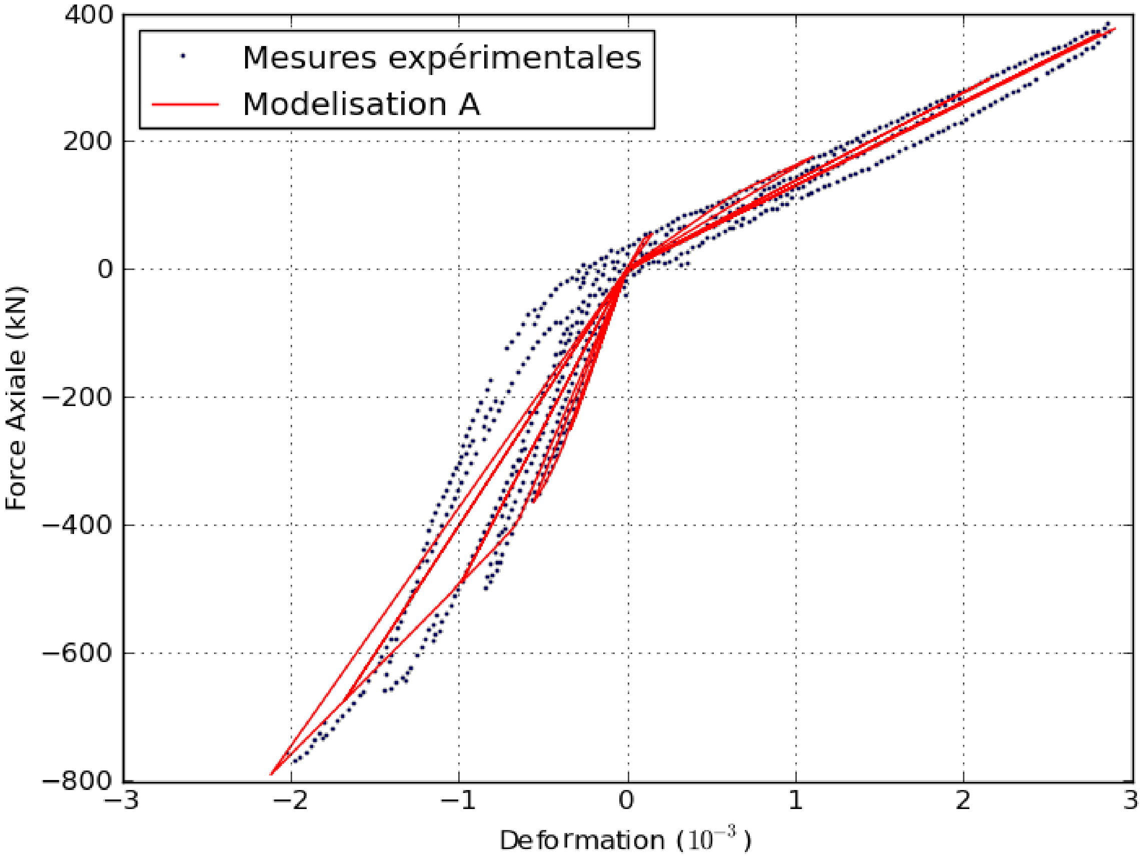

Figure 2: answer of modeling A (`DKTG` with `GLRC_DM`). In dotted lines: experimental solution [feeding-bottle 1].

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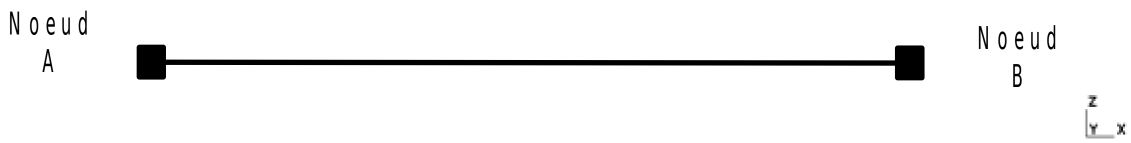
4 Modeling B

4.1 Characteristics of modeling

A modeling is used `POU_D_EM`. The law of behavior of the fibres concrete is `MAZARS_GC`. The law of behavior of the fibres steel is `VMIS_CINE_GC`.

4.2 Characteristics of the grid

The grid contains an element of the type `SEG2`. The section of the beam is made up of a concrete fibre and a steel fibre.



4.3 Sizes tested and results

The displacement of the node is tested B .

Identification	Moment	Type of reference 'NON_REGRESSION'	Type of reference 'SOURCE_EXTERNE'	
		Tolerance	Value of reference	Tolerance
Not B - DX	1,0	0.0001%	-2.436805E-04	5,00%
Not B - DX	3,0	0.0001%	1.689212E-04	30,00%
Not B - DX	5,0	0.0001%	-3.891909E-04	5,00%
Not B - DX	7,0	0.0001%	9.398004E-04	2,00%
Not B - DX	9,0	0.0001%	-5.599223E-04	9,00%
Not B - DX	11,0	0.0001%	1.5470623E-03	6,00%
Not B - DX	13,0	0.0001%	-1.1283811E-03	10,00%
Not B - DX	15,0	0.0001%	1.9670126E-03	4,00%
Not B - DX	17,0	0.0001%	-1.3747783E-03	5,00%
Not B - DX	19,0	0.0001%	1.9887658E-03	6,00%

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The axial answer of the beam and the experimental results are presented Figure 3.

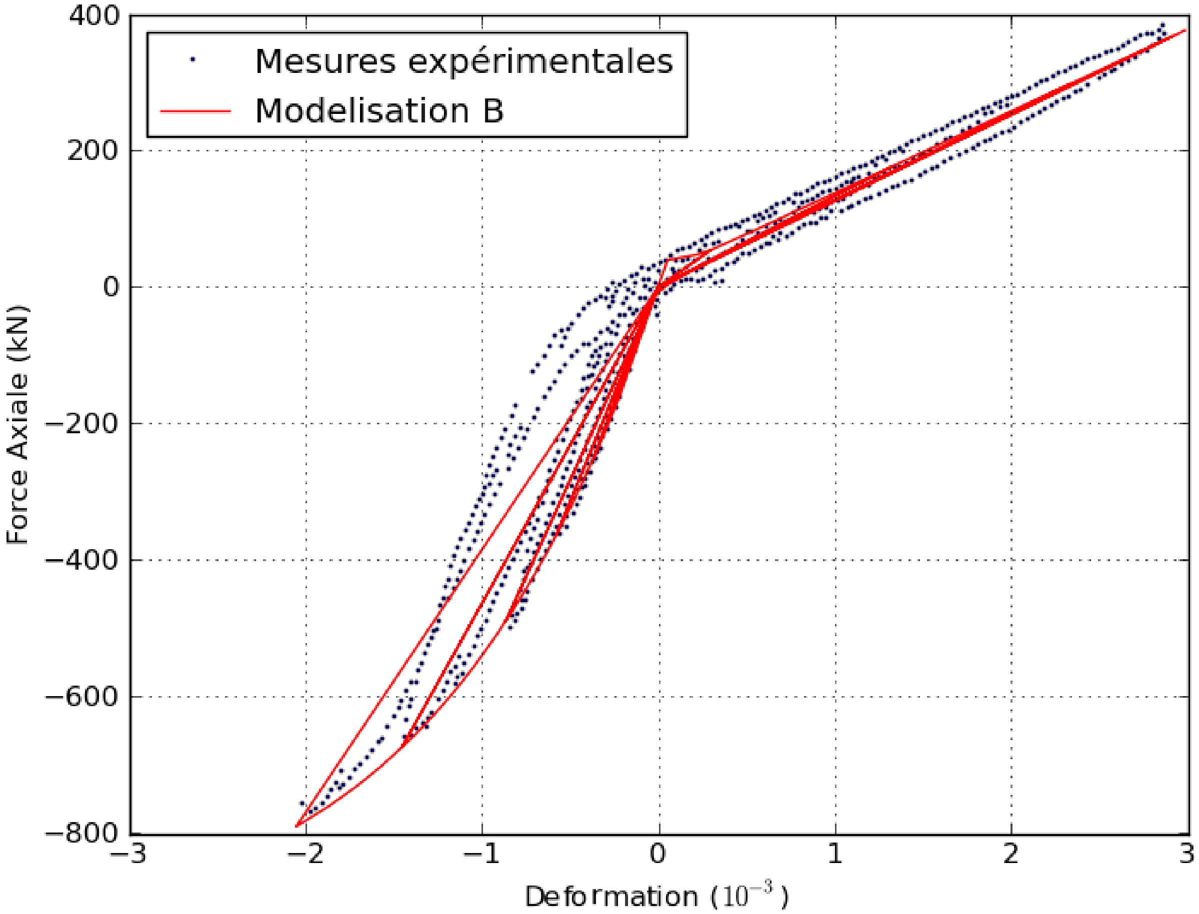

Figure 3 : answer of modeling B (`POU_D_EM` with `MAZARS_GC`). In dotted lines: experimental solution [feeding-bottle 1].

The axial response of the beam in comparison to the experimental results is presented.

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5 Summary of the results

The results of modelings A and B are compared with experimental measurements, [bib1]. The two models satisfactorily represent the dissymmetrical behavior of the beam in traction and compression. The elastic stiffnesses and post-rubber bands are correctly reproduced. The loops of hysteresis are less full in the results of modelings A and B because the models of behavior do not represent all the dissipative mechanisms of the material reinforced concrete.

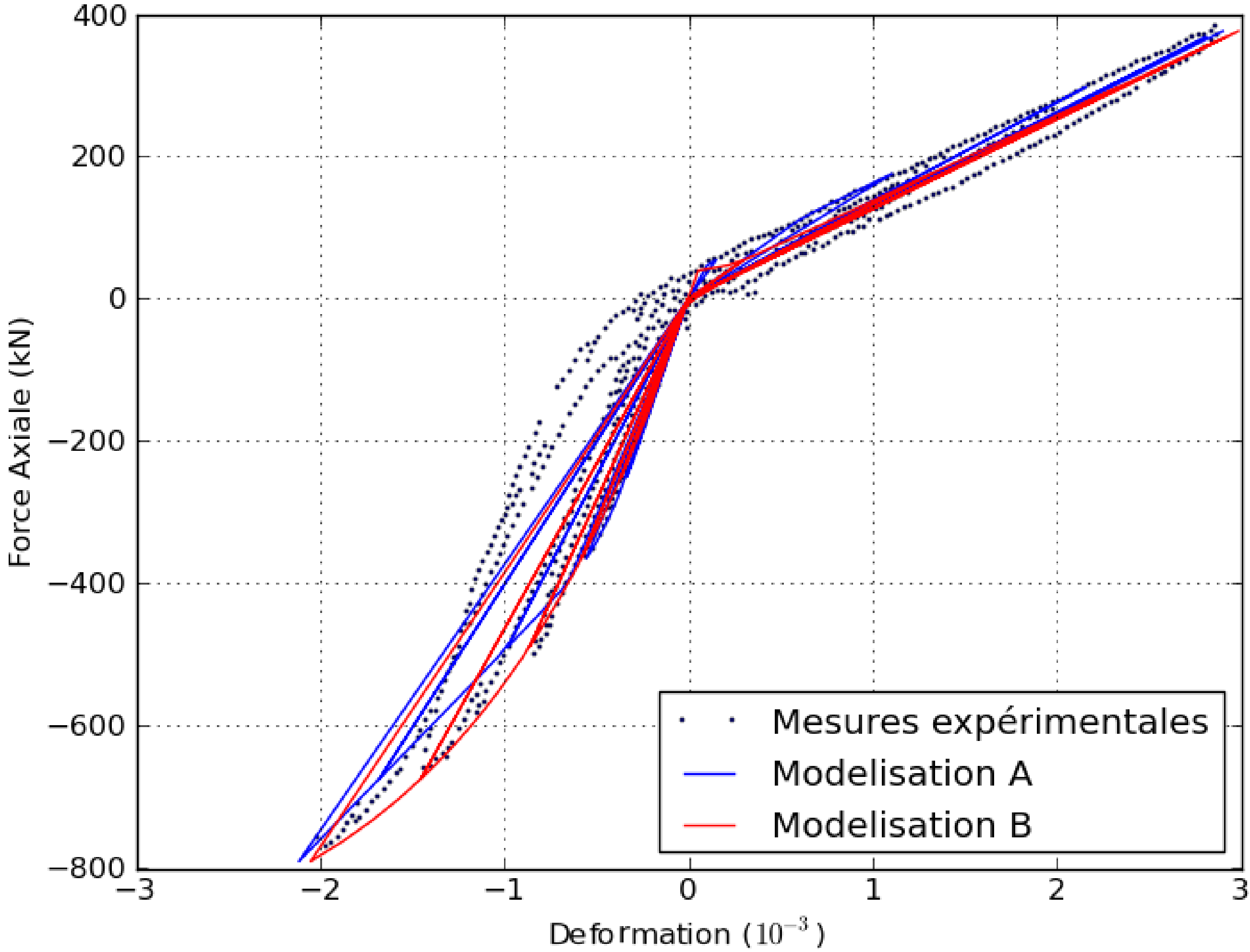

Figure 4 : answer of modelings A (`DKTG` with `GLRC_DM`) and B (`POU_D_EM` with `MAZARS_GC`). In dotted lines: experimental solution [feeding-bottle 1].

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