SSNV214 - Law of behavior `BETON_RAG` : cyclic loading of a concrete test-tube

Summary:

This document presents a test making it possible to validate the capacities of the model of behavior `BETON_RAG`, used to consider the behavior long-term of the structures affected by the reaction alkali-aggregate. One simulates the behavior of a test-tube under cyclic loading in simple traction.

1 Problem of reference

This test with for goal to validate the damage part of the model of behavior BETON_RAG .

1.1 Geometry

The test is pressed on a unit cubic finite element (1m X 1m).

1.2 Property DE the law of behavior

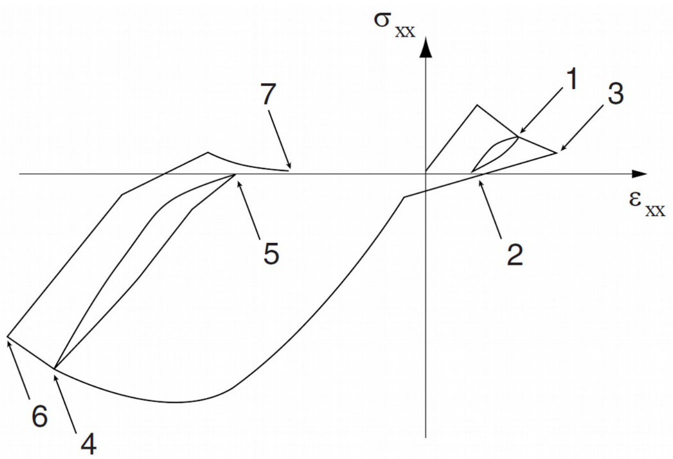
Young modulus: $E=32000\ MPa$
Poisson's ratio: $\nu=0.2$
Parameter of brittleness of the concrete in traction: $MT=1{,}7$
Parameter of brittleness of the concrete in compression: $MC=1{,}5$
Equivalent constraint of the concrete in traction : $\sigma_{ft}=5.66\,MPa$
Equivalent constraint of the concrete in compression: $\sigma_{fc}=38.3\ MPa$
Angle of the criterion of Drucker Prager: $\alpha=0{,}15\,rad$

1.3 Boundary conditions and loadings

The loading, applied to the nodes of the X=1m plan, consist of the application of two cycles of loading in traction then of two cycles of loading in compression:

Control in displacement

1. traction $\epsilon_{xx}=1{,}4.10^{-4}$
2. relaxation with $\sigma_{xx}=0$
3. traction $\epsilon_{xx}=1{,}0.10^{-3}$
4. compression $\epsilon_{xx}=-4{,}0.10^{-3}$
5. relaxation with $\sigma_{xx}=0$
6. compression $\epsilon_{xx}=-5{,}0.10^{-3}$
7. traction $\epsilon_{xx}=0$



The boundary conditions following are applied:
- for nodes in the X=0 plan → DX = 0
- for the N1 node (0, 0.0) → DX = DY = DZ = 0
- for the N5 node (0, 0.1) → DY = 0

2 Reference solution

This test makes it possible to validate the capacity of the model to reproduce a uniaxial cyclic loading. Piloting in imposed deformation makes it possible to traverse the totality of the curve, including the lenitive part. No unrecoverable deformation is visible since the part of the model tested is elastic endommageable. The results of the model are compared with the results of the benchmarck referred to bibliographical.

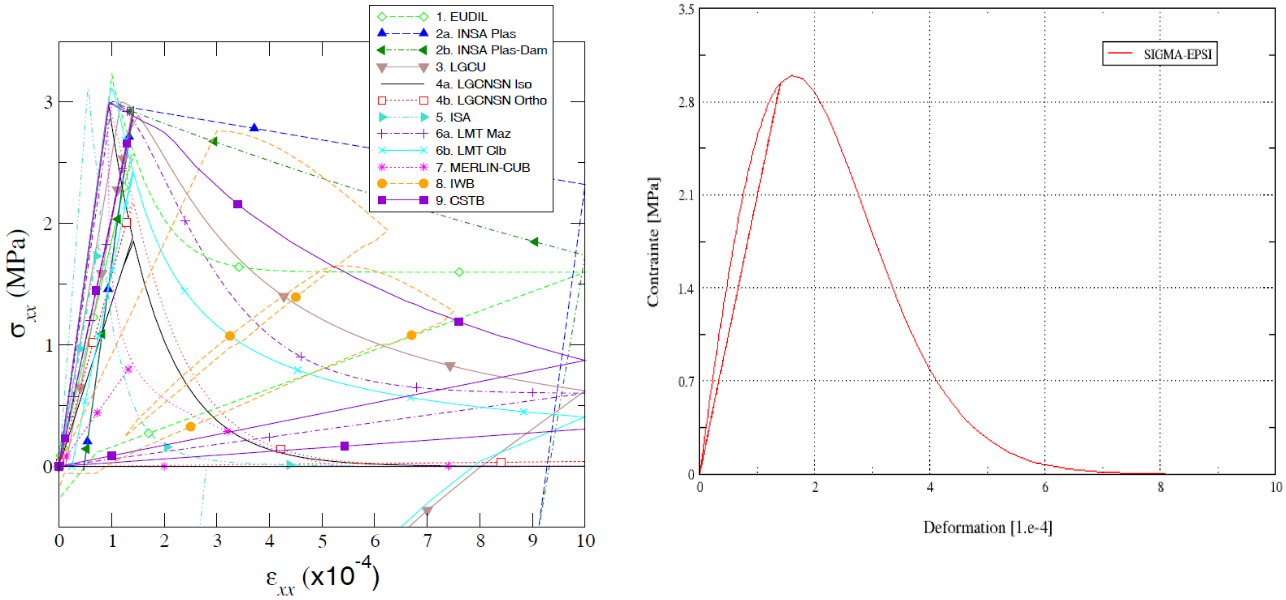


Figure 2-1 : Simulation of the behavior of the concrete under uniaxial cyclic loading of traction (reference of the benchmarck on the left, answer of the model `BETON_RAG` on the right)

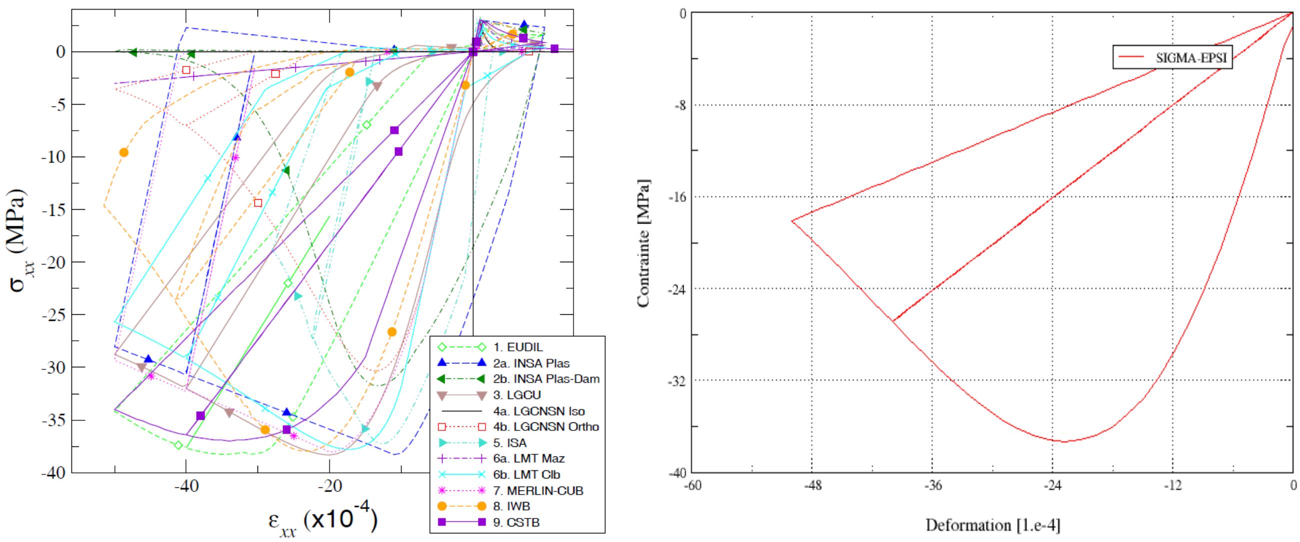


Figure 2-2 : Simulation of the behavior of the concrete under uniaxial cyclic loading of compression (reference of the benchmarck on the left, answer of the model `BETON_RAG` on the right)

2.1 Bibliographical reference

Shahrockh Ghavamian, Ignacio Carol, Arnaud Delaplace, " Discussions over MECA project results ", Re-examined French of Génie Civil, Volume 7 of 2003, page 543-581

3 Modeling A

3.1 Characteristic of modeling

The problem is modelled in 3D.

3.2 Characteristic of the grid

1 mesh HEXA8

3.3 Sizes tested and results

Postprocessing is carried out on the node N6 (1, 0.0):

Identification	Moments	Type	Reference	Tolerance
$SIXX(N6)$	1.0	external source	3.0	7.0%
$SIXX(N6)$	3.0	external source	0.0E+00	0.02
$SIXX(N6)$	7.0	external source	0.0E+00	1.0E-05

4 Modeling B

4.1 Characteristic of modeling

The problem is modelled in 3D.

To converge modeling A uses the elastic matrix, during all simulation. The use of the tangent matrix, during all simulation, led to a not-convergence when the damage becomes too important.
This case test makes it possible to validate the rocker of the tangent matrix towards the elastic matrix as soon as the step of time (after subdivision) becomes lower than a threshold given. One thus starts with the tangent matrix then at the time of the subdivision one rocks out of elastic matrix.

4.2 Characteristic of the grid

1 mesh HEXA8

4.3 Sizes tested and results

Postprocessing is carried out on the node N6 (1, 0.0):

Identification	Moments	Type	Reference	Tolerance
$SIXX(N6)$	1.0	external source	3.0	7.0%
$SIXX(N6)$	3.0	external source	0.0E+00	0.02
$SIXX(N6)$	7.0	external source	0.0E+00	1.0E-05

5 Summary of the results

Results calculated by *Code_Aster* are conform to those described in the benchmarck