00:00 References

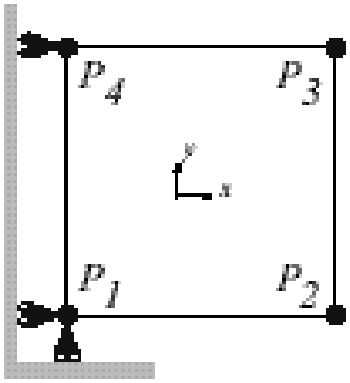
SSNP113 - Rotation of the principal stresses (model of MAZARS)

Abstract:

This case test of mechanics is inspired by works of Willam [bib1] and was used in benchmark EDF/R & D "Model three-dimensional of nonlinear behaviors of concrete material in cracking" [bib2] to evaluate the models of behavior dedicated to the concrete. It is characterized by a specific way of loading which creates a continuous rotation of the principal stresses. It is used here to test the model installation of Mazars in its local version (modelization 3D) and in its delocalized version (modelization 3D_GRAD_EPSI). The validation is carried out by comparison with the results got with code CASTEM2000 with the LGCNSN (Central School of Nantes).

1 Problem of reference

1.1 Geometry and boundary conditions



Appears 1.1-a: Geometry and boundary conditions

Length of the edges: $a=0.56\,m$

Thickness : $0.1\,m$

The loading is such as one obtains a homogeneous stress state and of plane stresses type even if the modelization in Code_Aster were carried out in 3D. The loading is imposed in the form of displacements imposed in two stages:

1) direction $(\Delta\varepsilon_{xx},\Delta\varepsilon_{yy},\Delta\varepsilon_{xy})=(1,-\nu,0)$ until the maximum stress (initiation of the lenitive phase)
2) direction $(\Delta\varepsilon_{xx},\Delta\varepsilon_{yy},\Delta\varepsilon_{xy})=(1,1.5,1)$ until $\varepsilon_{xx}=0.0015$

1) ε_{xx} : displacement on the side delimited by the side P_2-P_3 in the direction OX
2) ε_{yy} : displacement on the side delimited by the side P_3-P_4 in the direction OY
3) ε_{xy} : displacement on the side delimited by the side P_2-P_3 in the direction OY

Is $P5P6P7P8$ the plane of the cube in $z=0.1$.
Practically, the following conditions are imposed

- during all the loading: $P1P4P8P5:\ dx=0$; $P1:\ dy=dz=0$; $P5:\ dy=0$
- during phase 1: $P2\ \ P6:\ dy=0$; $P2P3P7P6:\ dx=1$; $P3P4P8P7:\ dy=-0.2$
- during phase 2: $P2P3P7P6:\ dx=1$; $P4\ \ P8:\ dy=1.5$; $P3\ \ P7:\ dy=3.5$; $P2\ \ P6:\ dy=2.$

1.2 Properties of the material

For the model of Mazars, the following parameters were used:

Behavior elastic:

$$E=32\,000\,MPa\,,\nu=0.2$$

Behavior damaging:

$$\varepsilon_{d0}=9.375.10^{-4};\ Ac=1.15\ ;\ At=0.8\ ;\ Bc=1391.3\ ;\ Bt=10\ 000\ ;\ k=0.7$$

2 Reference solution

It acts of a comparison code-code. The reference used is the code Castem2000 (version 2001). The results were got by the LGCNSN (Central School of Nantes) with the same ones materials parameters and the same discretization in time. Contrary to the computation carried out with *Code_Aster*, Castem computation was carried out under $2D$ the assumption of plane stresses.

The delocalized version of the model of Mazars was tested with a characteristic length null in order to check that one finds the same results as with the local version.

2.1 bibliographical References

1) Willam K., Pramono E. and Sture S. - Fundamental exits of smeared ace models, Proc. of the Int. Conf. one fractures and concrete and rock'n'roll, Huston Texas, 1987, pp 17-19

2) CR-99-232, concrete Evaluating tests one models of non-linear behavior of cracking using three dimensional modelling, Benchmark EDF/Division R & D – S. Ghavamian

3 Modelization A

3.1 Characteristic of the modelization

Modelization 3D
Element MECA_HEXA8

3.2 Characteristic of the mesh

Many nodes: 8
Number of meshes and type: 1 HEXA8

3.3 Quantities tested and results

One compared to the 3 time step different (at the end of stage 1, during the phase of growth of the damage and at the end of the loading) strains, the stresses as well as the value of the damage.

Identification	Reference	*Aster*	% N°10
difference ε_{xx}	9.375 10-5	9.375 10-5	5.8 10-14
σ_{xx}	3.00 106	3.00 106.4.7	10-14
ε_{yy}	– 1.875 10-5	– 1.875 10-5	9.0 10-14
σ_{yy}	0.	– 2.83 10-10	– 2.83 10-10
ε_{xy}	0.	0.	-
σ_{xy}	0.	0.	-
D	0.	2.22 10-16	2.22 10-16

Identification	Reference	*Aster*	% N°25
difference ε_{xx}	1.64 10-4	1.64 10-4	0.065
σ_{xx}	2.04 106	2.04 106	-0.048
ε_{yy}	8.67 10-5	8.68 10-5	0.099
σ_{yy}	$1.35\ 10^{6.1.3}$	$5\ 10^{6}$	-0.016
ε_{xy}	$7.03\ 10^{-5}$	$7.04\ 10^{-5}$	0.081
σ_{xy}	$6.34\ 10^{5}$	$6.\ 33\ 10^{5}$	-0.016
D	0.66211	0.66238	0.040

Identification	Reference	Aster	% N°310
difference ε_{xx}	1.50 10-3	1.50 10-3	0.06
σ_{xx}	3.69 105	3.69 105	-0.002
ε_{yy}	2.09 10-3	2.09 10-3	0.064
σ_{yy}	$4.59\ 10^{5}$	$4.\ 59\ 10^{5}$	5.22 10-4
ε_{xy}	$1.41\ 10^{-3}$	$1.41\ 10^{-3}$	0.063
σ_{xy}	$2.16\ 10^{5}$	$2.\ 16\ 10^{5}$	6.85 10-4
D	0.99423	0.99424	8.07 10-4

4 Modelization B

4.1 Characteristic of the modelization

the use of the delocalized version model of Mazars passes by the use of modelization 3D_GRAD_EPSI and implies the use of quadratic elements.
The test is carried out with a characteristic length null.

Modelization: 3D_GRAD_EPSI
Element : MGCA_HEXA20

4.2 Characteristic of the mesh

Many nodes: 20
Number of meshes and type: 1 HEXA20

4.3 Quantities tested and results

One compared to the 3 time step different (at the end of stage 1, during the phase of growth of the damage and at the end of the loading) strains, the stresses as well as the value of the damage.

Identification	Reference	*Aster*	% N°10
difference ε_{xx}	9.375 10-5	9.375 10-5	2.02 10-13
σ_{xx}	3.00 106	3.00 106	-2.33 10-13
ε_{yy}	– 1.875 10-5	– 1.875 10-5	5.42 10-14
σ_{yy}	0.	5.98 10-10	5.98 10-10
ε_{xy}	0.	6.88 10-21	6.88 10-21
σ_{xy}	0.	0.	-
D	0.	3.88 10-15	3.88 10-15

Identification	Reference	*Aster*	% N°25
difference ε_{xx}	1.64 10-4	1.64 10-4	0.038
σ_{xx}	2.04 106	2.04 106	-1.89 10-4
ε_{yy}	8.67 10-5	8.67 10-5	0.022
σ_{yy}	1.35 10 6.1.3	5 10 6	-3.39 10-4
ε_{xy}	7.03 10-5	7.03 10-5	0.018
σ_{xy}	6.34 105	6.34 105.1.4	10-5
D	0.66211	0.66211	-1.88 10-4

Identification	Reference	*Aster*	% N°310
difference ε_{xx}	1.50 10-3	1.50 10-3	2.02 10-13
σ_{xx}	3.69 105	3.69 105	9.02 10-5
ε_{yy}	2.09 10-3	2.09 10-3	– 2.39 10-4
σ_{yy}	4.59 10 5	4. 59 10 5	-8.66 10-5
ε_{xy}	1.41 10-3	1.41 10-3	1.23 10-13
σ_{xy}	2.16 105	2.16 105	7.66 10-5
D	0.99423	0.99423	4.42 10-4

5 Summary of the results

With very weak variations about $0.05\ \%$ to the maximum on the stresses in the phase more nonlinear and about $0.002\ \%$ after complete damage on a test where the loadings are not radial, one can consider as the model installation of Mazars as well in local version as NON-local, is faithful to the original model.