SSNV151 - Traction/Compression with the law of behavior BETON_DOUBLE_DP

Summary

This case of validation is intended to check the model of behavior $3D$ BETON_DOUBLE_DP formulated within the framework of thermoplasticity, for the description of the nonlinear behavior of the concrete in traction and compression, with the taking into account of the irreversible variations of the thermal and mechanical characteristics of the concrete, particularly sensitive at high temperature.
The description of cracking is treated within the framework of plasticity, using an energy equivalence, by identifying the density of energy of cracking in mode I, with the plastic work of a homogeneous medium are equivalent, where the plastic deformation is uniformly distributed in an “elementary” zone. This approach preserves the continuity of the formulation of the model, on the whole of its behavior, and contributes to avoid the possible digital difficulties during the change of state of material.
The pathological sensitivity of the digital solution to the space discretization (grid), generated by the introduction of a softening behavior of the concrete in traction and compression, is partially solved by introducing an energy of cracking or rupture, dependent a characteristic length l_c, dependent in keeping with elements.
The resolution of the equations constitutive of the model is carried out by an implicit scheme.

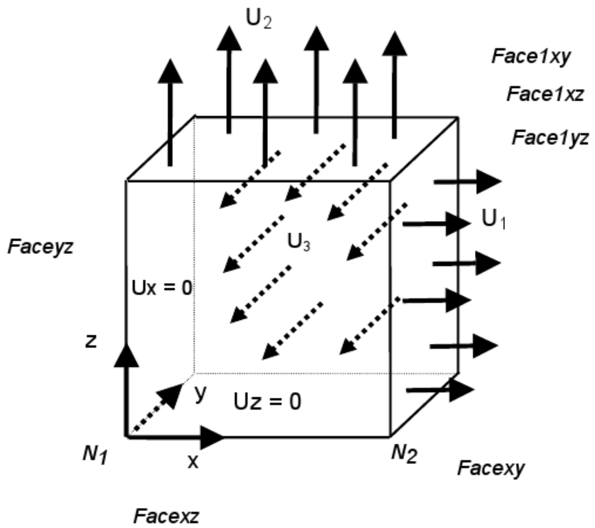
It is about a cube with 8 nodes subjected to a uniaxial pressing, in imposed displacement to which is added a biaxial traction when one reached an important work hardening in traction. This loading led to the typical case of a hydrostatic state of stress, solved by projection at the top of the cone of traction, when one places oneself in a hydrostatic diagram forced equivalent/forced. It is about a case test of not-regression.

1 Problem of reference

1.1 Geometry

It is about a cube with 8 nodes, whose three faces have a normal displacement no one, and the three opposite faces have an imposed and identical normal displacement.
The made cube $1\,mm$ on side. In modeling A, the cube is directed according to the reference mark $Oxyz$.

Modeling A



1.2 Material properties

To test the establishment of thermal dilation and the withdrawal of desiccation, one forces a field of temperature and a field of drying variables so that the deformations generated by the two phenomena are compensated, while considering that the dilation coefficients thermal and withdrawal of desiccation are equal. The values related to drying do not have any physical direction, the test is from this point of view, purely data-processing.

For the usual linear mechanical characteristics:

Young modulus:	$E=32\,000\,MPa$
Poisson's ratio:	$\nu=0.18$
Thermal dilation coefficient:	$\alpha=10^{-5}/°C$
Coefficient of withdrawal of desiccation:	$\kappa=10^{-5}$
Temperature of reference	$T_{ref}=0\,°C$
Drying of reference	$C_{ref}=20$

For the nonlinear mechanical characteristics of the model BETON_DOUBLE_DP :

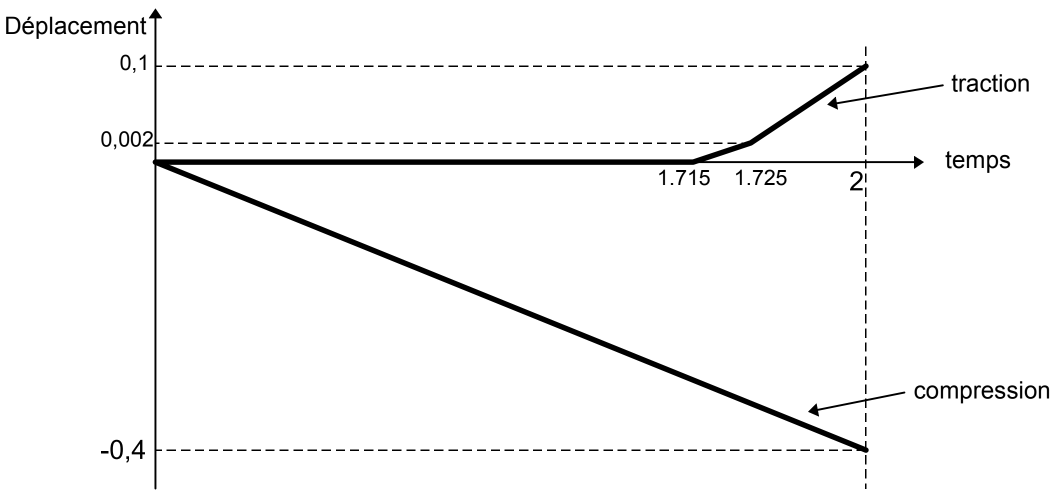
Resistance in uniaxial pressing:	$f'c=40\,N/mm^2$
Resistance in uniaxial traction:	$f't=4\,N/mm^2$
Report of resistances in compression biaxial/uniaxial pressing:	$\beta=1.16$
Energy of rupture in compression:	$\mathrm{Gc}=10\,Nmm/mm^2$
Energy of rupture in traction:	$\mathrm{Gt}=0.1\,Nmm/mm^2$
Report of the limit elastic to resistance in uniaxial pressing:	30%

1.3 Boundary conditions and loadings mechanical

Increasing field of temperature of $0°C$ with $20°C$.
Field of drying decreasing from 20 to 0.

Lower face of the cube ($facexy$) :	blocked according to oz .
Higher face of the cube ($face1xy$) :	variable displacement imposed in mm
Left face of the cube ($faceyz$) :	blocked according to ox .
Right face of the cube ($face1yz$) :	variable displacement imposed in mm
Face before cube ($facexz$) :	blocked according to oy .
Face postpones cube ($face1xz$) :	variable displacement imposed in mm

The mechanical loading is applied in displacement imposed to the various faces of the cube. One applies a compression to the face $face1xz$, affected by a first multiplying coefficient and a traction according to the faces $face1xy$ and $face1yz$, affected by a second multiplying coefficient, no one during the first part at the beginning of loading, according to the following diagram:

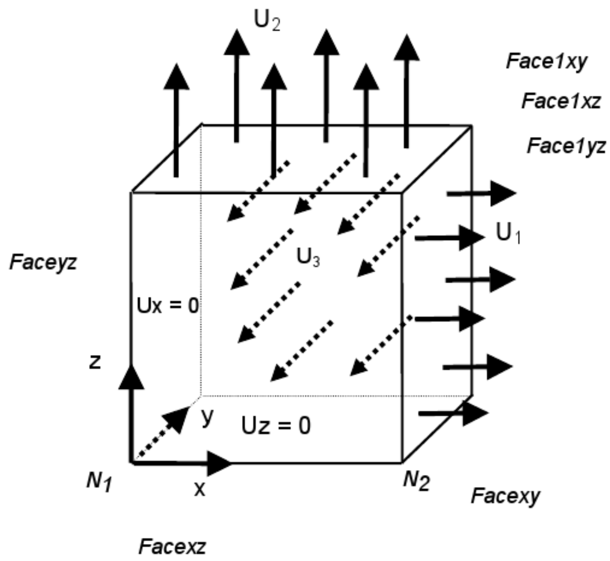


2 Modeling A

2.1 Characteristics of modeling

3D (HEXA8)

1 element, stress field and uniform deformation.



2.2 Characteristics of the grid

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

2.3 Sizes tested and results

The components were tested xx and yy stress field SIGM_ELNO, plastic deformation cumulated in compression, plastic deformation cumulated in traction (first and second internal variable, second component of the field VARI_ELNO) and the plastic state (the fourth variable of the field VARI_ELNO). The plastic state is worth 1 in compression, 11 after projection at the top of the cone of compression, 2 in traction, 22 after projection at the top of the criterion of traction, 3 in compression and traction together, and 33 after projection out of the two tops of the two cones. Displacement being imposed, the field EPSI_ELNO is not tested.
The values given here correspond to version 7.2.25.

Field SIGM_ELNO component SIXX

Identification	Reference	*Aster*	% difference
For a displacement imposed in $U_3=-1.$ and $U_1=U_2=0.$	–	–	–
For a displacement imposed in $U_3=-1.725$ and $U_1=U_2=0.010$	–	2.5737449	–
For a displacement imposed in $U_3=-1.8$ and $U_1=U_2=0.02872$	–	0.6767446	–
For a displacement imposed in $U_3=-2.$ and $U_1=U_2=0.1$	–	2.666667 10^{-6}	–

Field SIGM_ELNO component SIYY

Identification	Reference	*Aster*	% difference
For a displacement imposed in $U_3=-1.$ and $U_1=U_2=0.$	–	– 17.4575632	–
For a displacement imposed in $U_3=-1.725$ and $U_1=U_2=0.010$	–	2.5737449	–
For a displacement imposed in $U_3=-1.8$ and $U_1=U_2=0.02872$	–	0.6767446	–
For a displacement imposed in $U_3=-2.$ and $U_1=U_2=0.1$	–	-3.622988 10^{-5}	–

Field VARI_ELNO component V1 (plastic deformation cumulated in compression)

Identification	Reference	*Aster*	% difference
For a displacement imposed in $U_3=-1.$ and $U_1=U_2=0.$	-	0.1995285	-
For a displacement imposed in $U_3=-1.725$ and $U_1=U_2=0.010$	-	0.3429299	-
For a displacement imposed in $U_3=-1.8$ and $U_1=U_2=0.02872$	-	0.3449657	-
For a displacement imposed in $U_3=-2.$ and U_1 = U_2 = 0.1	-	0.3849539	-

Field VARI_ELNO component $V2$ **(plastic deformation cumulated in traction)**

Identification	Reference	*Aster*	% difference
For a displacement imposed in $U_3=-1.$ and $U_1=U_2=0.$	-	-	-
For a displacement imposed in $U_3=-1.725$ and $U_1=U_2=0.010$	-	1.231450e-03	-
For a displacement imposed in $U_3=-1.725$ and $U_1=U_2=0.02872$	-	2.638289e-02	-
For a displacement imposed in $U_3=-2.$ and $U_1=U_2=0.1$	-	8.373868e-02	-

Field VARI_ELNO component $V4$ **(plastic state)**

Identification	Reference	*Aster*	% difference
For a displacement imposed in $U_3=-1.$ and $U_1=U_2=0.$	-	1.	-
For a displacement imposed in $U_3=-1.725$ and $U_1=U_2=0.010$	-	22.	-
For a displacement imposed in $U_3=-1.725$ and $U_1=U_2=0.02872$	-	22.	-
For a displacement imposed in $U_3=-2.$ and $U_1=U_2=0.1$	-	3.	-