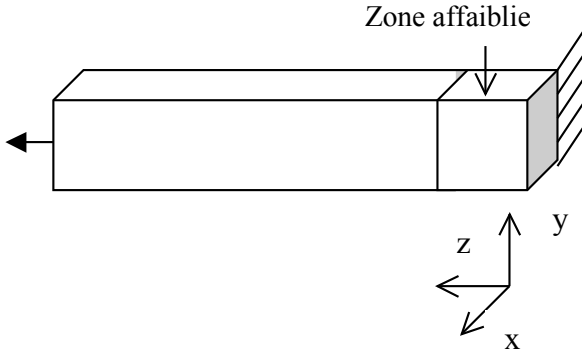
SSNV147 - Tension of a brittle bar: validation of Summarized

control:

The use of lenitive models can lead to brutal snap-back which makes difficult the course of computation. To follow these instabilities, two types of control are available in Code_Aster: control by elastic prediction (PRED_ELAS), which depends on the constitutive law and control in strain (DEFORMATION) generic. To validate these techniques, one carries out a traction test on a bar of square section which one weakened a section in order to cause the localization of the damage.

1 Problem of reference

1.1 Geometry and boundary conditions



Appears 1.1-a : geometry of studied structure

the studied structure is a bar $10\,m$ length, of square section of $0.1\times 0.1\,m$. A face is clamped, the opposite face is subjected to a force FZ varying linearly with the time of 1 with $5\,N$.

1.2 Material properties

Constitutive law	Behavior elastic	Behavior damaging (left healthy)	Behavior damaging (weakened zone)
ENDO_FRAGILE	$E=20\,000\,MPa$ $\nu=0$	$\sigma_y=6\,MPa$ $E_T=-10000\,MPa$	$\sigma_y=5\,MPa$ $E_T=-10000\,MPa$
ENDO_ISOT_BETON	$E=20\,000\,MPa$ $\nu=0$	$\sigma_y=6\,MPa$ $E_T=-10000\,MPa$	$\sigma_y=5\,MPa$ $E_T=-10000\,MPa$
ROUSS_PR and ROUSSELIER	$E=206\,400\,MPa$ $\nu=0.3$	$D=2$ $\sigma_1=490\,MPa$ $f_0=5\text{E-}04$ curve of tension: $R(p)=r_i+(r_o-r_i)e^{-bp}$ p : cumulated plastic strain $r_i=1500\,MPa$ $r_o=520\,MPa$ $b=2.4$	$D=2$ $\sigma_1=400\,MPa$ $f_0=5\text{E-}04$ curve of tension: $R(p)=r_i+(r_o-r_i)e^{-bp}$ p : cumulated plastic strain $r_i=1500\,MPa$ $r_o=520\,MPa$ $b=2.4$
BETON_DOUBLE_DP	$E=31000\,MPa$ $\nu=0.22$	$f_c=38.3\,MPa$ $f_t=4.0\,MPa$ $\beta=1.16$ $G_t=2.83\text{E}-04\,Nmm/mm^2$ $G_c=2.83\text{E}-02\,Nmm/mm^2$	$f_c=38.3\,MPa$ $f_t=3.0\,MPa$ $\beta=1.16$ $G_t=2.83\text{E}-04\,Nmm/mm^2$ $G_c=2.83\text{E}-02\,Nmm/mm^2$

2 Reference solution

the values tested are values of NON-regression.

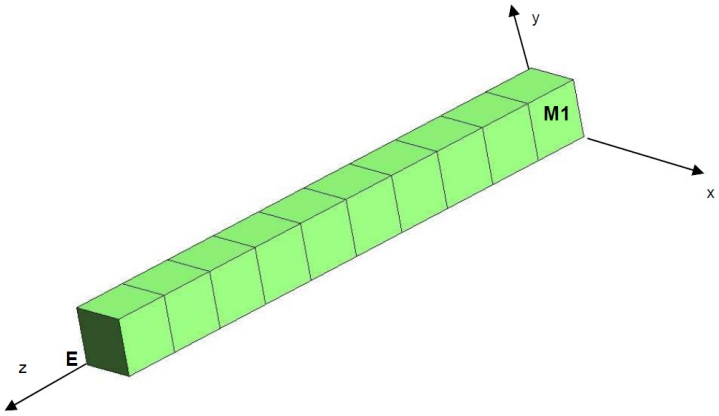
3 Modelization A

3.1 Characteristic of the modelization

The model tested is 3D. The constitutive law used is model ENDO_FRAGILE. One validates control by elastic prediction.

3.2 Characteristics of the mesh

The mesh is obtained by GIBI. It is composed of 10 elements HEXA8 (only one element in the section)



3.3 Quantities tested and results

to validate the solution obtained, 11 at the sequence number are tested:

1) the following displacement z of the face on which the loading is imposed,
2) the stress zz as well as the value of the damage in the weakened mesh

Name of the field	Component	Place	*Code_Aster*
DEPL	DZ	E	9.25E-05
SIEF_ELGA	SIZZ	$M1$, point 1.0.5	
VARI_ELGA	V1	$M1$, point 1	0.96428571486

One also tests elastic work on the structure as well as the real work obtained thanks to command POST_ELEM.
More specifically to validate the constancy of control, one in addition checks with the same sequence number (11) the value of time and ETA_PILOTAGE.

Name of the field	Component	*Code_Aster*
TRAV_EXT	TRAV_ELAS	3.3125E-07
TRAV_EXT	TRAV_REEL	1.91875E-06
INST	-	11
ETA_PILOTAGE	-	0.5

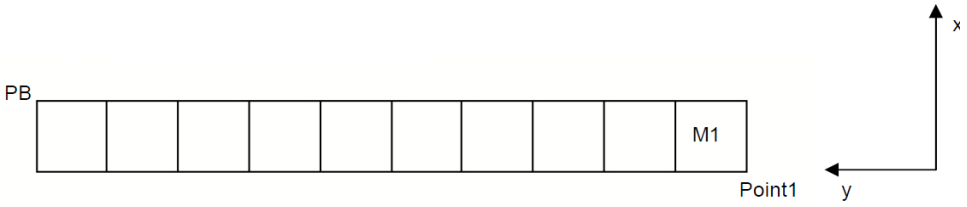
4 Modelization B

4.1 Characteristic of the modelization

The modelization tested is AXIS. The constitutive law used is model ENDO_FRAGILE. One validates control by elastic prediction.

4.2 Characteristics of the mesh

The mesh is obtained by GIBI. It is composed of 10 elements QUA8.



4.3 Quantities tested and results

to validate the solution obtained, 11 at the sequence number are tested:

1) the following displacement y of the face on which the loading is imposed,
2) the stress yy as well as the value of the damage in the weakened mesh

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Name of the field	Component	Place	*Aster*
DEPL	DY	PB	9.25E-05
SIEF_ELGA	SIYY	$M1$, point 1.0.5	
VARI_ELGA	V1	$M1$, point 1	0.96428571486

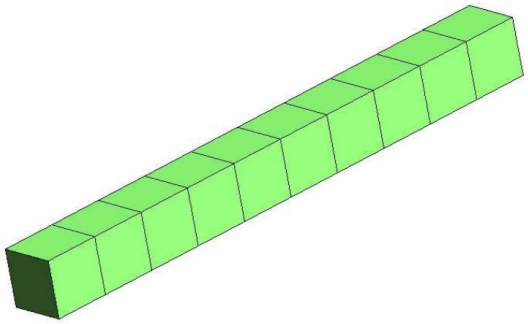
5 Modelization C

5.1 Characteristic of the modelization

The model tested is 3D. The constitutive law used is model ENDO_ISOT_BETON. One validates control by strain.

5.2 Characteristics of the mesh

The mesh is obtained by GIBI. It is composed of 10 elements HEXA8 (only one element in the section)



5.3 Quantities tested and results

to validate the solution obtained, 41 at the sequence number are tested:

1) the following displacement z of the face on which the loading is imposed,
2) the stress zz as well as the value of the damage in the weakened mesh

Name of the field	Component	Place	*Aster*
DEPL	DZ	E	9.25E-05
SIEF_ELGA	SIZZ	$M1$, point 1.0.5	
VARI_ELGA	V1	$M1$, point 1	0.90

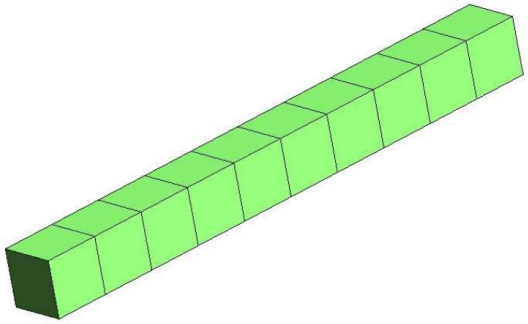
6 Modelization D

6.1 Characteristic of the modelization

The model tested is 3D. The constitutive law used is model ROUSS_PR. One validates control by strain.

6.2 Characteristics of the mesh

The mesh is obtained by GIBI. It is composed of 10 elements HEXA8 (only one element in the section)



6.3 Quantities tested and results

to validate the solution obtained, 30 at the sequence number are tested:

1) the following displacement z of the face on which the loading is imposed,
2) the stress zz in the weakened mesh

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Name of the field	Component	Place	*Aster*
DEPL	DZ	E	2.723E-03
SIEF_ELGA	SIZZ	$M1$, point 1	585.8

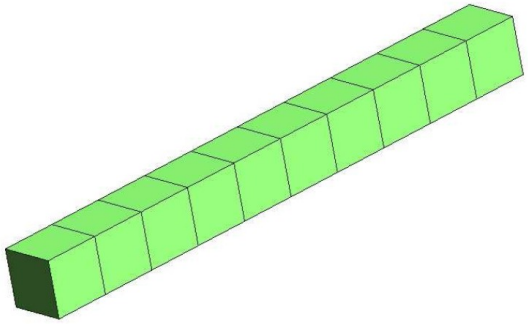
7 Modelization E

7.1 Characteristic of the modelization

The model tested is 3D. The constitutive law used is model ENDO_ISOT_BETON. One validates control by elastic prediction.

7.2 Characteristics of the mesh

The mesh is obtained by GIBI. It is composed of 10 elements HEXA8 (only one element in the section)



7.3 Quantities tested and results

to validate the solution obtained, one tests at the sequence number 19:

1) the following displacement z of the face on which the loading is imposed,
2) the stress zz as well as the value of the damage in the weakened mesh

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Name of the field	Component	Place	*Aster*
DEPL	DZ	E	9.25E-05
SIEF_ELGA	SIZZ	$M1$, point 1.0.5	
VARI_ELGA	V1	$M1$, point 1	0.90

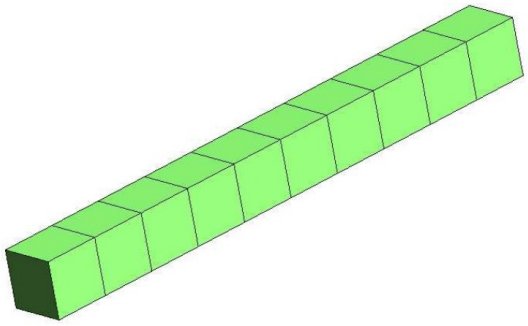
8 Modelization F

8.1 Characteristic of the modelization

The model tested is 3D. The constitutive law used is the BETON_DOUBLE_DP model . One validates control by elastic prediction.

8.2 Characteristics of the mesh

The mesh is obtained by GIBI. It is composed of 10 elements HEXA8 (only one element in the section)



8.3 Quantities tested and results

to validate the solution obtained, 41 at the sequence number are tested:

1) the following displacement z of the face on which the loading is imposed,
2) the stress zz in the weakened mesh

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Name of the field	Component	Place	*Aster*
DEPL	DZ	E	1.08163518E-04
SIEF_ELGA	SIZZ	$M1$, point 1	2.94149327

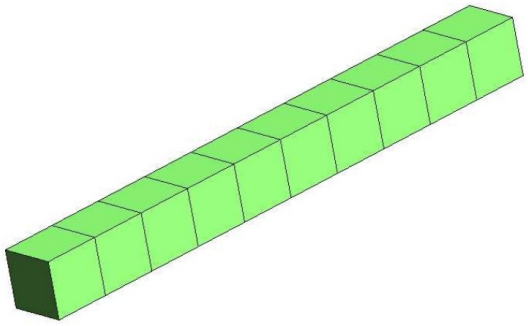
9 Modelization I

9.1 Characteristic of the modelization

The model tested is 3D. The constitutive law used is model ROUSSELIER (version large deformations). One validates control by strain.

9.2 Characteristics of the mesh

The mesh is obtained by GIBI. It is composed of 10 elements HEXA8 (only one element in the section)



9.3 Quantities tested and results

to validate the solution obtained, 21 at the sequence number is tested:

1) the following displacement z of the face on which the loading is imposed,
2) the stress zz as well as the value of the damage in the weakened mesh
3) the value of the indicator of plasticity in the weakened mesh

Name of the field	Component	Place	*Aster*
DEPL	DZ	E	2.72012E-03
SIEF_ELGA	SIZZ	$M1$, point 1	586.395
VARI_ELGA	V3	$M1$, point 1	0.

10 Summary of the results

This benchmark makes it possible to check the good performance of control for the various lenitive constitutive laws. The got results provide values of non regression.