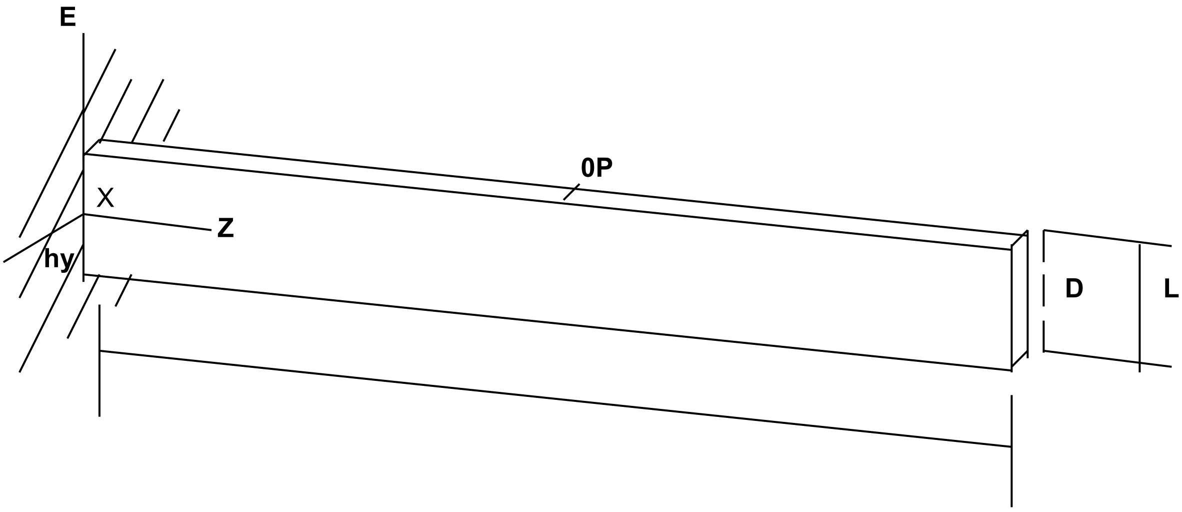
SSNV196 – Beam 3D in bending (stabilized elements HEXA8 under-integrated)

Summarized:

This test makes it possible to 3D compare the elements hexahedrons with 8 nodes under-integrated stabilized by method ASM
into standard elements HEXA8 of Aster on a beam in pure bending in elasticity and plasticity. A third modelization in HEXA20 makes it possible to compare the results and the performances of the elements.

1 Problem of reference

1.1 Geometry



dimensions of structure are there:

Length $L=25\,m$
Width $D=4\,m$
Thickness $e=1\,m$

1.2 Properties of the material

Modulus Young: $E=10000.\,Pa$

Poisson's ratio: $\nu=0.25$

Tangent modulus: $E_T=1000.\,Pa$

Yield stress: $\sigma_Y=200.\,Pa$

1.3 Boundary conditions and loadings

Fixed support in the plane $x=0$ ($u_x=u_y=u_z=0$). (face $X0$)

$u_z=0$ on all the nodes to simulate a plane strain state.

Shearing stress σ_{xy} : $h_y=15(1-\frac{1}{4}y^2)$ on the face $x=L$. (face XL)

2 Reference solution

2.1 Method of calculating used for the reference solution

the deflection of reference is calculated on a very fine mesh with elements HEXA20. She is regarded as the reference solution. She corresponds to the modelization C.

2.2 Results of reference

Elasticity :

Not	Quantity and unit	Value
P	Mark with arrows u_y (mm)	3.72
P	Deflection u_x (mm)	-0.439

2.3

Plasticity : (model of Von Mises with isotropic hardening)

Not	Quantity and unit	Value
P	Mark with arrows u_y (mm)	4.548
P	Deflection u_x (mm)	-0.5127

2.4 bibliographical References

[1] [R3.06.11] reference document Aster: Finite elements HEXA8 under-integrated stabilized by method ASM. X.Desroches

[2] T.Belytschko and L.P.Bindeman. Assumed strain stabilization of the eight node hexahedral element. Methods computer *in Applied Mechanics and Engineering, 105 (1993), pp 225-260 [3] F.Abed*

- Meraïm and A.Combescure. Stabilization of the finite elements under-integrated. Ratio interns *n°247 LMT-Cachan A, January 2001*

3 Modelization Characteristic

3.1 of the Standard modelization of modelization

used: element MECA_HEXS8 (hexahedrons with 8 stabilized under-integrated nodes) limiting Conditions: DDL_IMPO =

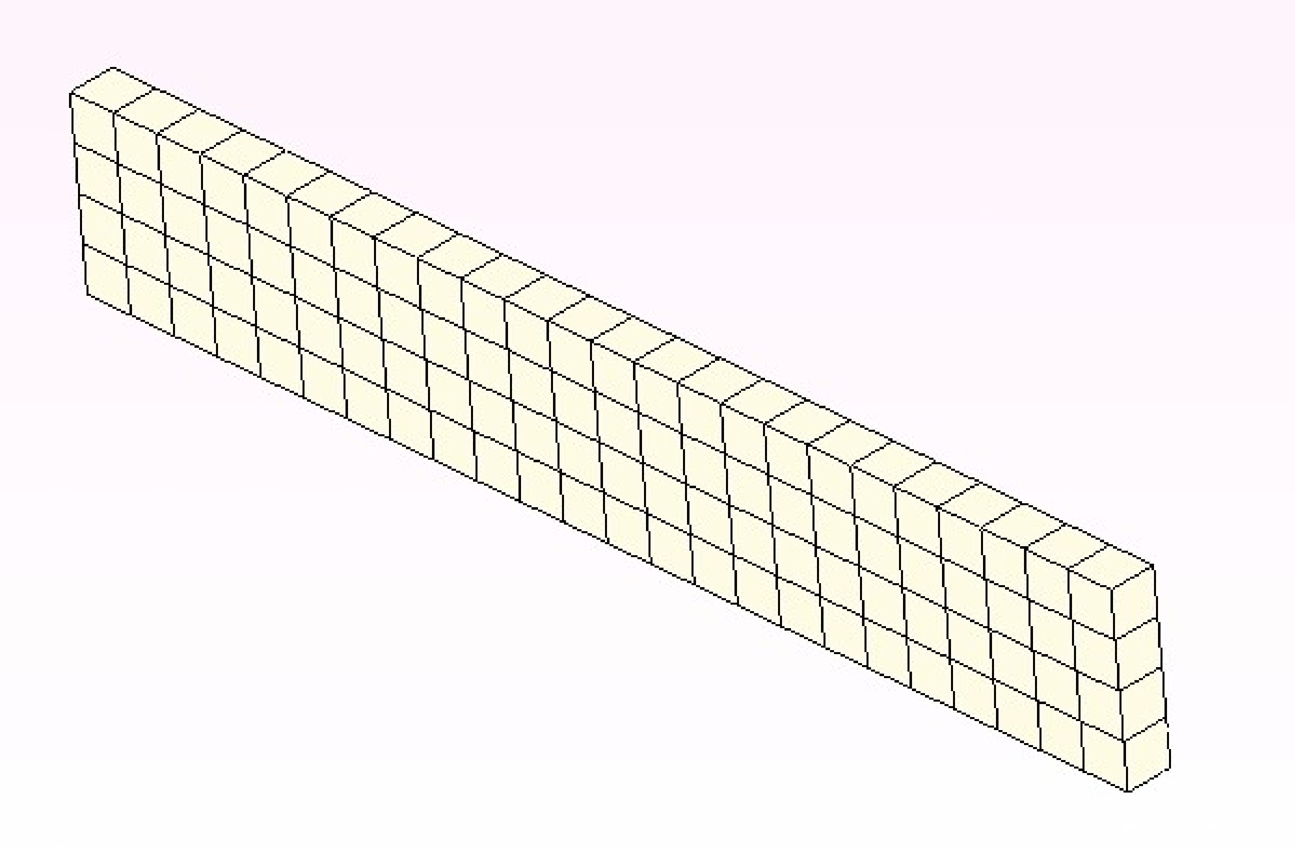
(GROUP_NO = `TOUT ` , DZ = 0.) FACE_IMPO =
(GROUP_MA = `X0 ` , DX = 0. , DY = 0.) Shears

on the face: FORCE_FACE XL = (GROUP_MA = "XL `, FY =) Characteristic h_y

3.2 of the mesh Many nodes

: 250 Number of meshes

and types: 96 HEXA8, 200 QUAD4 Values tested



3.3

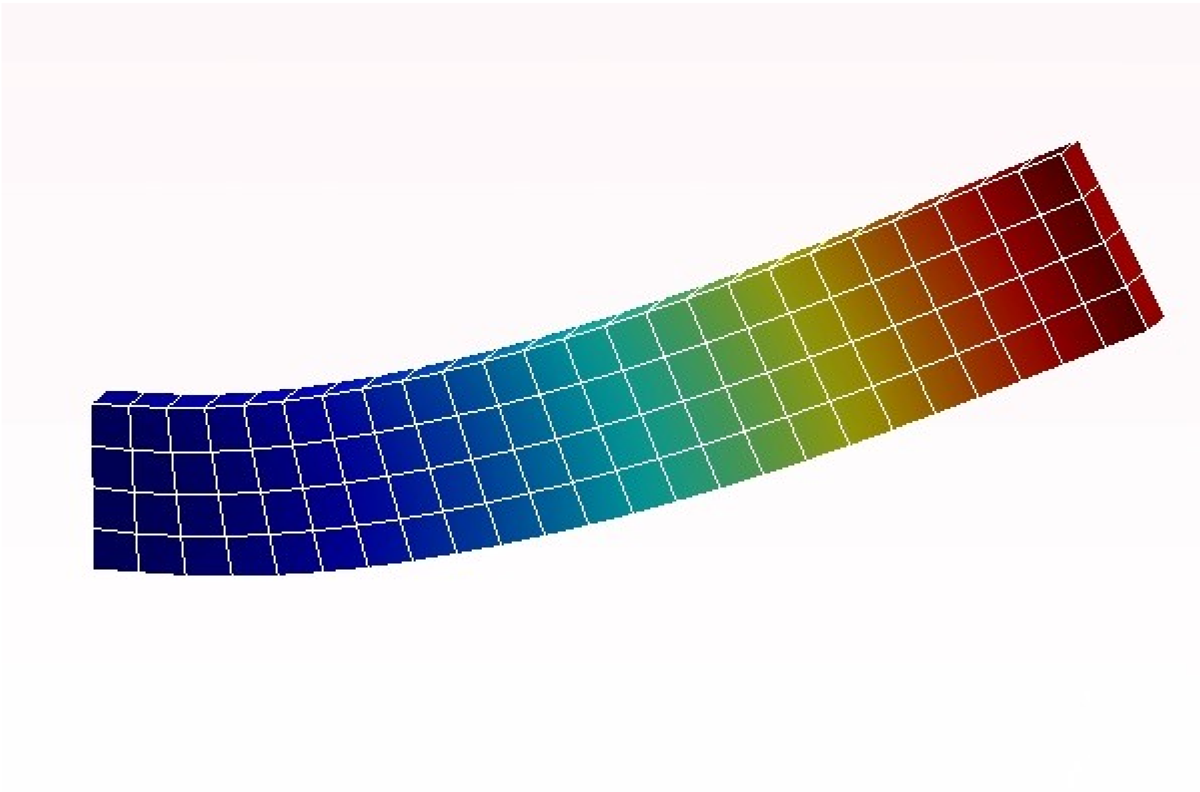
3.4 Identification

Reference	Aster % difference	Marks with arrows in
elasticity The node is outside the field of definition with a right profile of the EXCLU type node: ,		

component P : 3.72 3.7128 DY	-0.193	The node is outside the field of definition with a right profile of the EXCLU type node:	,
component P : – 0.439 – DX	0.4385 0.104	Deflection	in
plasticity The node is outside the field of definition with a right profile of the EXCLU type node: ,			
component P : 4.547 4.6959 DY	3.276	The node is outside the field of definition with a right profile of the EXCLU type node:	,
component P : – 0.5127 – DX	0.5289 -3.157	Deformed shape	

3.5 Elastic design

: Modelization



4 B Characteristic

4.1 of the Standard modelization of modelization

used: element MECA_HEXA8 (hexahedrons with 8 nodes) limiting
Conditions: DDL_IMPO =

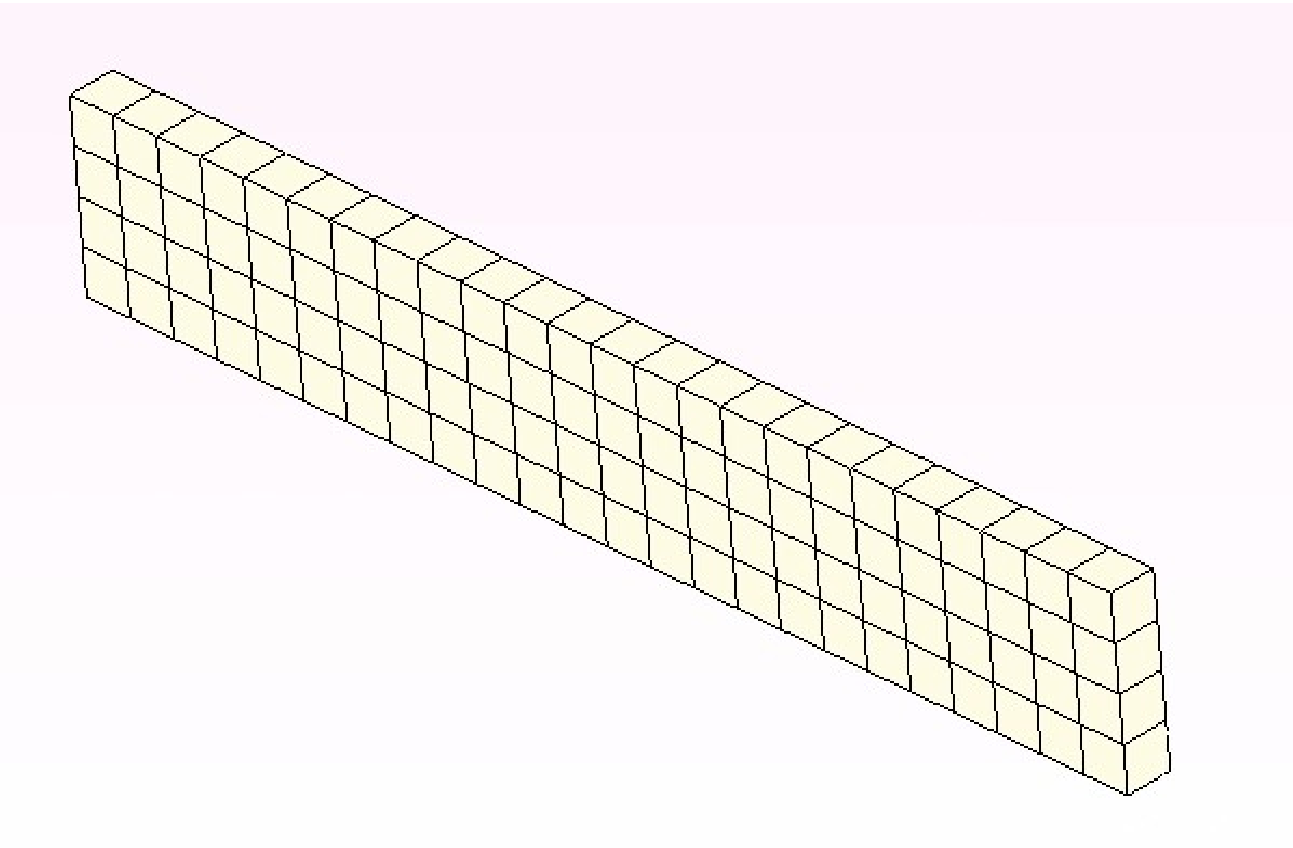
(GROUP_NO = "TOUT " , DZ = 0.) FACE_IMPO =
(GROUP_MA = "X0 " , DX = 0. , DY = 0.) Shears

on the face: FORCE_FACE XL = (GROUP_MA = "XL `, FY =) Characteristic h_y

4.2 of the mesh Many nodes

: 250 Number of meshes

and types: 96 HEXA8, 200 QUAD4 Values tested



4.3

4.4 Identification

Reference	Aster % difference	Marks with arrows in
elasticity The node is outside the field of definition with a right profile of the EXCLU type node: ,		

component P : 3.72 3.5934 DY	-3.4	The node is outside the field of definition with a right profile of the EXCLU type node:	,
component P : – 0.439 – DX	0.4243 -3.35	Deflection	in
plasticity The node is outside the field of definition with a right profile of the EXCLU type node: ,			
component P : 4.547 4.0203 DY	-11.58	The node is outside the field of definition with a right profile of the EXCLU type node:	,
component P : – 0.5127 – DX	0.4621 9.875	RemarqueOn	

4.5 notes

qu" with the same number of meshes (and thus of nodes), the results of L" HEXA8 standard are definitely less good, in elasticity as in plasticity. Moreover, if one increases the number D" elements one N" never reaches the deflection of reference, which is the case with L" element stabilized. On a mesh
with relatively little nodes (250), L" element stabilized is more powerful in time computation (- 10%). Modelization

5 C Characteristic

5.1 of the Standard modelization of modelization

used: element MECA_HEXA20 (hexahèdres with 20 nodes) limiting
Conditions: DDL_IMPO =

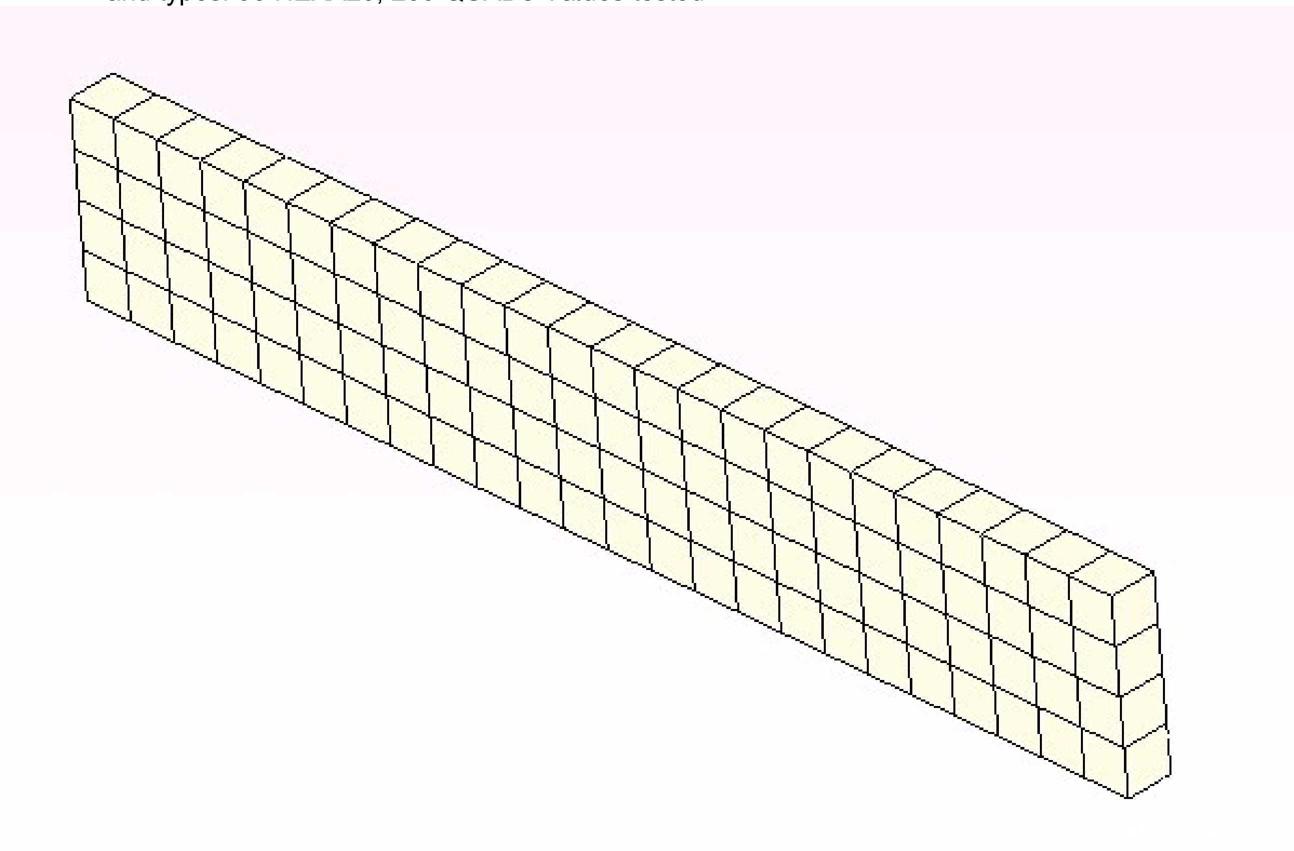
(GROUP_NO = `TOUT ` , DZ = 0.) FACE_IMPO =
(GROUP_MA = "X0 " , DX = 0. , DY = 0.) Shears

on the face: FORCE_FACE XL = (GROUP_MA = "XL `, FY =) Characteristic h_y

5.2 of the mesh Many nodes

: 815 Number of meshes

and types: 96 HEXA20, 200 QUAD8 Values tested



5.3 Identification

Aster Marks with arrows	in
elasticity The node is outside the field of definition with a right profile of the EXCLU type node: ,	

component P: 3.72 The node is outside the field of definition with a right profile of the EXCLU type node: DY	,
component P: – 0.439 Deflection DX	in
plasticity The node is outside the field of definition with a right profile of the EXCLU type node: ,	
component P: 4.547 The node is outside the field of definition with a right profile of the EXCLU type node: DY	,
component P: – 0.5127 RemarqueCette DX	

5.4 modelization

is that which is used as reference for computations with the hexahedrons to 8 nodes. Summary of

6 the results One notes

on this example D" a beam in bending that blockings of L" standard element HEXA8 are raised by L" element HEXA8 under-integrated and stabilized by method ASM ("assumed strain method"). Moreover, this

element is more powerful in time computation.