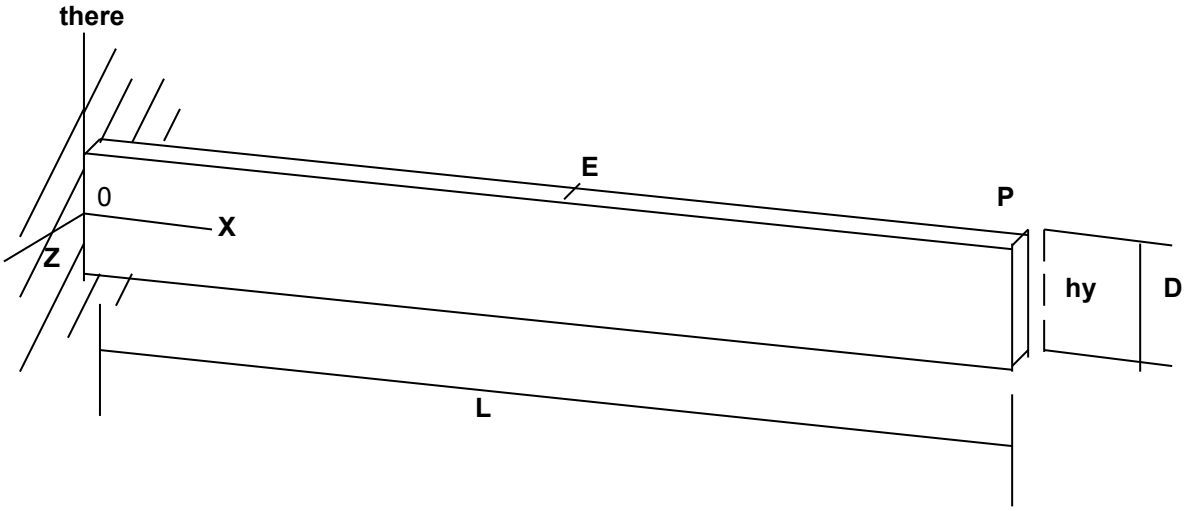
SSNV196 – Beam 3D in inflection (stabilized elements HEXA8 under-integrated)

Summary:

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

1 Problem of reference

1.1 Geometry



Dimensions of the structure are:

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

1.2 Properties of material

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

Poisson's ratio: $\nu=0.25$

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

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

1.3 Boundary conditions and loadings

Embedding in the plan $x=0$ ($u_x=u_y=u_z=0$). (face $X0$)

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

Shear 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 arrow of reference is calculated on a very fine grid with elements HEXA20. She is regarded as the reference solution. She corresponds to modeling C.

2.2 Results of reference

Elasticity :

Not	Size and unit	Value
P	Arrow u_y (mm)	3.72
P	Arrow u_x (mm)	-0,439

2.3

Plasticity : (law of Von Mises with isotropic work hardening)

Not	Size and unit	Value
P	Arrow u_y (mm)	4,548
P	Arrow u_x (mm)	-0.5127

2.4 Bibliographical references

[1] [R3.06.11] reference document Aster: Finite elements under-integrated HEXA8 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 under-integrated finite elements. *Report interns n°247 LMT-Cachan, January 2001*

3 Modeling A

3.1 Characteristics of modeling

Type of modeling used: element MECA_HEXS8 (hexahedrons with 8 stabilized under-integrated nodes)
Limiting conditions:

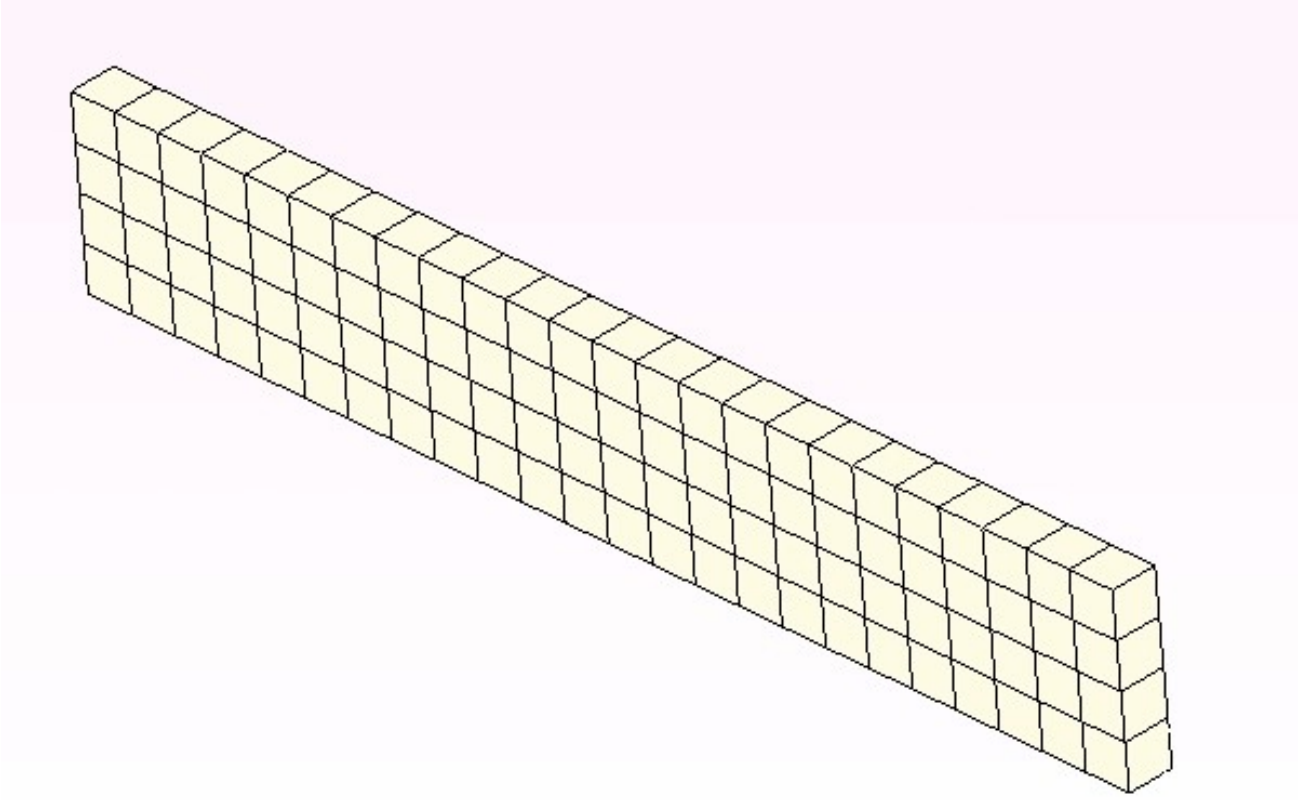
```
DDL_IMPO =     ( GROUP_NO = 'ALL', DZ = 0.)
FACE_IMPO =    ( GROUP_MA = 'X0',   DX = 0., DY = 0.)
```

Shearing on the face XL : FORCE_FACE= (GROUP_MA = 'XL', FY = h_y)

3.2 Characteristics of the grid

Many nodes: 250

Many meshs and types: 96 HEXA8, 200 QUAD4



3.3

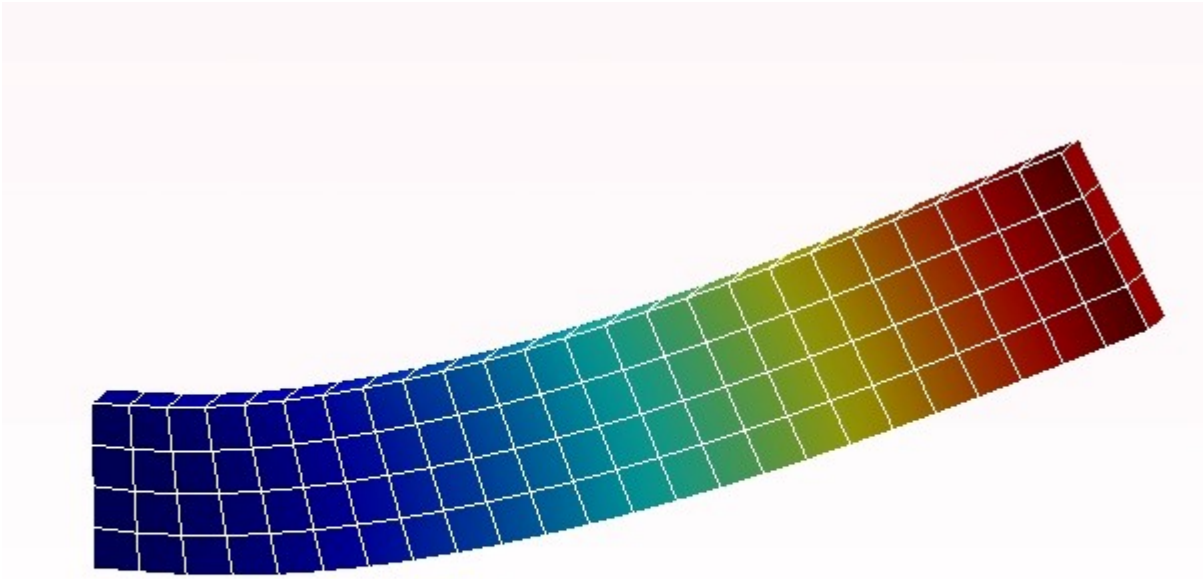
3.4 Values tested

Identification	Reference	*Aster*	% difference
Arrow in elasticity			
Node: P , component: DY	3.72	3.7128	-0,193
Node: P , component: DX	– 0,439	– 0.4385	0,104
Arrow in plasticity			

Node: P , component: DY	4,547	4.6959	3,276
Node: P , component: DX	– 0.5127	– 0.5289	-3,157

3.5 Deformation

Elastic design :



4 Modeling B

4.1 Characteristics of modeling

Type of modeling used: element MECA_HEXA8 (hexahedrons with 8 nodes)
Limiting conditions:

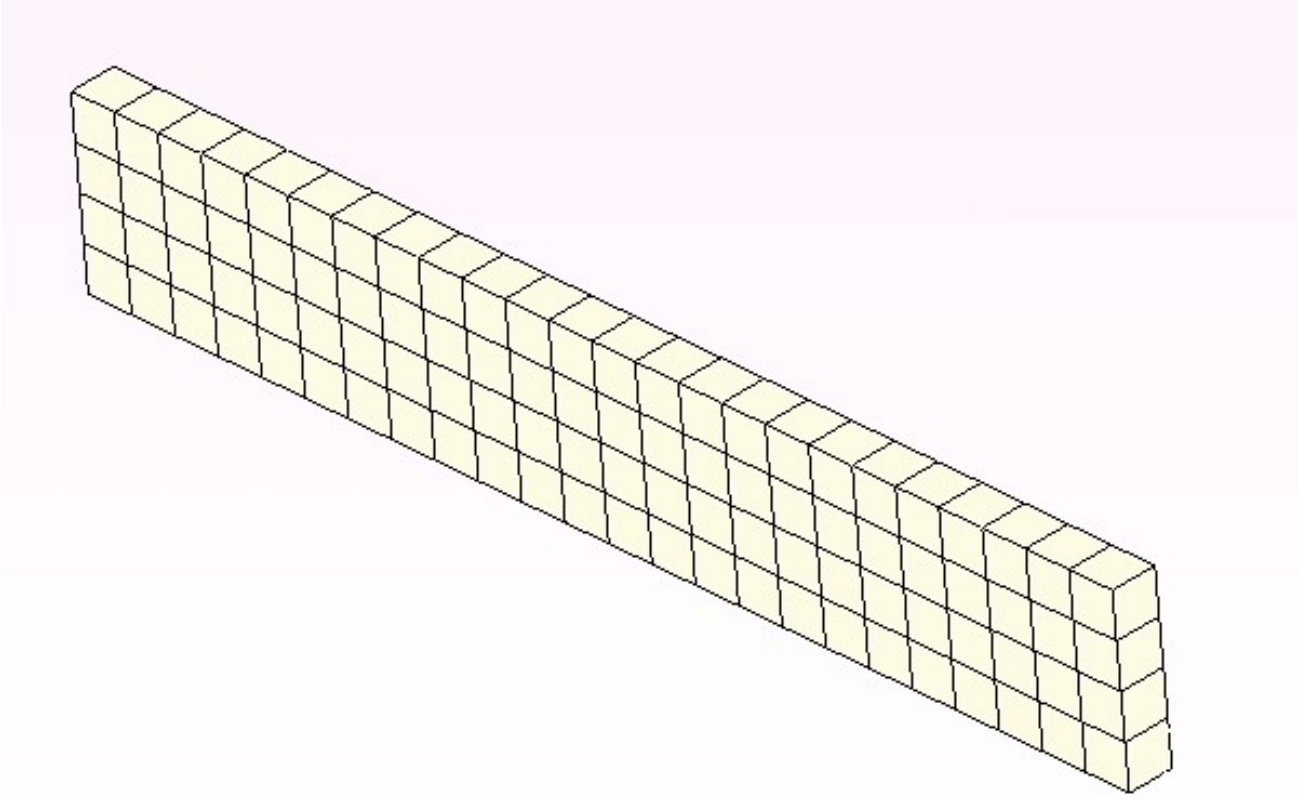
```
DDL_IMPO =      ( GROUP_NO = 'ALL', DZ = 0.)
FACE_IMPO =     ( GROUP_MA = 'X0',   DX = 0., DY = 0.)
```

Shearing on the face XL : FORCE_FACE= (GROUP_MA = 'XL', FY = h_y)

4.2 Characteristics of the grid

Many nodes: 250

Many meshs and types: 96 HEXA8, 200 QUAD4



4.3

4.4 Values tested

Identification	Reference	*Aster*	% difference
Arrow in elasticity			
Node: P , component: DY	3.72	3.5934	-3.4
Node: P , component: DX	– 0,439	– 0.4243	-3.35
Arrow in plasticity			

Node: P , component: DY	4,547	4.0203	-11.58
Node: P , component: DX	– 0.5127	– 0.4621	9,875

4.5 Notice

One notes that with the same number of meshs (and thus of nodes), the results of the standard HEXA8 are definitely less good, in elasticity as in plasticity. Moreover, if one increases the number of elements one never reaches the arrow of reference, which is the case with the stabilized element. On a grid with relatively little nodes (250), the stabilized element is more performing in time calculation (- 10%).

5 Modeling C

5.1 Characteristics of modeling

Type of modeling used: element MECA_HEXA20 (hexahèdres with 20 nodes)
Limiting conditions:

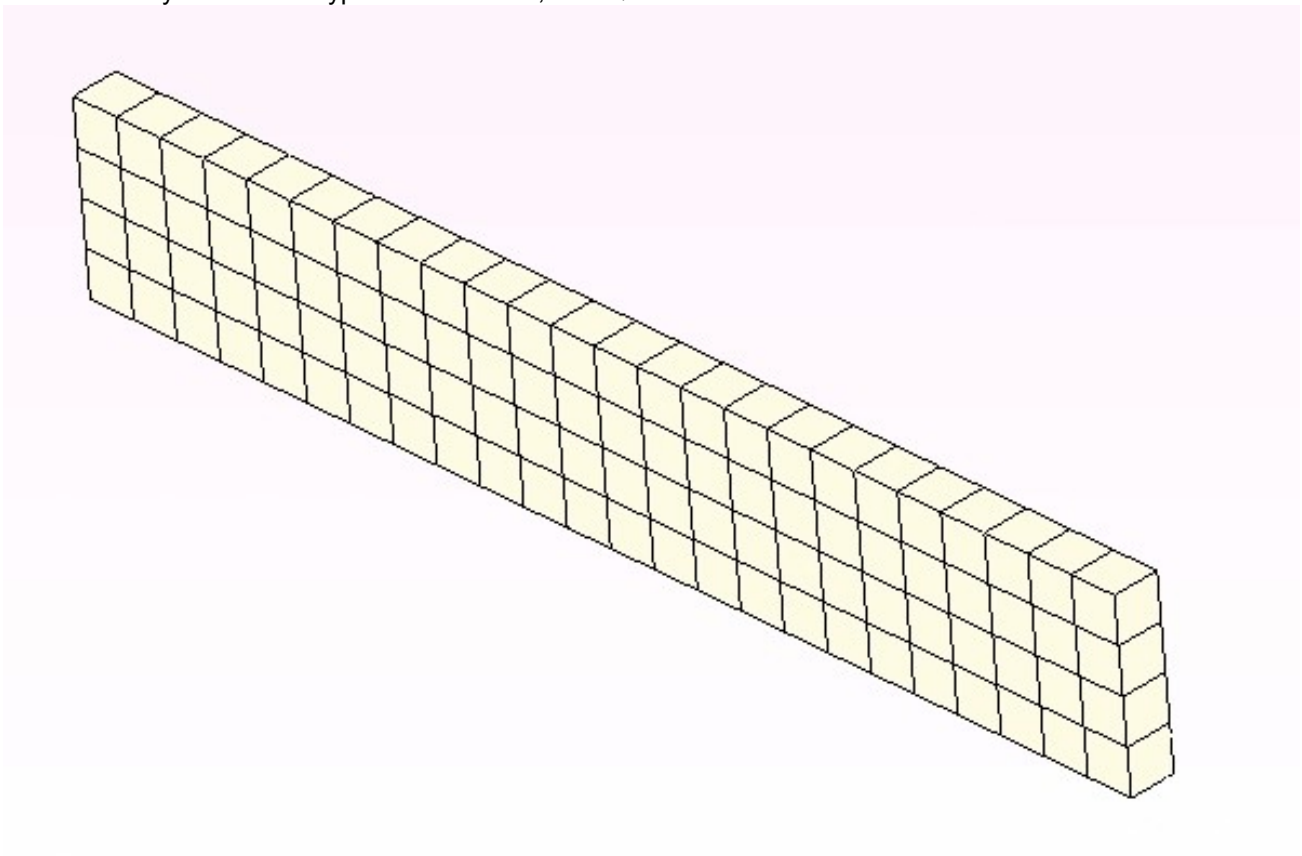
```
DDL_IMPO =     ( GROUP_NO = ‘ ALL ‘ , DZ = 0.)
FACE_IMPO =    ( GROUP_MA = ‘ X0 ‘,   DX = 0. , DY = 0.)
```

Shearing on the face XL : FORCE_FACE= (GROUP_MA = ‘XL‘, FY = h_y)

5.2 Characteristics of the grid

Many nodes: 815

Many meshs and types: 96 HEXA20, 200 QUAD8



5.3 Values tested

Identification	*Aster*
Arrow in elasticity	
Node: P , component: DY	3.72
Node: P , component: DX	– 0,439
Arrow in plasticity	

Node: P , component: DY	4,547
Node: P , component: DX	– 0.5127

5.4 Notice

This modeling is that which is used as reference for calculations with the hexahedrons to 8 nodes.

6 Summary of the results

One notes on this example of a beam in inflection that blockings of standard element HEXA8 are raised by element HEXA8 under-integrated and stabilized by method ASM (“assumed strain method”).

Moreover, this element is more performing in time calculation.