# SSLX103 – Inflection of a reinforced concrete 3D beam with reinforcements modelled by bars

**Summary:**

The objective of this test is to validate the modeling of steels by linear elements bars SEG2 in concrete modelled by quadratic voluminal elements.
Two modelings are compared:

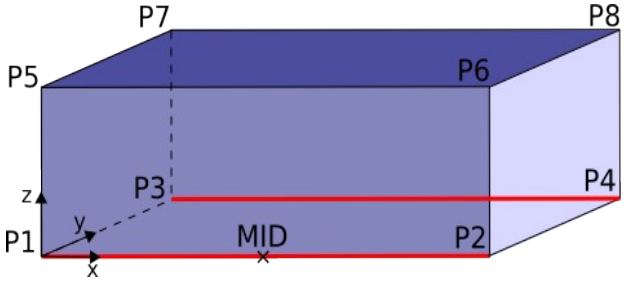
- a quadratic voluminal element contains an element bars linear
- a quadratic voluminal element contains two elements bars linear

with a calculation of reference where the elements bars quadratic are obtained with Castem.

# 1 Problem of reference

## 1.1 Geometry

One considers a concrete beam length $l=5\,m$ and of square section of $w=h=1\,m$ of with dimensions. It contains two longitudinal reinforcements $P1P2$ and $P3P4$. The section of the two bars is of $0{,}003\,m^2$.




## 1.2 Properties of material

The material concrete is elastic isotropic with the following properties:

- $E=30\,GPa$
- $\nu=0.2$

The material steel is elastic isotropic with the following properties:

- $E=200\,GPa$
- $\nu=0.25$

## 1.3 Boundary conditions and loadings

The edge $P1P3P7P5$ is blocked.
One imposes a displacement of $0{,}001\,m$ according to the direction $z$ at the edge $P2P4P8P6$.

## 1.4 Initial conditions

Nothing

# 2 Reference solution

It is a question of validating the use of linear elements to represent steels present in concrete represented by voluminal elements.

Two modelings are possible:

- Modeling a: a quadratic voluminal element contains an element bars linear. The nodes medium of the quadratic voluminal elements are not connected to the bars ( L ) .
- Modeling b: a quadratic voluminal element contains two elements bars linear. All the voluminal nodes are connected to nodes of steels ( LL ) .

The reference solution was obtained with CASTEM 2000. The grid used contains the same number of meshs but the elements bars modelling the reinforcements are quadratic ( Q ) .

The results in term of constraint in the concrete, displacement and effort in steel are compared.

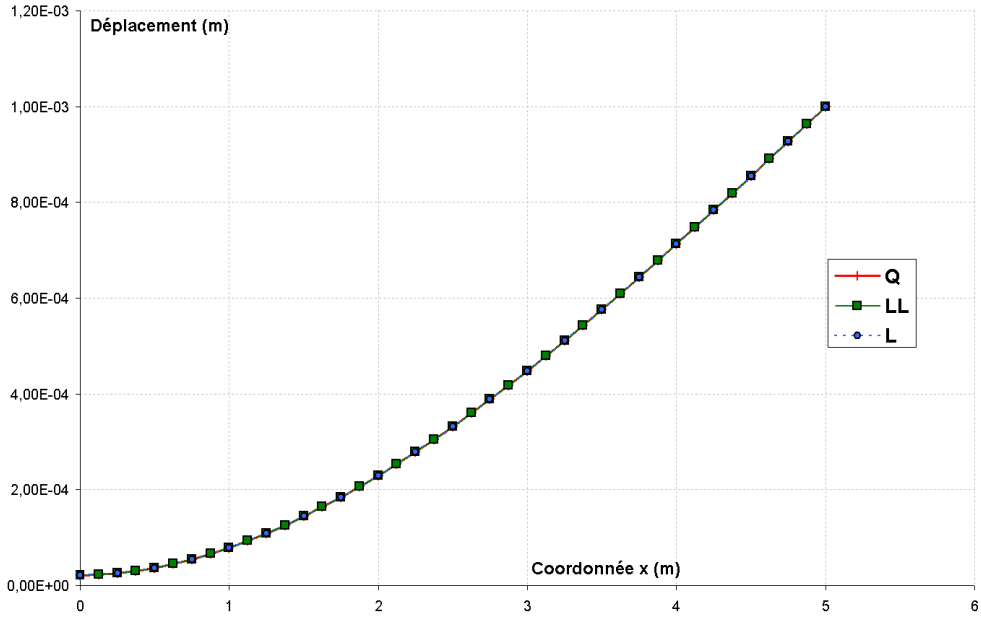



**Illustration 1: Displacement along the beam**

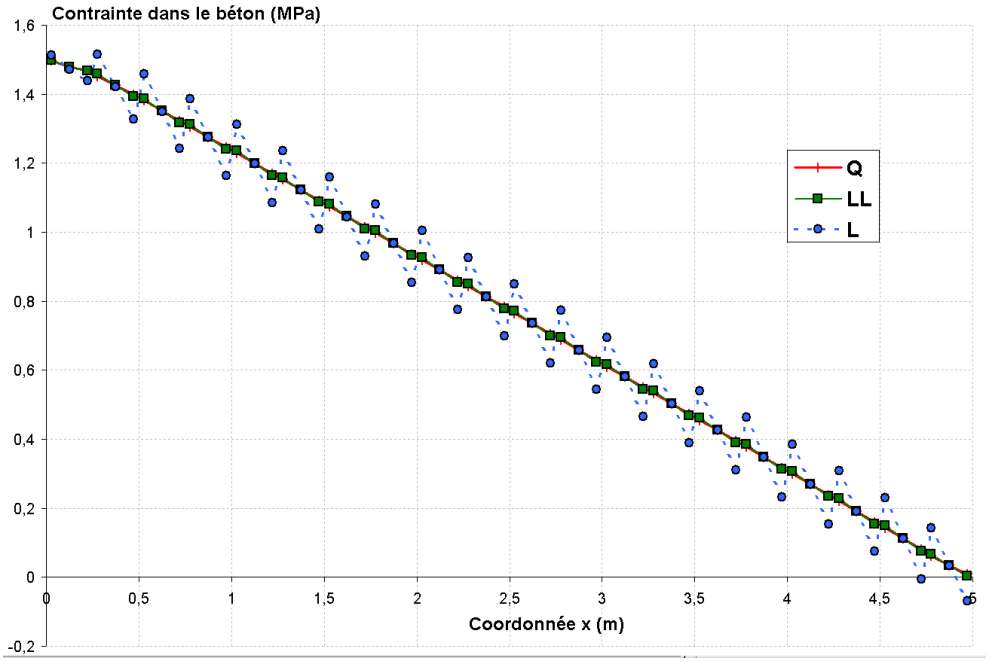



**Illustration 2: Constraints in the concrete**

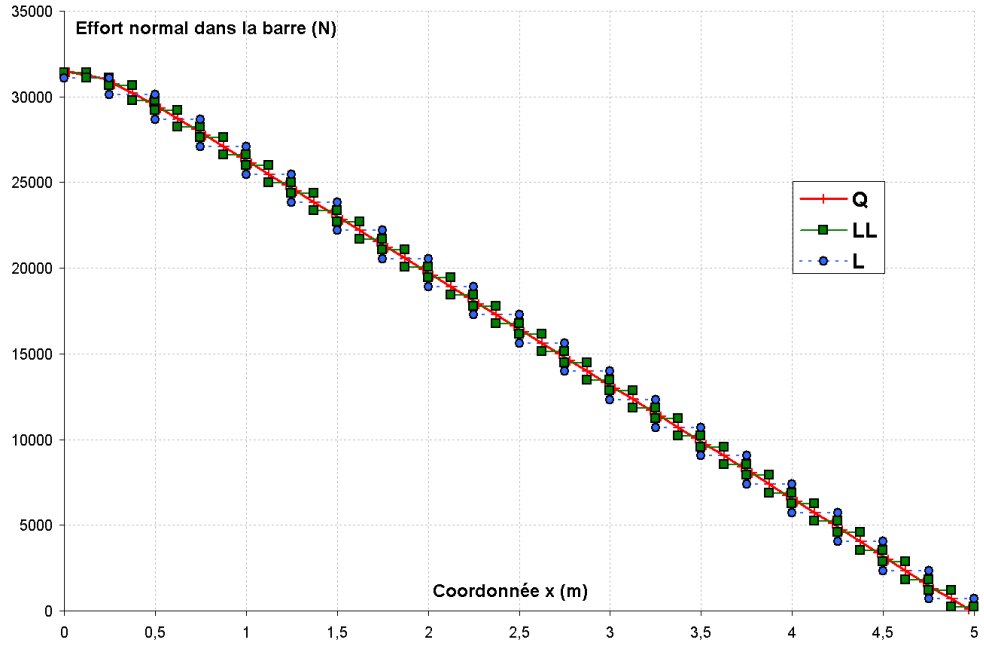



**Illustration 3: Bar tension**

It results from it that modeling B ( LL ) is very close to the quadratic Castem model Q . Modeling A ( L ) is not sufficient and one can observe oscillations on the constraints in the concrete.
The model ( LL ) is thus recommended for the modeling of elements bars in conjunction with voluminal quadratic elements.

## 2.1 Bibliographical references

[1] NECS. NOTE OF STUDY: Study of modeling reinforced concrete: quadratic concrete mesh with element bars linear. N001_A301_2012_ET_EDF. 2012.

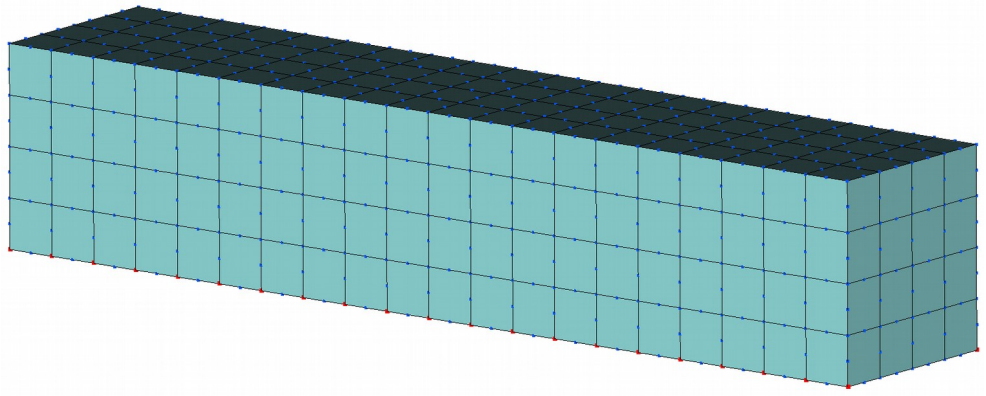
# 3 Modeling A

## 3.1 Characteristics of modeling

Modelings are used 3D and BAR.

## 3.2 Characteristics of the grid

The grid contains 320 elements of the type HEXA20 and 40 elements of the type SEG2.



## 3.3 Sizes tested and results

One tests displacement, the constraints in the concrete and the bar tension $P1P2$ in the middle of the beam.

| Identification | Type of reference | Value of reference | Tolerance |
|---|---|---|---|
| Not $MID$ - $DZ$ | 'EXTERNAL SOURCE' | 3.31642E-04 | 1% |
| Not $MID$ - $DZ$ | 'NON_REGRESSION' | 3.3164387632833E-04 | 0.1% |
| Element $755$ - $SIXX$ not $19$ | 'EXTERNAL SOURCE' | 7.65317E+05 | 12% |
| Element $755$ - $SIXX$ not $19$ | 'NON_REGRESSION' | 8.4944649489882E+05 | 0.1% |
| Element $11$ - $N$ | 'EXTERNAL SOURCE' | 16260 | 5% |
| Element $11$ - $N$ | 'NON_REGRESSION' | 15620.717115628 | 0.1% |

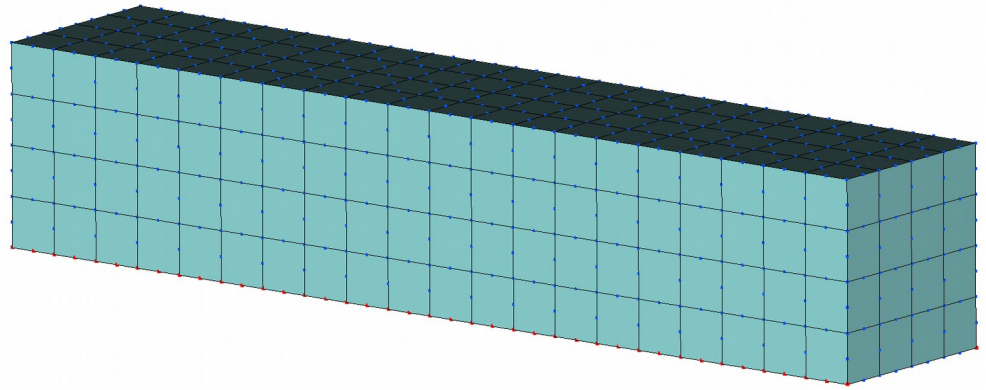
# 4 Modeling B

## 4.1 Characteristics of modeling

Modelings are used 3D and BAR.

## 4.2 Characteristics of the grid

The grid contains 320 elements of the type HEXA20 and 80 elements of the type SEG2.



## 4.3 Sizes tested and results

One tests displacement in the corner high left of the plate.

| Identification | Type of reference | Value of reference | Tolerance |
|---|---|---|---|
| Not $MID$ - $DZ$ | 'EXTERNAL SOURCE' | 3.31642E-04 | 1% |
| Not $MID$ - $DZ$ | 'NON_REGRESSION' | 3.3164387632833E-04 | 0.1% |
| Element $795$ - $SIXX$ not $19$ | 'EXTERNAL SOURCE' | 7.65317E+05 | 1% |
| Element $795$ - $SIXX$ not $19$ | 'NON_REGRESSION' | 7.7144384489479E+05 | 0.1% |
| Element $21$ - $N$ | 'EXTERNAL SOURCE' | 16260 | 1% |
| Element $21$ - $N$ | 'NON_REGRESSION' | 16131.31000564 | 0.1% |

# 5 Summary of the results

It is noted that modeling B ( LL ) is very close to the quadratic Castem model Q . Modeling A (L) is not sufficient and one can observe oscillations on the constraints in the concrete.

To use two linear elements by voluminal elements is thus recommended for the modeling of the reinforced concrete .