BEAMS ASSIGNMENT.
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We modify Matlab code given in order to fit with the requirements and solve the three cases:

2 nodes Euler Bernulli element

2 nodes Timoshenko Full Integrate element

2 nodes Timoshenko Reduce Integration element.

We must solve the beam problem submitted to the constant pressure of 1 Pa all along its upper face.

Beam is 4 m long and its cross section is supposed to be a rectangle with area equals to 0.4 meters multiplied by different side values, but all considerably smaller than 4 meters.

Matlab code is given and we just modify some file variables and define others.

We have different element files, but we will solve the 3 cases just with the corresponding to the 64 elements mesh. So we will use the same for each case.

We decrease the error with higher number of elements. And 64 elements throws low errors.

I enclose 3 folders, one for each case:

- EulerBernoulli folder
- TimoshenkoFullIntegrate
- TimoshenkoReduceIntegrate

In all of them there are these files:

- A **main script**. It calls **Stress_Beam and ToGiD_Beam** scrip`ts, which generates cant_64.flavia and cant_64.flavia.msh in which we can find the results. This results can be viewed with GID program.
  In this main script we input the variable side of the rectangle, which will be multiplied for 0.4 in all cases.
  At the end of the script we add some code to plot results
- **timing.m** is just to time each of the parts of the program execution.
- **cant_64 .m** define the mesh. We define material properties and add pointloads
- Results folder with all the figures of the displacements in y direction, shear and moments according one side of the rectangle takes all its values: 0.001, 0.005, 0.010, 0.020, 0.050, 0.100, 0.200 and 0.400 meters. There is also a subfolder with some GID snapshots.

2 nodes Euler Bernulli element

Main script is Beam_EulerBernoulli.m

Executed for all side values we find that we always obtain the same results for displacement in y direction, Bending moment Mz and Shear.

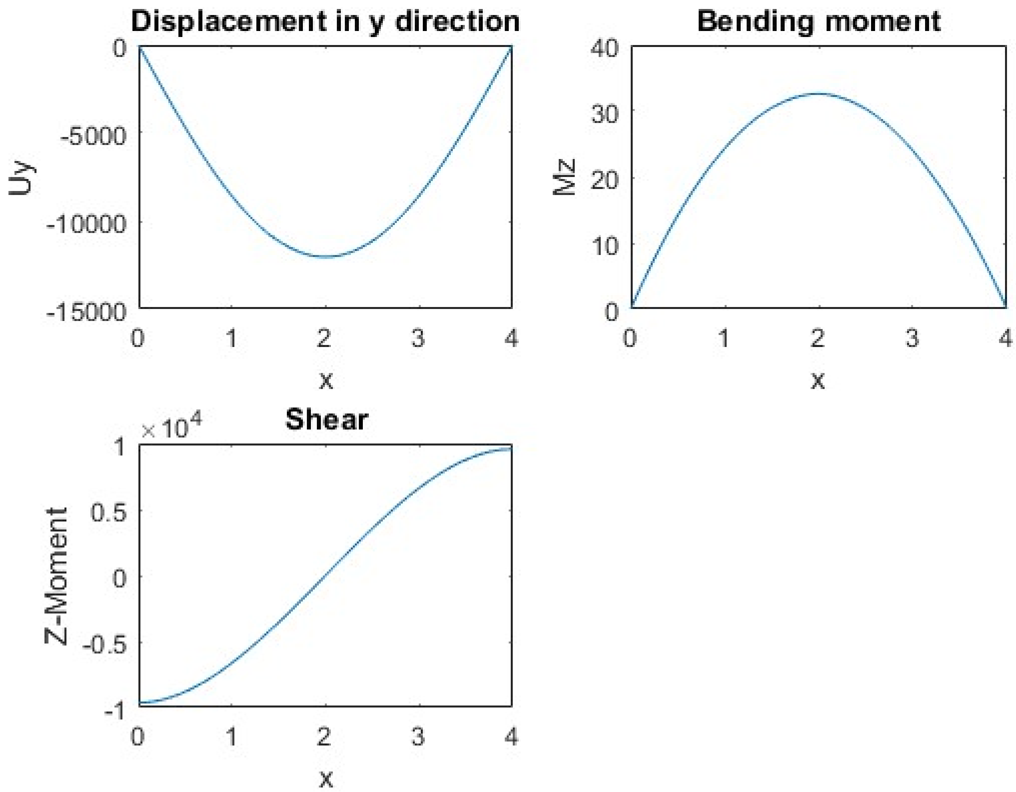

Figure 1

As we expected maximum displacement in y direction (due to the pressure) is in the middle of the Beam, and 0 in its borders.

Bending moment is also maximum in the middle and 0 in its borders.

Shear goes thru minimum value in left border to maximum on the other side, and close to 0 in the middle.

But any of them varies with the side of the rectangle of the beam.

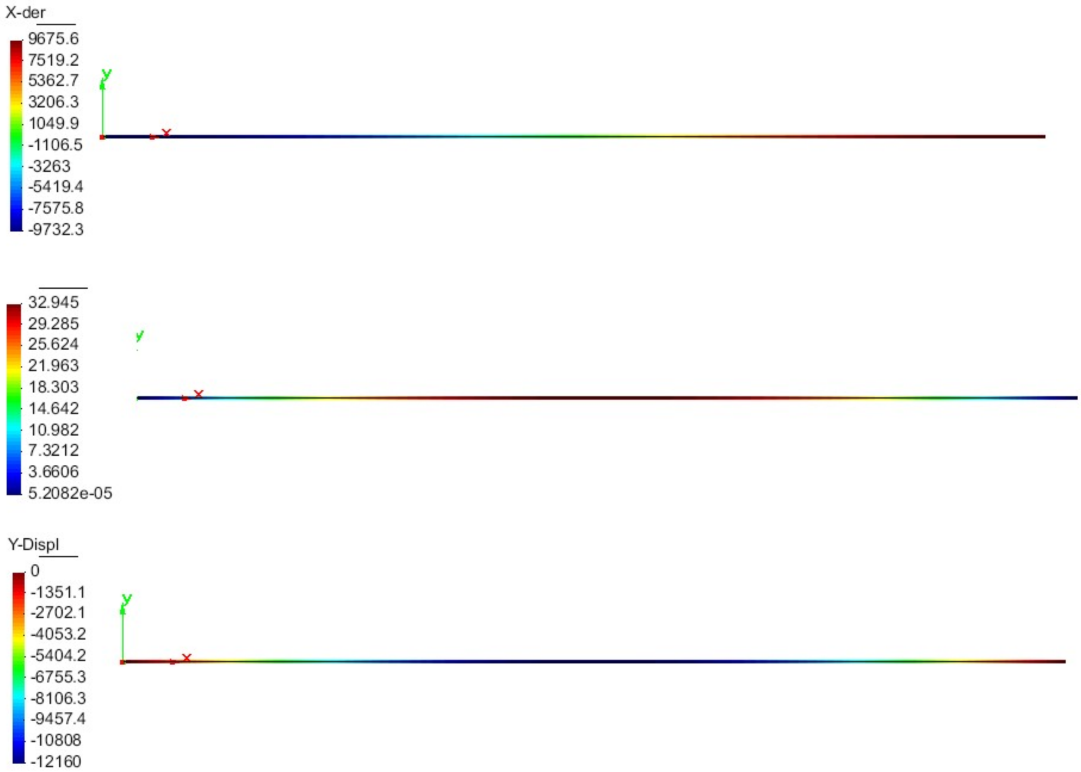
X-der
9675.6
7519.2
5362.7
3206.3
1049.9
-1106.5
-3263
-5419.4
-7575.8
-9732.3
y
x
32.945
29.285
25.624
21.963
18.303
14.642
10.982
7.3212
3.6606
5.2082e-05
y
x
Y-Displ
0
-1351.1
-2702.1
-4053.2
-5404.2
-6755.3
-8106.3
-9457.4
-10808
-12160
y
x

Figure 2

2 nodes Timoshenko Full Integrate element

Now main script is Beam_Timoshenko.m

And now **displacement in y direction, Bending moment Mz and Shear vary with the side of the rectangle of the beam.**

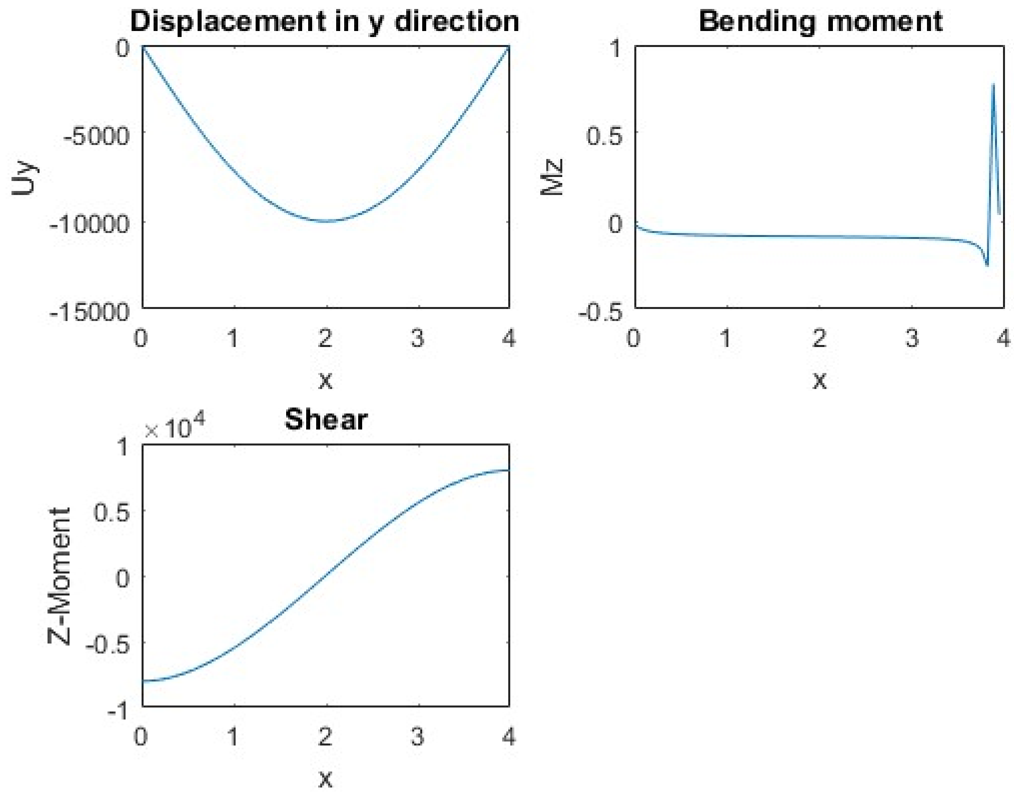

Figure 3. Side of the rectangle=0.001 m

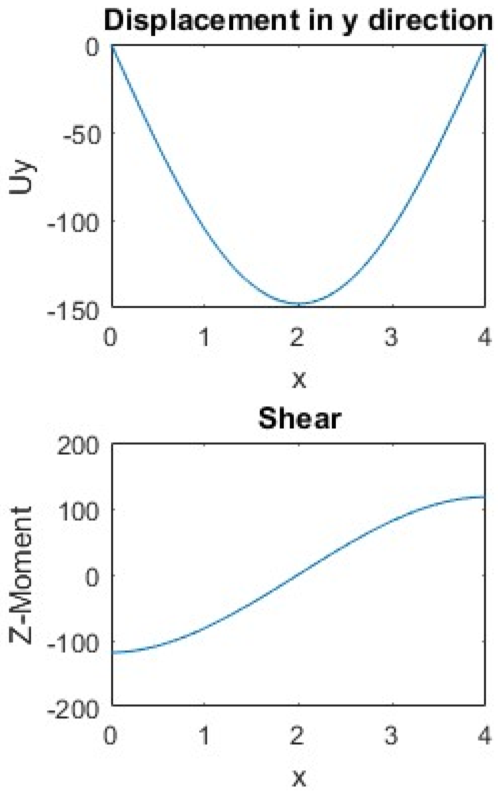

Figure 4. Side of the rectangle=0.4 m

As we expected maximum displacement in y direction (due to the pressure) is maximum in the middle of the Beam, and 0 in its borders.

Larger side value is (and largest area is) , the smaller the displacement in the y direction.

Shear goes thru minimum in left border to its maximum value on the other side, and close 0 in the middle.

Larger side value is (and largest area is) , the bigger the maximum and minimums values are.

But, both **Shear and bending moments throw bad results.**

2 nodes Timoshenko Reduce Integration element.

Main script is Beam_Timoshenko.m

In this case we have use the reduce integration for the shear stiffness matrix. It is defined in the main script in this way:

```
K_s = [   1    ,    len/2 ,    -1    ,    len/2 ;
            len/2 , len^2/4 , -len/2 , len^2/4 ;
             -1    ,   -len/2 ,     1    ,   -len/2 ;
            len/2 , len^2/4 , -len/2 ,  len^2/4 ];
```

and we have use just a Gauss point, gauss1=gauss2=gaus=0.0

In this case, as in the first one, we always obtain the same results for displacement in y direction, Bending moment Mz and Shear.

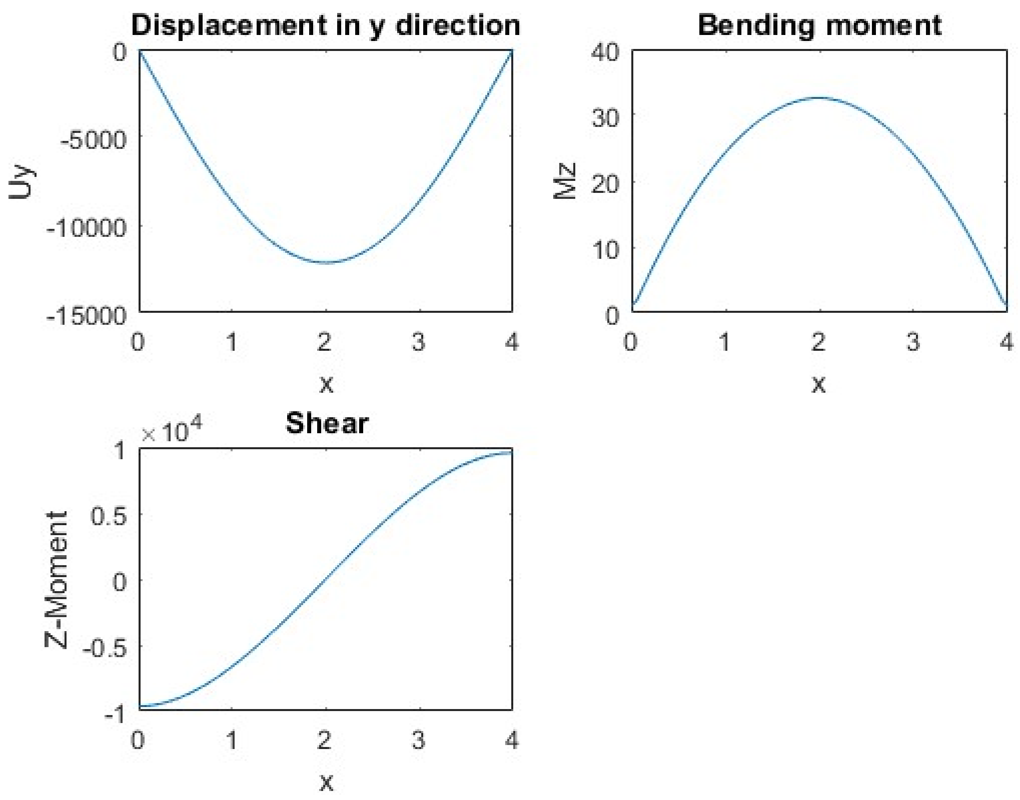

Figure 5

As we expected maximum displacement in y direction is in the middle of the Beam, and 0 in its borders.

Bending moment is also maximum in the middle and 0 in its borders.

Shear goes thru minimum value in left border to maximum on the other side, and 0 in the middle.

But, once more, **no of them varies with the side of the rectangle of the beam.**

DISCUSS OF THE RESULTS

CASES	Maximum Y displacement	Maximum Moment	Maximum Shear
Euler-Bernoulli a/L=0.25e-03 to a/L=0.1	1.19248e+04	3.29451e+01	9.73225e+03
Timoshenko Reduce Integration a/L=0.25e-03 to a/L=0.1	1.20503e+04	3.26257e+01	9.64654e+03
Timoshenko Full Integrate a/L=0.25e-03	1.00149e+04	7.79383e-01	8.00802e+03
a/L=1.25e-03	5.97065e+03	4.77789e+03	1.22396e-01
a/L=2.5e-03	3.96923e+03	6.38587e-02	3.17660e+03
a/L=0.05	2.37660e+03	1.57930e-02	1.90210e+03
a/L=0.0125	1.07904e+03	4.84736e-03	8.63629e+02
a/L=0.025	5.64890e+02	2.24923e-03	4.52602e+02
a/L=0.05	2.90238e+02	1.08555e-03	-2.32300e+02
a/L=0.1	1.47603e+02	5.33509e-04	1.18138e+02

(*) Maximum values are taken without taking into account the sign (absolute value)
a is the side of the variable value of the rectangle

We find **similar results when we solve the problem with the 2 nodes Euler Bernulli element and with the 2 nodes Timoshenko Reduce Integration element**.
And this results are **<u>independent of the side of the rectangle</u>.**

But in the Timoshenko Full Integrate, displacements, moments and shear depends on a.
Displacement takes a maximum value when a=0.001, almost the value of the other 2 cases. But it decreases as a is smaller.
Moments and Shear depends on a, but we get bad results.

Bending moment has maximum close to right side, instead of the middle of the beam.

We can conclude that **Timoshenko Full Integrate** is more general and more realistic theory than Euler-Bernoulli ones. So it can take into account different transverse section values. And throws **good results for displacements**.

But Timoshenko Full Integrate assume that plane section orthogonal to the beam axis before deflection is not necessarily orthogonal to the beam axis after deformation. This means: our side variable value z is not necessarily orthogonal to the beam axis after deformation, so as shear and moments depends on z, we will not obtain good results of them.

This restriction is not present in Euler-Bernoulli case, so good results on Shear and Moments could be obtained.

Timoshenko Reduce Integration comes from Timoshenko Reduce Integration when we lock the shear. In this case we use reduced integration and just one only one integration point. This simplify the problem, but we get an effect (Shear locking effect) which leads to a numerical solution similar to the Euler-Bernoulli ones.

Timoshenko Full Integrate	**good results for displacements**, because is more realistic and displacements not depends on z **bad results for Share and Moments** because they depends on z
Euler Bernulli and **Timoshenko Reduce Integration**	**bad results for displacements** **good results for Share and Moments** because it does not have restrictions on z, or it has been simplified