Computational Structural Mechanics and Dynamics

Assignment 6

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Assignment

a) Program In Mat Lab the Timoshenko 2 Nodes Beam element with reduce integration for the shear stiffness matrix

$$K_b^{(e)} = \left(\frac{EI}{l}\right)^{(e)} \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 \end{bmatrix}$$ (The point interpolation is exact for $K_b^{(e)}$)

$$K_s^{(e)} = \left(\frac{GA^*}{l}\right)^{(e)} \begin{bmatrix} 1 & \frac{l^{(e)}}{2} & -1 & \frac{l^{(e)}}{2} \\ \cdots & \frac{(l^{(e)})^2}{4} & -\frac{l^{(e)}}{2} & \frac{(l^{(e)})^2}{4} \\ & \cdots & 1 & -\frac{l^{(e)}}{2} \\ \text{Simetr.} & & \cdots & \frac{(l^{(e)})^2}{4} \end{bmatrix}$$ (Reduced integration)

Hint: For stress evaluation make gaus1 = gaus2 = 0.0

- First the reduced function becomes:

```
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 ];
```

```

    K_b = K_b * const;

    const = D_mats/len;

    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 ];

    K_s = K_s * const;

```

- Starting with the 2 nodes Timoshenko Full Integrate element:

➢ For a=0.001 m, displacement, bending moment and shear force results are shown in Figure 1, Figure 2 and Figure 3.

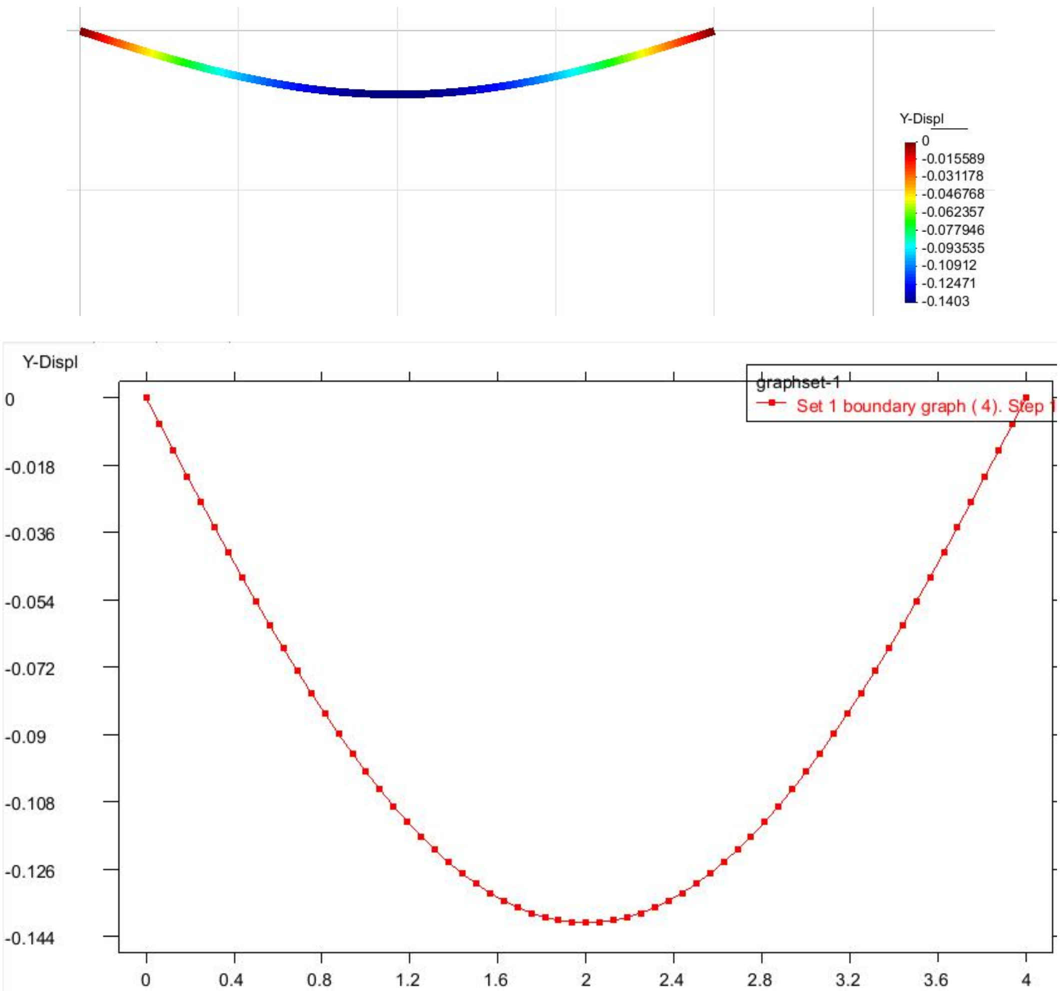


Figure 1.Displacement for a=0.001

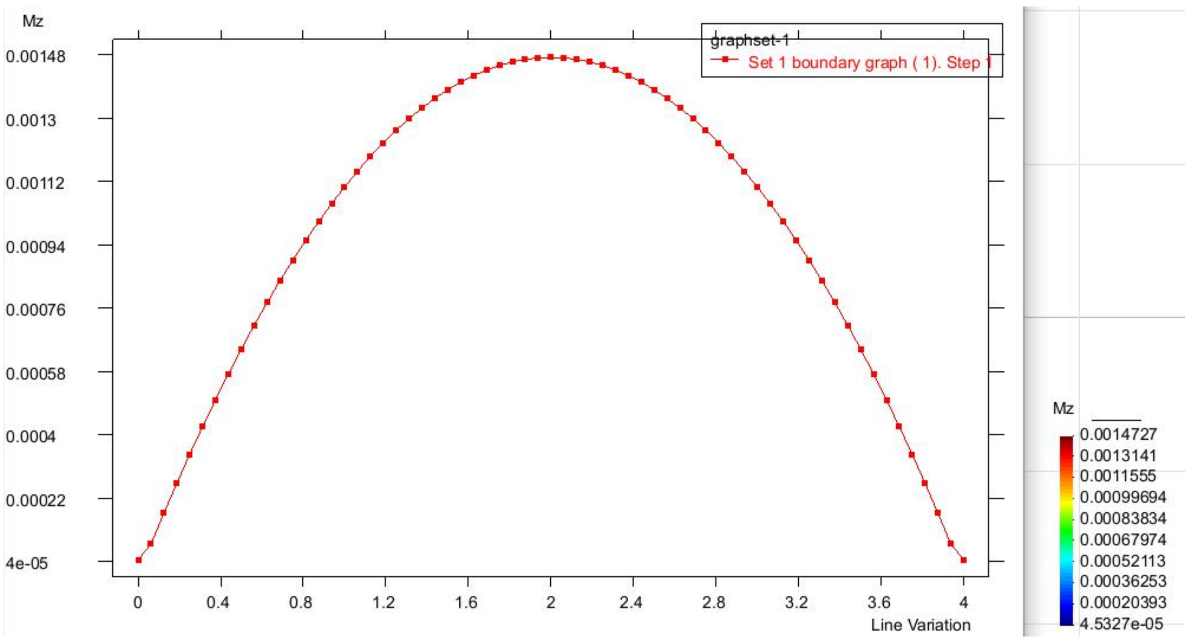


Figure 2.Bending Moment for a=0.001

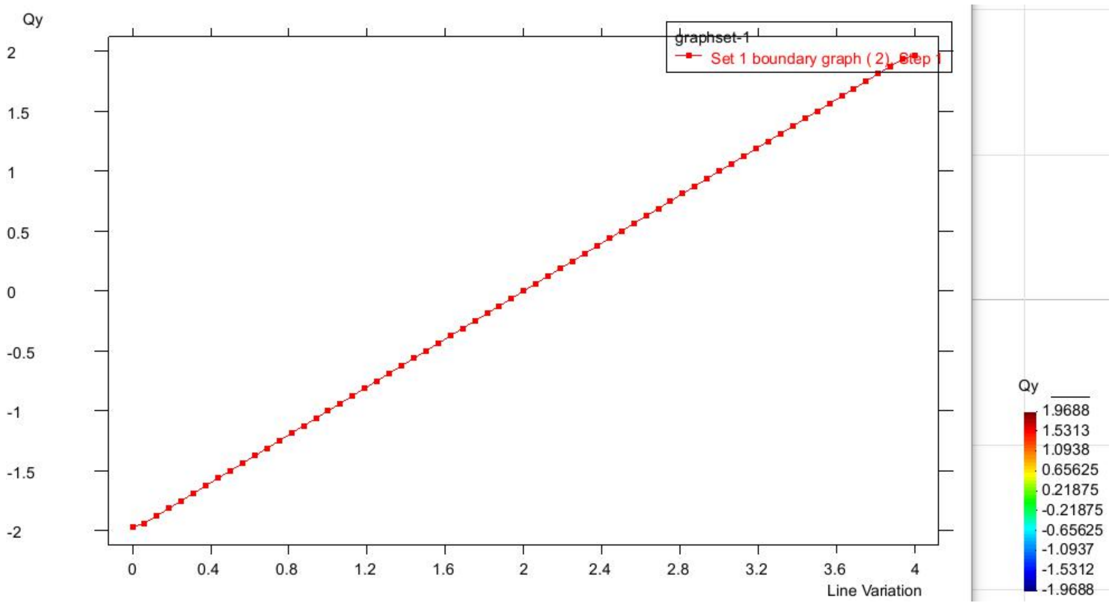


Figure 3.Shear Force for a=0.001

- For a=0.05m, displacement, bending moment and shear force results are shown in Figure 4, Figure 5 and Figure 6.

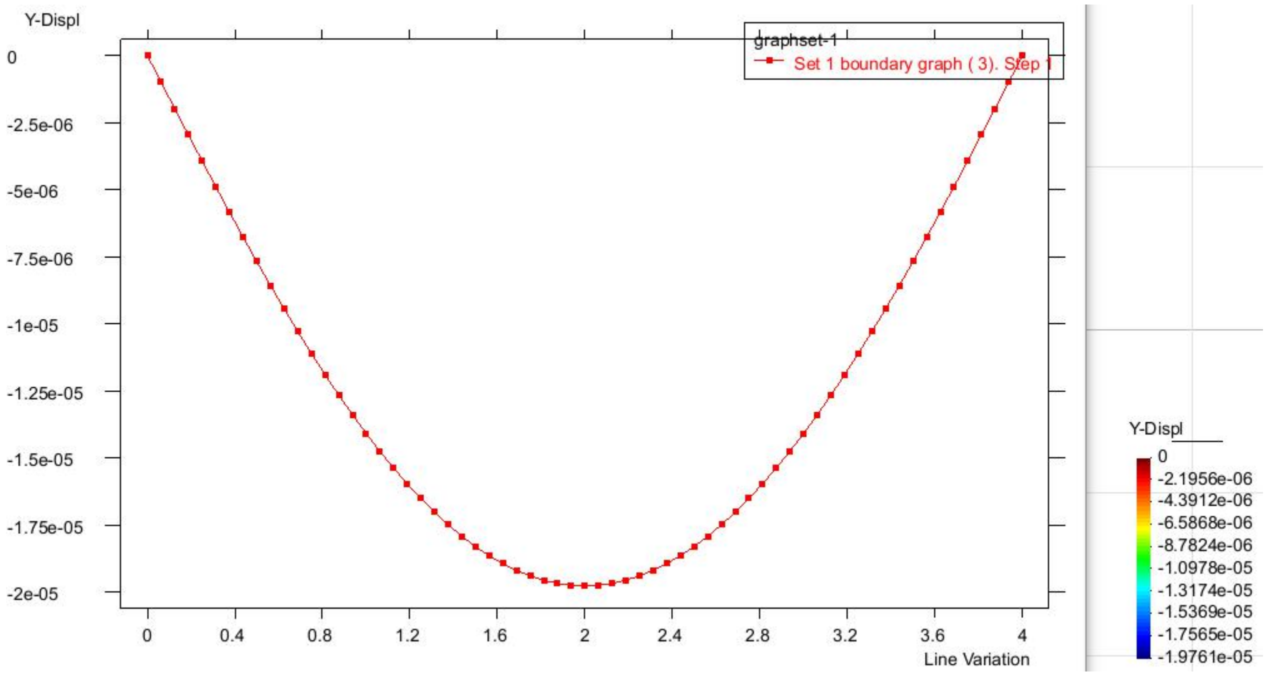
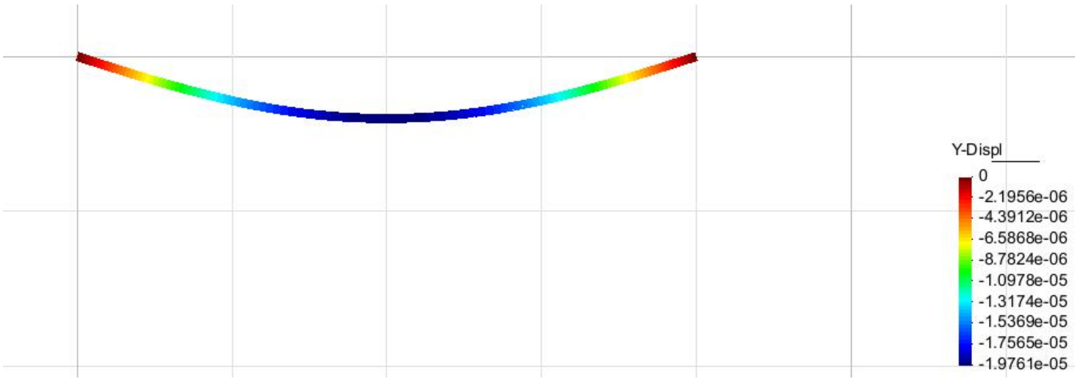


Figure 4.Displacement for a=0.05



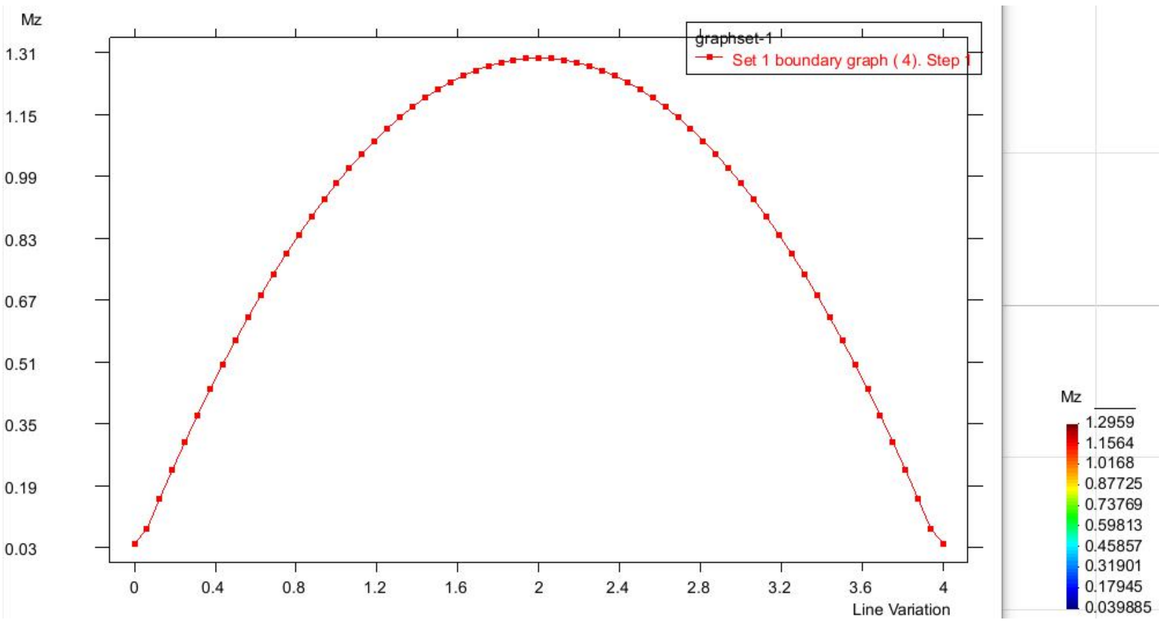


Figure 5.Bending Moment for a=0.05

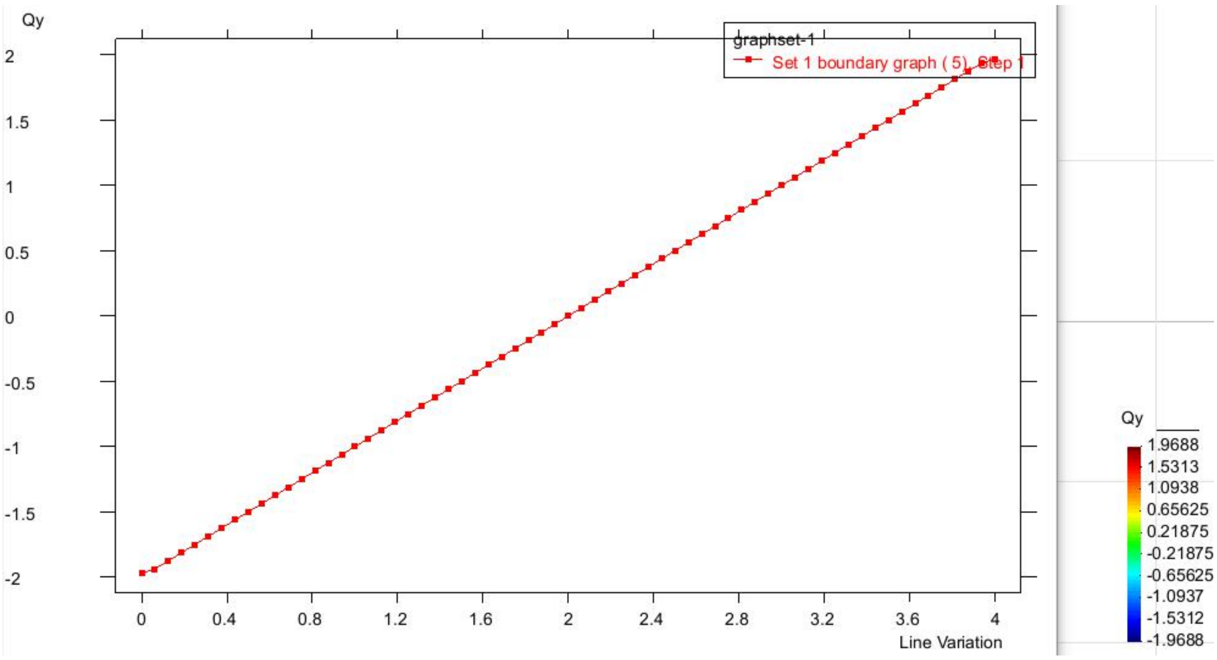
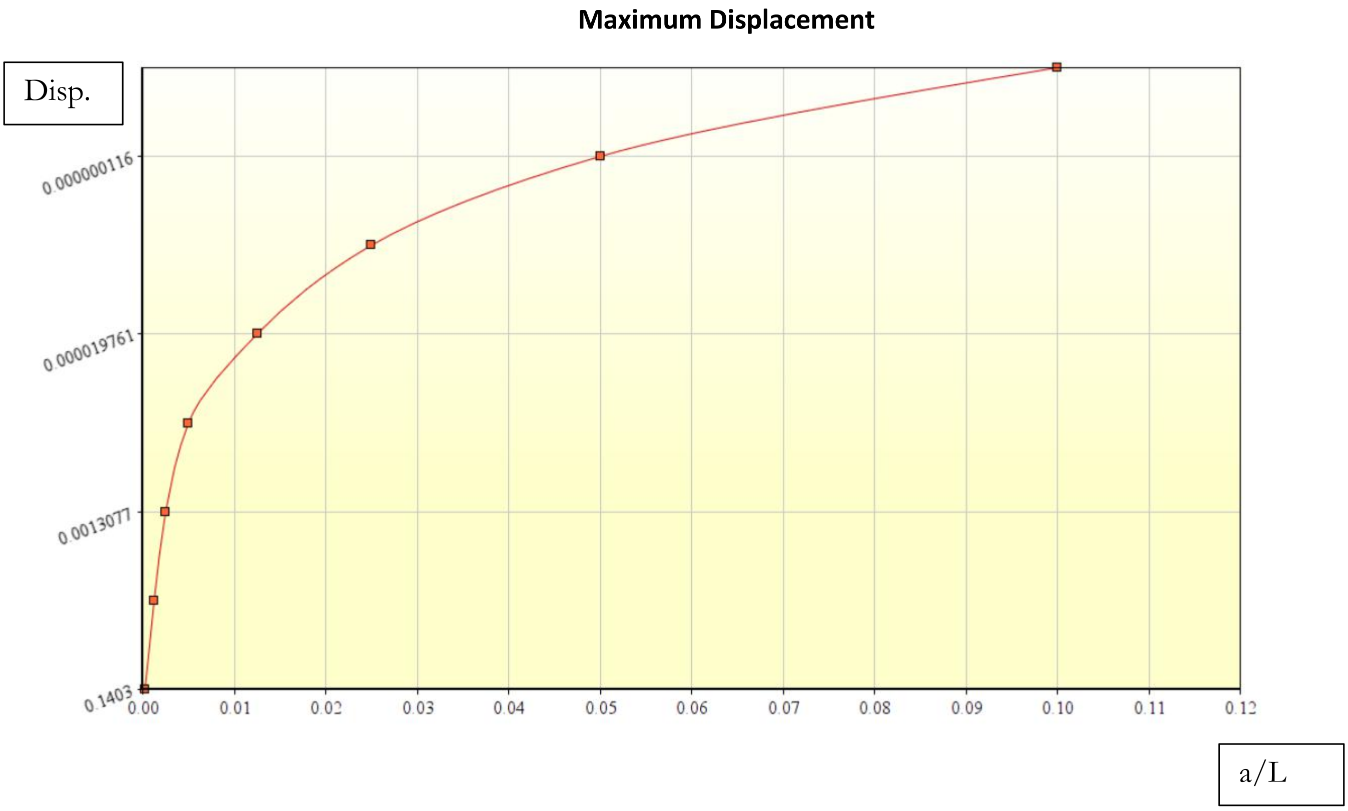


Figure 6.Shear Force for a=0.05

For the other a values, the results are present in Table 1.

a	a/L	Maximum Displacement	Maximum Shear Force	Maximum Bending Moment
0.001	0.00025	0.1403	1.9688	0.00147
0.005	0.00125	0.0055147	1.9688	0.03618
0.01	0.0025	0.0013077	1.9688	0.13726
0.02	0.005	0.000271	1.9688	0.45527
0.05	0.0125	0.000019761	1.9688	1.2959
0.1	0.025	1.68E-06	1.9688	1.7603
0.2	0.05	1.16E-07	1.9688	1.9335
0.4	0.1	7.55E-09	1.9688	1.9822



It can been seen from the diaghram, the ratio of a/L increases thus the displacement decreases. This model recreates the actual behavior of the beam under loading.

Also the values for deformation are exaggerated for small areas due to the area isphysically unattainable.

Furthermore, the moment is converging as the ratio of a/L increases. This shows thatthe model is not responding properly for a low a/L ratio. Therefore, it can not be used for these low values.

Now we study with the 2 nodes Timoshenko reduced and we get the followring results:

- For a=0.001 m, displacement, bending moment and shear force results are shown in Figure 7, Figure 8 and Figure 9.

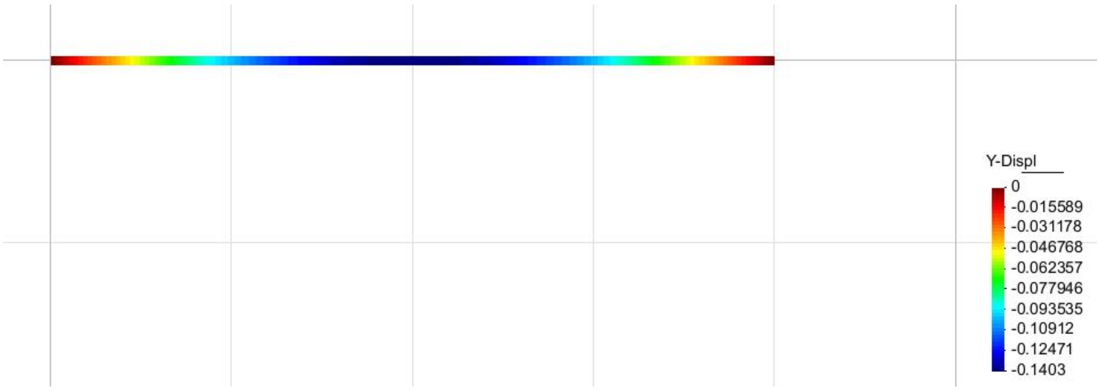


Figure 7.Displacement for a=0.001

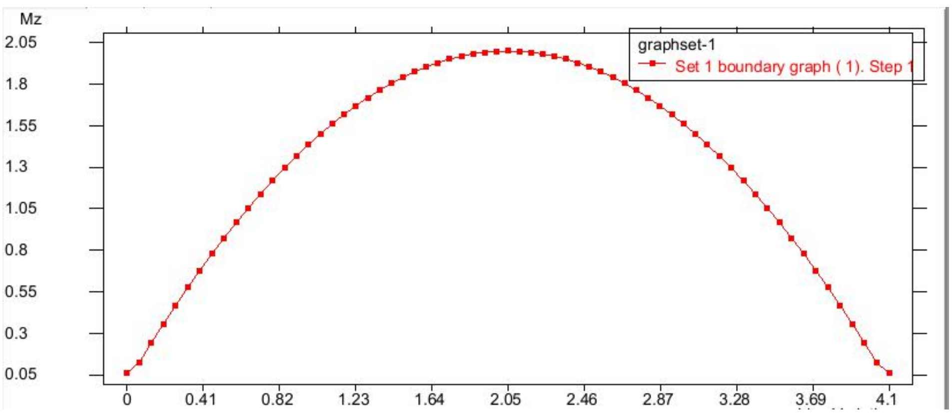


Figure 8.Bending Moment for a=0.001

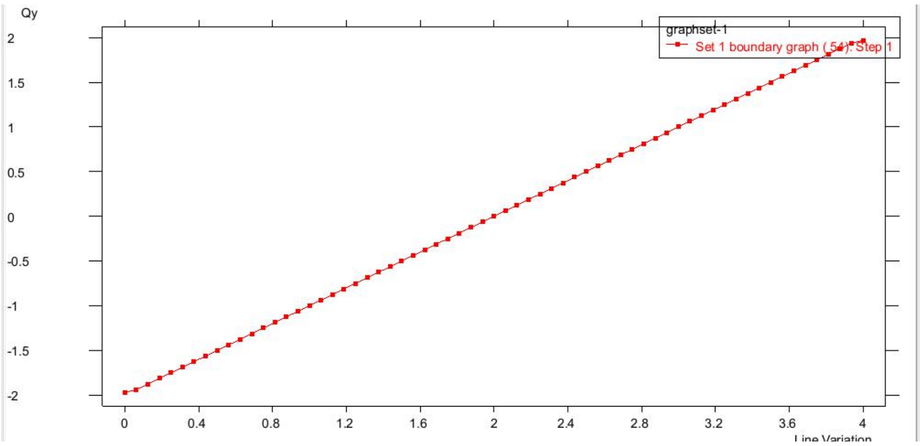


Figure 9.Shear Force for a=0.05

- For a=0.05 m, displacement, bending moment and shear force results are shown in Figure 10, Figure 11 and Figure 12.

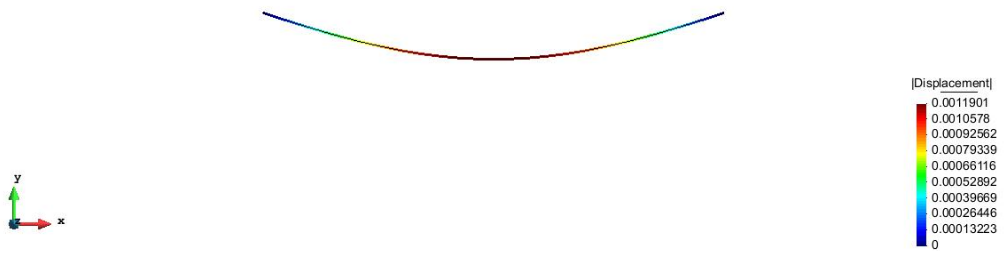


Figure 10.Displacement for a=0.05

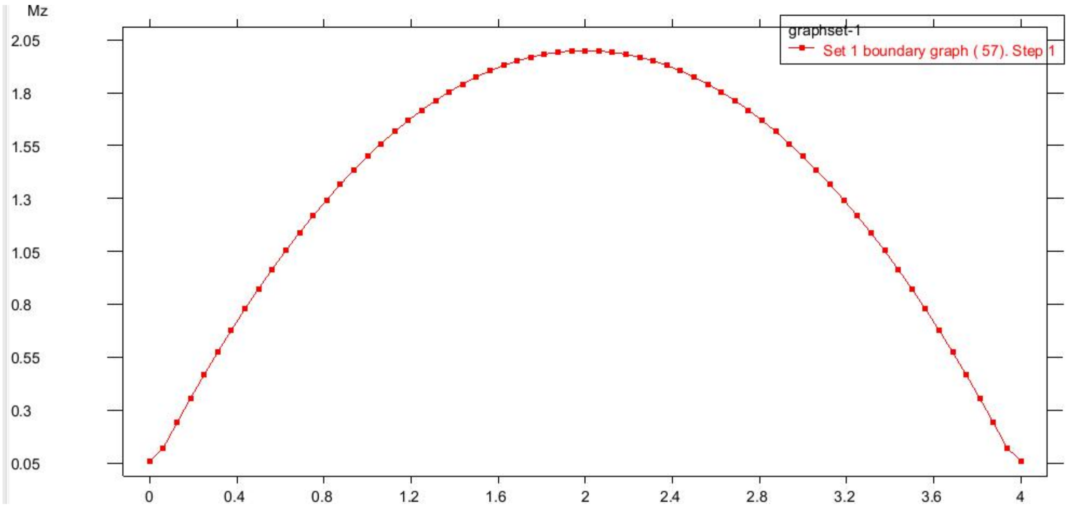


Figure 11.Bending Moment for a=0.05

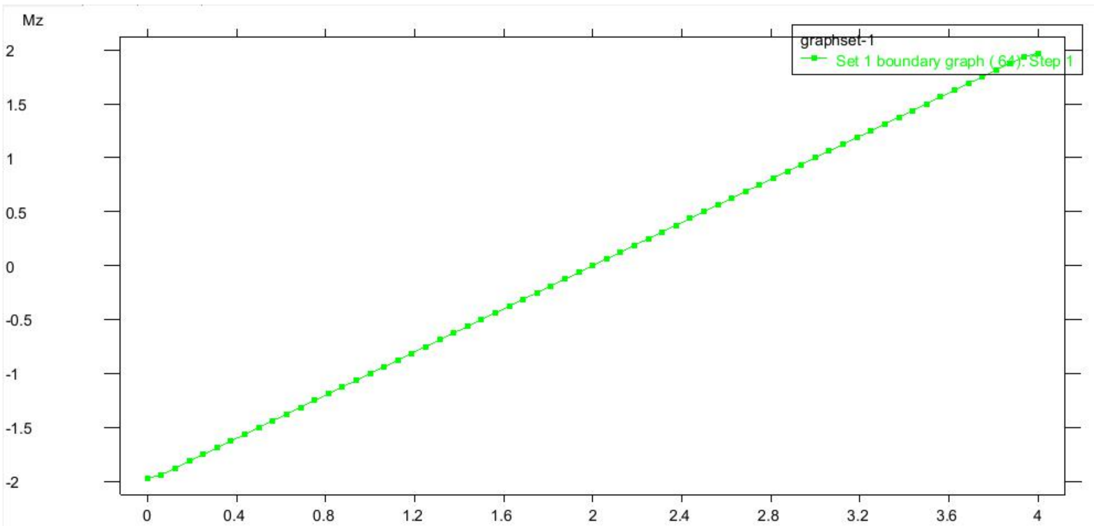
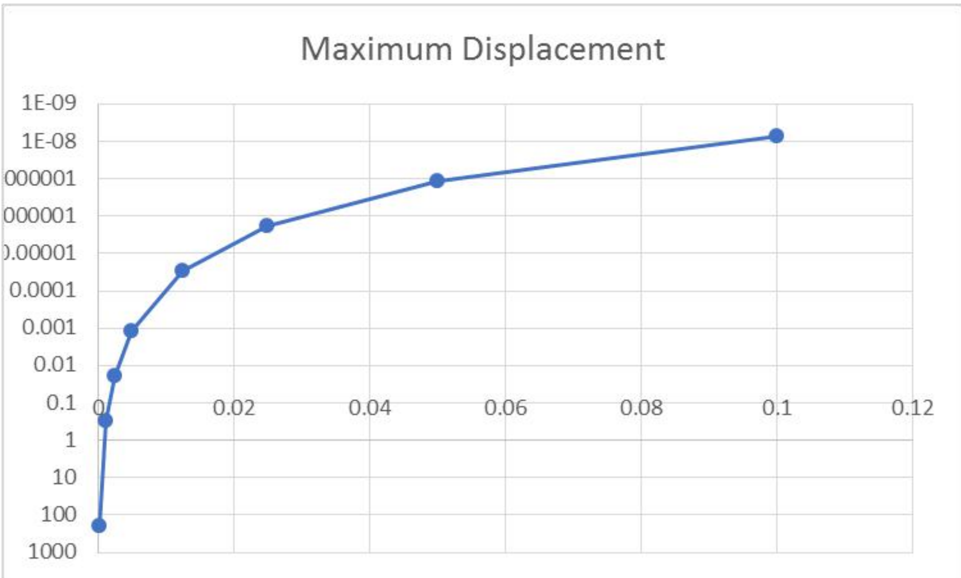


Figure 12.Shear Force for a=0.05

Other results are shown in Table 2.

a	a/L	Maximum Displacement	Maximum Shear Force	Maximum Bending Moment
0.001	0.00025	190.4	1.9688	1.999
0.005	0.00125	0.30464	1.9688	1.999
0.01	0.0025	0.019041	1.9688	1.999
0.02	0.005	0.0011901	1.9688	1.999
0.05	0.0125	0.000030475	1.9688	1.99
0.1	0.025	1.91E-06	1.9688	1.99
0.2	0.05	1.20E-07	1.9688	1.99
0.4	0.1	7.61E-09	1.9688	1.99

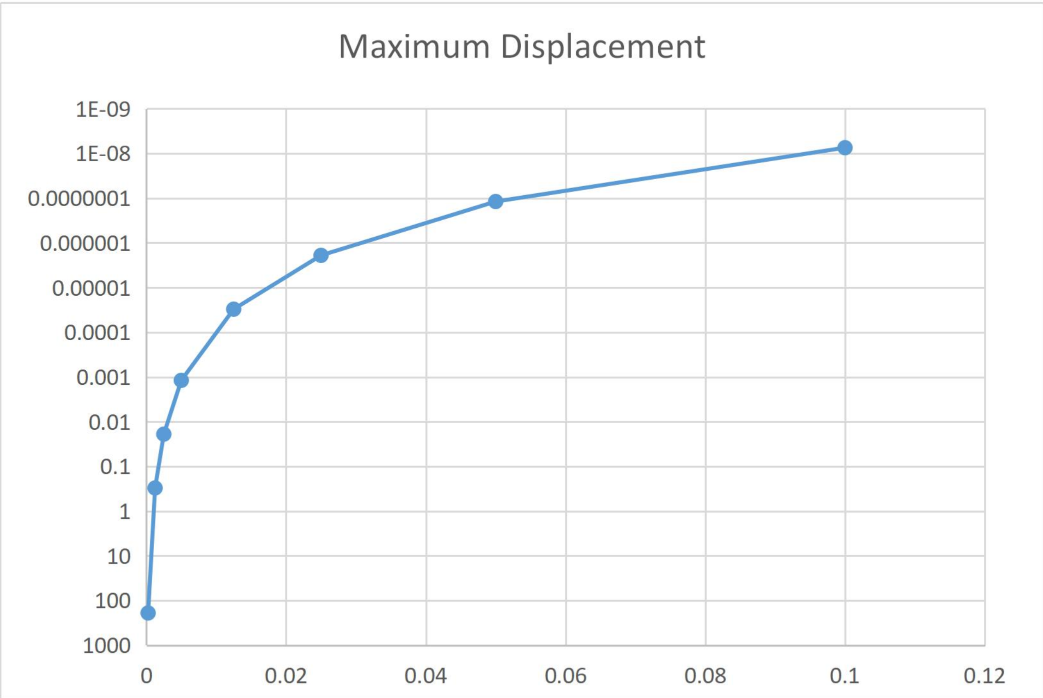


The ratio of a/L increases with the area. Therefore the displacement decreases.
This model recreates the actual behavior of the beam under loading. The values are exaggerated for deformation for small areas; this is because the area physically unattainable.
Furthermore, we see that the moment and the shear stay constant from the ratio of a/L.

No we should study with Euler Bernoulli model:

First, the resuls from GiD are respresent in the following table.

a	**a/L**	**Maximum Displacement**	**Maximum Shear Force**	**Maximum Bending Moment**
0.001	0.00025	190.48	0	1.9999
0.005	0.00125	0.30476	0	1.9999
0.01	0.0025	0.019048	0	1.9999
0.02	0.005	0.0011905	0	1.9999
0.05	0.0125	0.000030476	0	1.9999
0.1	0.025	1.9048E-06	0	1.9999
0.2	0.05	1.1905E-07	0	1.9999
0.4	0.1	7.4405E-09	0	1.9999



The ratio of a/L increases when the area increases, thus the displacement decreases.
This model recreates the actual behavior of the beam under loading.
The values are exaggerated for deformation for small areas; this is because the area physically unattainable.
Furthermore, we see that the shear forc is null for all cases and that shows te model does not take the shear in account.