EG3111 Finite Element Analysis and Design

COMSOL Practical #3: Beam and Frame Elements

Aim
To introduce Beam elements in COMSOL and check the answers to Example Sheet #3.

The video "COMSOL Practical #3" shows you how to solve this. Try it yourself first, and then you can watch the video if you need some help.

Task
Simulate the 4 examples in Example Sheet #3 and check the results are the same.

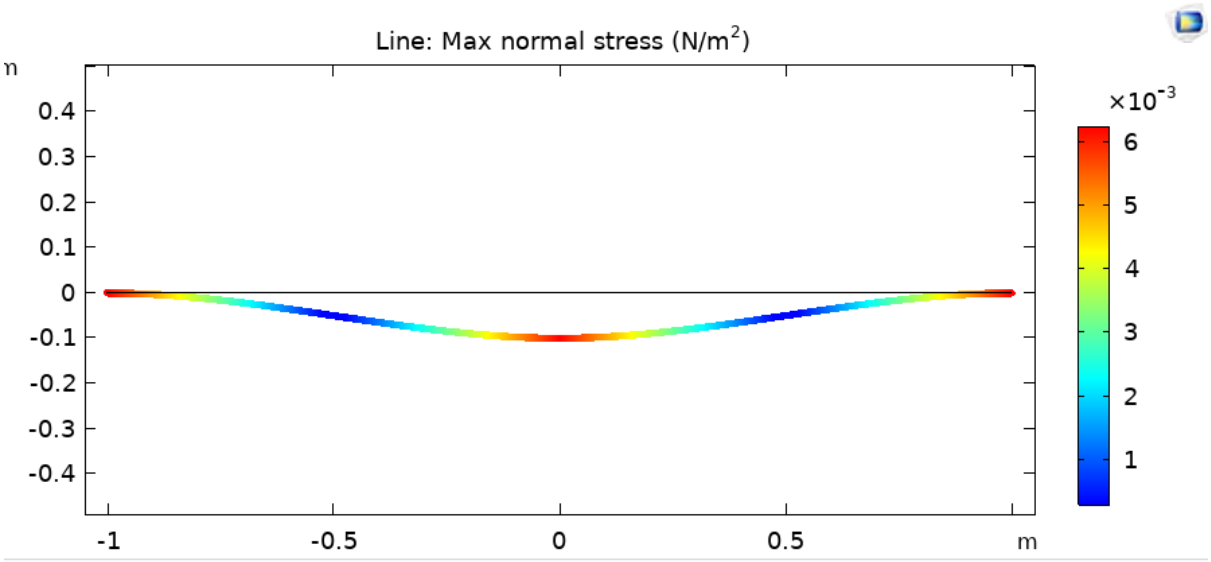
Tips

- Select "Beam (beam)" for the problem Physics. These are frame elements.
- Note that you now have to enter a value for A and I in the "Cross-sectional data" field for these elements. The first three examples involve no extension so A is not used for these problems.
- The first three questions use two beam elements. To enforce COMSOL to do this, draw the horizontal structure as two connected horizontal lines, so that there is a node in the middle of the beam.
- To check the results it is easiest just to set all quantities to 1, i.e. $E = A = I = L = P = p_0 = 1$.
- For example 3, the load can be entered as a function of x. Note that the left hand end of the beam needs to be at x=0 if the y-force is simply -1*(x/2) to vary from 0 at $x = 0$ to -1 at $x = 2L = 2$.

Solutions

1. The calculated solution with all quantities set to one is

$$\begin{bmatrix} w_2 \\ \theta_2 \end{bmatrix} = -\frac{P}{24a}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = -\frac{1}{24}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -0.0417 \\ 0 \end{bmatrix}$$



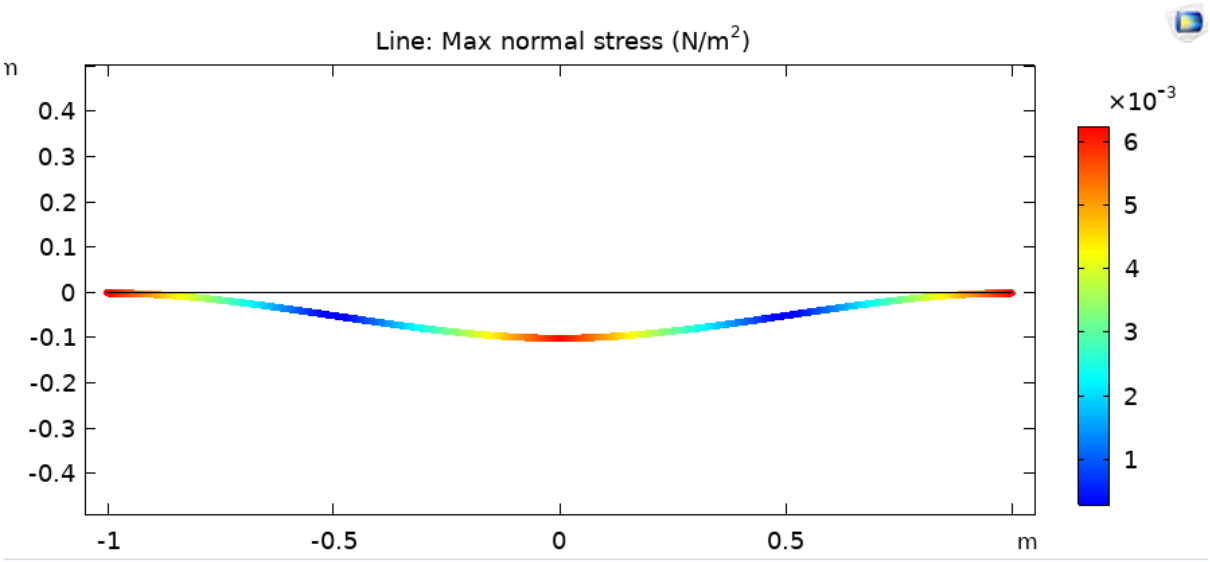
Messages | Progress | Log | Table 3

Rotation field, Z component (rad), Point: 2	Displacement field, Y component (m), Point: 2
0.00000000000000001850371707708498	-0.04166666666666542

2. The calculated solution is

$$\begin{bmatrix} w_2 \\ \theta_2 \end{bmatrix} = -\frac{p_0}{24a}\begin{bmatrix} L \\ 0 \end{bmatrix} = -\frac{1}{24}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -0.0417 \\ 0 \end{bmatrix}$$

The solution is the same as Q1.

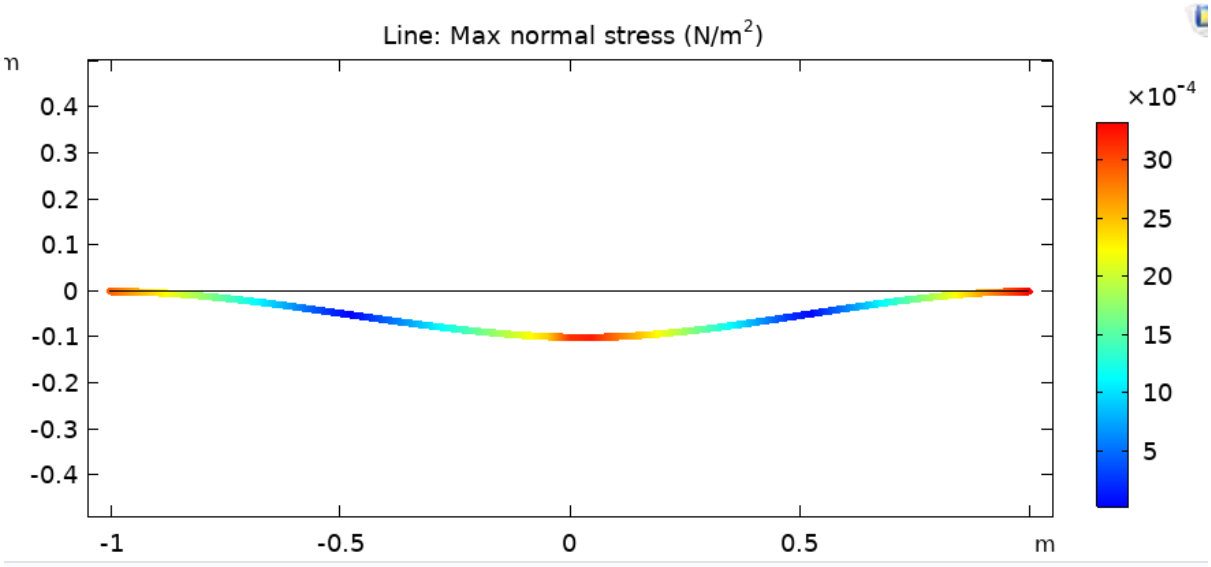


Messages | Progress | Log | Table 3

Rotation field, Z component (rad), Point: 2	Displacement field, Y component (m), Point: 2
0.00000000000000001850371707708498	-0.04166666666666542

3. The calculated solution is

$$\begin{bmatrix} w_2 \\ \theta_2 \end{bmatrix} = -\frac{p_0}{240a}\begin{bmatrix} 5L \\ 1 \end{bmatrix} = -\frac{1}{240}\begin{bmatrix} 5 \\ 1 \end{bmatrix} = \begin{bmatrix} -0.0208 \\ -0.0042 \end{bmatrix}$$



Messages | Progress | Log | Table 4

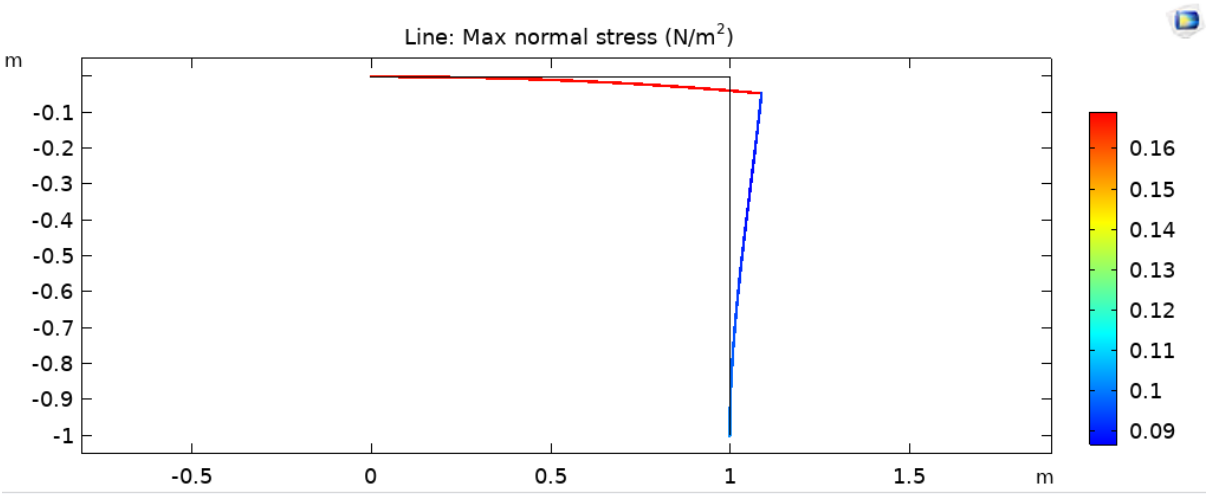
Rotation field, Z component (rad), Point: 2	Displacement field, Y component (m), Point: 2
-0.004166666666666495	-0.02083333333333271

4. The calculated solution is

$$u_2 = \frac{P\left(10\alpha + \frac{4}{3}k\right)}{\left(4\alpha + \frac{4}{3}k\right)\left(k + 12\alpha\right)} \qquad \text{so} \begin{bmatrix} u_2 \\ v_2 \\ \theta_2 \end{bmatrix} = \begin{bmatrix} 0.1634 \\ -0.0865 \\ -0.1875 \end{bmatrix}$$

$$v_2 = \frac{-6\alpha P}{\left(4\alpha + \frac{4}{3}k\right)\left(k + 12\alpha\right)}$$

$$\theta_2 = \frac{-P}{L\left(4\alpha + \frac{4}{3}k\right)}$$



Messages | Progress | Log | Table 6

Displacement field, X component (m), Point: 3	Displacement field, Y component (m), Point: 3	Rotation field, Z component (r
0.16346153846153666	-0.08653846153846191	-0.1875000000000004