Homework2_SUN

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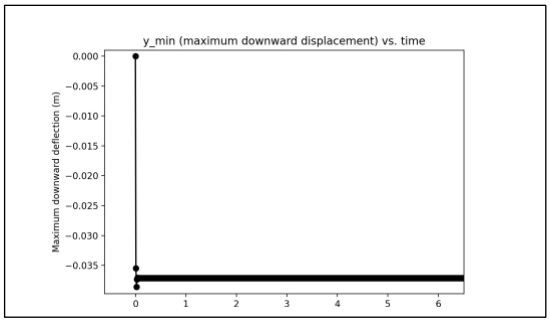
***Abstract*— This is HW2 for 263F**

I. QUESTION1

Plot of the maximum displacement of Y as a function of time:

Figure1. plot of the maximum displacement of Y as a function of time



As seen in Figure 1, $y_{max} reaches$ to a steady state of $-0.0372m$ very quickly, which is less than $0.2s$. To examine the accuracy of the simulation, I plug the same loading condition into the Euler-Bernoulli Beam theory to see if the simulation matches:

$$y_{max} = \frac{Pc(l^2-c^2)^{1.5}}{9\sqrt{3}El}, \text{where} c = \min(d, l-d)$$

$$\frac{2000 \cdot 0.25 \cdot (1^2 - 0.25^2)^{1.5}}{9 \cdot \sqrt{3} \cdot 70 \cdot 10^9 \cdot 1 \cdot 10^{-8} \cdot 1} = 0.04159m$$

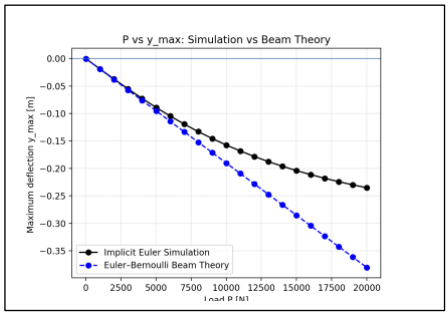
Comparing the Euler-Bernoulli Beam theory and the simulation, there is an error of :

$$\frac{0.04159 - 0.0372}{0.04159} \times 100\% = 10.5\%$$

II. QUESTION 2

The benefit of implicit Euler simulation is its ability to simulate large deformations. Examining Figure 2, the beam theory displays a linear relationship between the applied force and vertical displacement. From the stress and strain curve, we know that materials do display a linear relationship to a certain point called the proportional limit. However, the material starts to yield beyond this point, which means the stress and strain no longer have a linear relationship. From the given geometry and material property of the hollow pipe, it will yield if not fail under 20000N of applied force, thus the beam theory is not accurate under large deformation. As we can see from the plot, the two curves begin to diverge at 5000N of applied force.

Figure2. displacement of the y-axis of free nodes vs. forces using simulation and beam theory



ACKNOWLEDGMENT

The source code is taken from Dr.khalid's Google Colab notebook shared on Slack, then modified by Shixuan Sun to accomplish HW2