Preparation of Papers for IEEE Sponsored Conferences & Symposia*

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I. Question 1

Plot the maximum vertical displacement, y_{max}, of the beam as a function of time. Depending on your coordinate system, y_{max} may be negative. Does y_{max} eventually reach a steady value? Examine the accuracy of your simulation against the theoretical prediction from Euler beam theory.

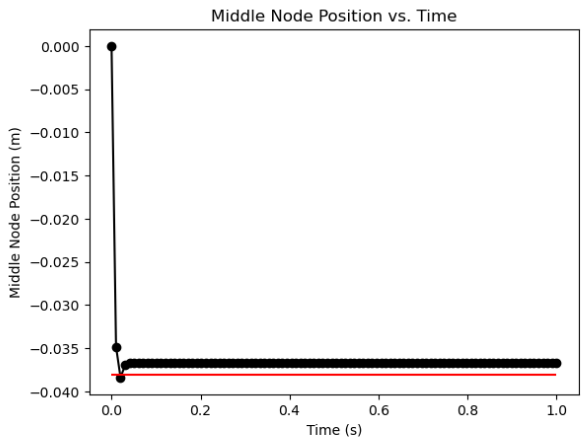

Fig. 1. Middle Node Position vs Time with comparision to Euler Beam Theory Prediction.

Based on Euler Beam theory with an applied force of $P = 2000N$ at $d = 0.75m$ the theoretical max deflection is $0.03805m$ while the steady state attenuation of the deflection is $0.03670m$ or a 3.5% difference from the theoretical value. Yielding slightly less steady state deflection than expected. This is only a small difference at such a load and it can be anticipated that in subsequent steps as we diverge from lower loading conditions the difference in the applied loads will deviate as well.

II. Question 2

What is the benefit of your simulation over the predictions from beam theory? To address this, consider a higher load $P = 20,000$ N such that the beam undergoes large deformation. Compare the simulated result against the prediction from beam theory in Eq. 5. Euler beam theory is only valid for small deformation whereas your simulation, if done correctly, should be able to handle large deformation. You should create a plot of P $(20N \leq P \leq 20,000)$ N vs. y_{max} using data from both simulation and beam theory and quantify the value of P where the two solutions begin to diverge.

Here we can see in the red that the nodebased beam simulation predicts the bending to be greatly reduced when

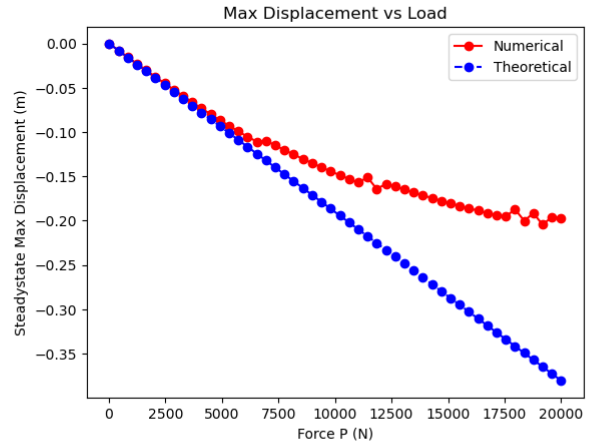

Fig. 2. Max deflection at various loads ranging from $P = 20$ N to $P = 20,000$ N.

compared with the normal bernoulli beam bending equation as the deflections increase. At approximately 3600 N applied load at $d = 0.75$ m is the first time that the deviation between the nodebased model and the theoretical model differ by more than 5%.

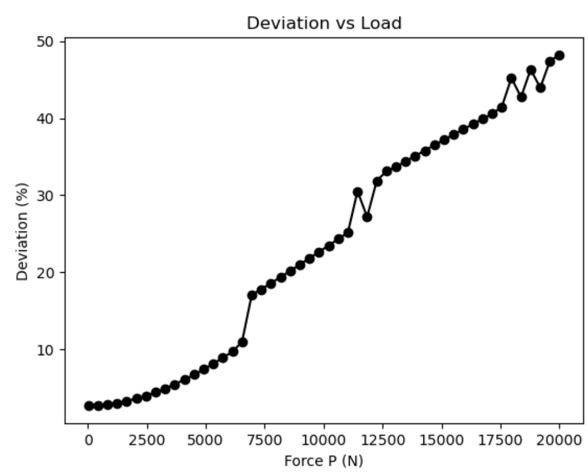

Fig. 3. Deviation of Euler Beaming Bending from node based model as applied force ranges from $P = 20$ N to $P = 20,000$ N.

In the above figure (figure 3) we can see that as the applied load increases the deviation from the Euler beam bending prediction increases reaching a maximum error of at $20,000$ N applied load of 48.2% This is expected as we increase the applied load to these extreme values the seen deflection will rightly increase with it.

REFERENCES

[1] M. K. Jawed, Lecture_06_Main_Falling_Beam_N_nodes_Fixed_DOFs.ipynb, UCLA, 2025