MAE 263F Fall 2025 Homework_2

Luke Chang 905954847

I. Task Output

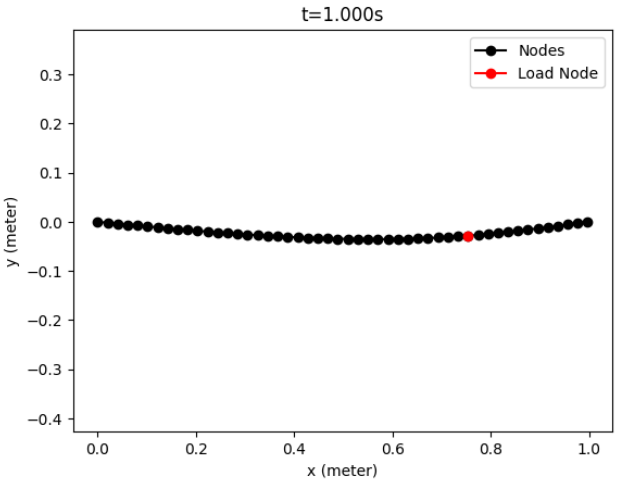

Fig. 1. Structure at t = 1s & P = 2,000N

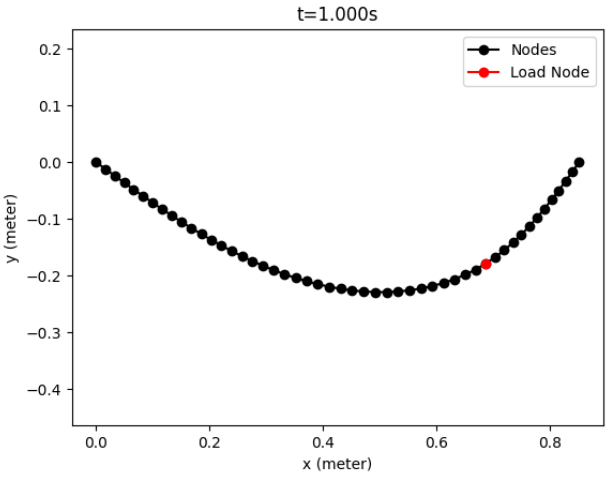

Fig. 2. Structure at t = 1s & P = 20,000N

II. Report Questions

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

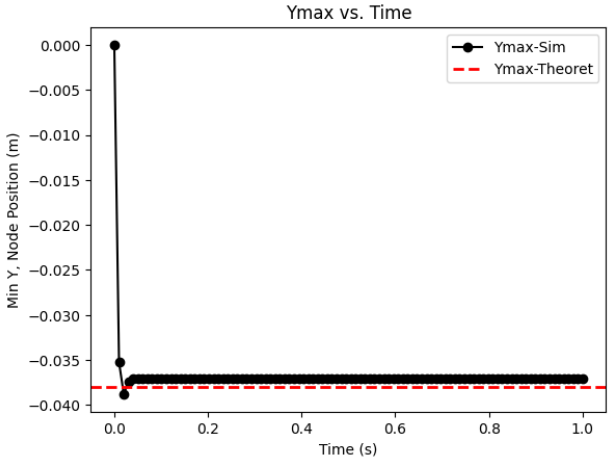

Fig. 3. Maximum Vertical Displacement with time in comparison to Theoretical Vmax with P = 2,000N

As seen from figure 3, ymax reaches a steady value very quickly to about -0.037m. And compared to the theoretical ymax calculated of -.038m, there is a very little discrepancy from the Euler Beam theory deflection of around only 2.52% error, showing the simulation's accuracy.

B. What is the benefit of your simulation over the predictions from beam theory? To address this, consider a higher load P = 20, 000N 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 (20 N ≤ P ≤ 20, 000 N) vs. ymax using data from both simulation and beam theory and quantify the value of P where the two solutions begin to diverge.

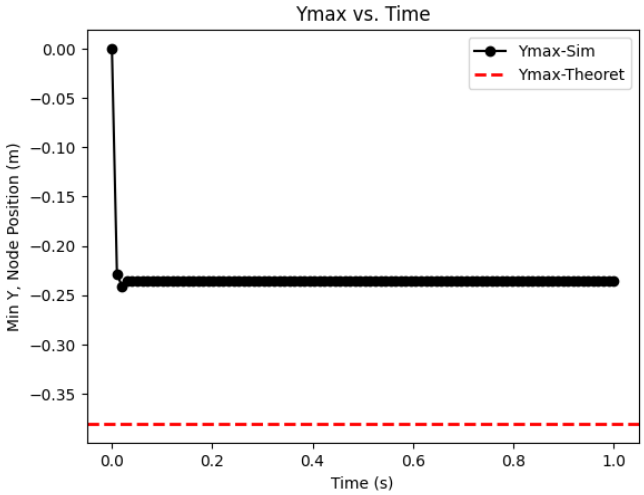

Fig. 4. Maximum Vertical Displacement with time in comparison to Theoretical Vmax with P = 20,000N

As seen from figure 4, ymax also reaches a steady value very quickly to about -0.23m with a much higher P load. However, compared to the theoretical ymax calculated of -.38m, there is a significant discrepancy from the Euler Beam theory deflection of over 61% error showing the large deformation divergence.

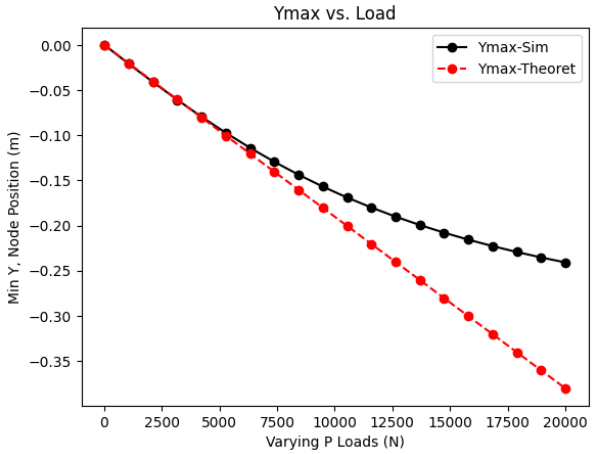

Fig. 5. Maximum Vertical Displacement with time in comparison to Theoretical Vmax with 20 N ≤ P ≤ 20, 000 N

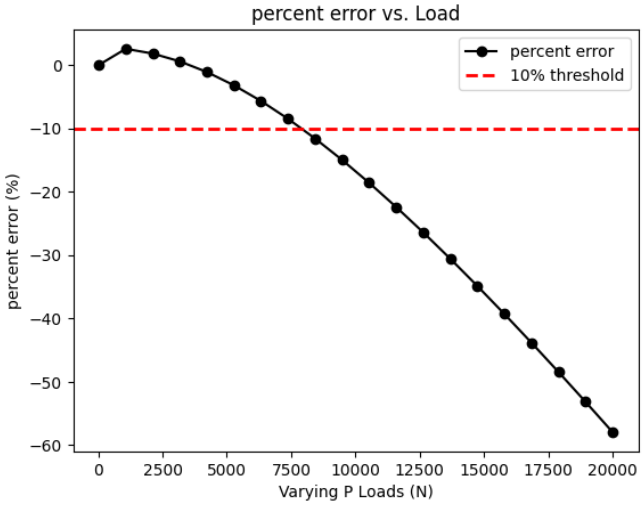

Fig. 6. Percent error between Maximum Vertical Displacement with time in comparison to Theoretical Vmax with 20 N ≤ P ≤ 20, 000 N

From Figure 5, we see the simulated maximum Y node diverge from theoretical at around 7000N. This is furthered by Figure 6 where around 7500N we see percent error cross the 10% error threshold.

REFERENCES

[1] K. J. Majeed, "Spring-Mass Network Simulation Example (Implicit Euler)," course Colab notebook, MAE 263F: Mechanics of Flexible Structures and Soft Robots, University of California, Los Angeles, Fall 2025.