

# MAE263F HW1

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## I. ASSIGNMENT 1

Q1

Implicit method:

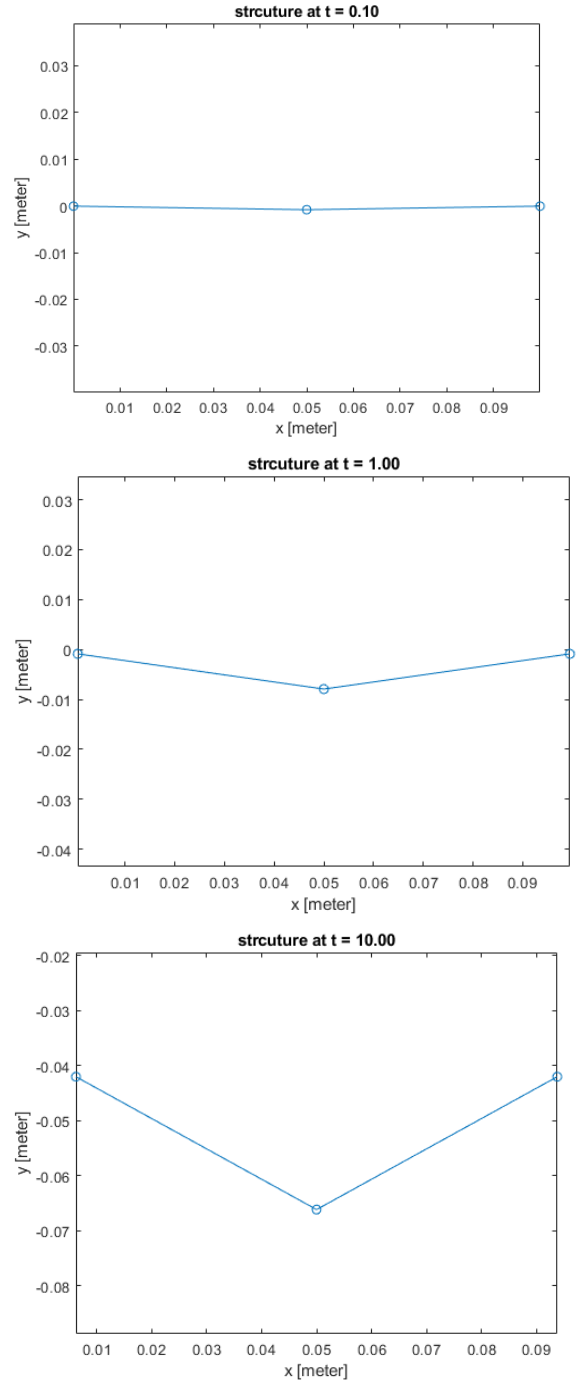
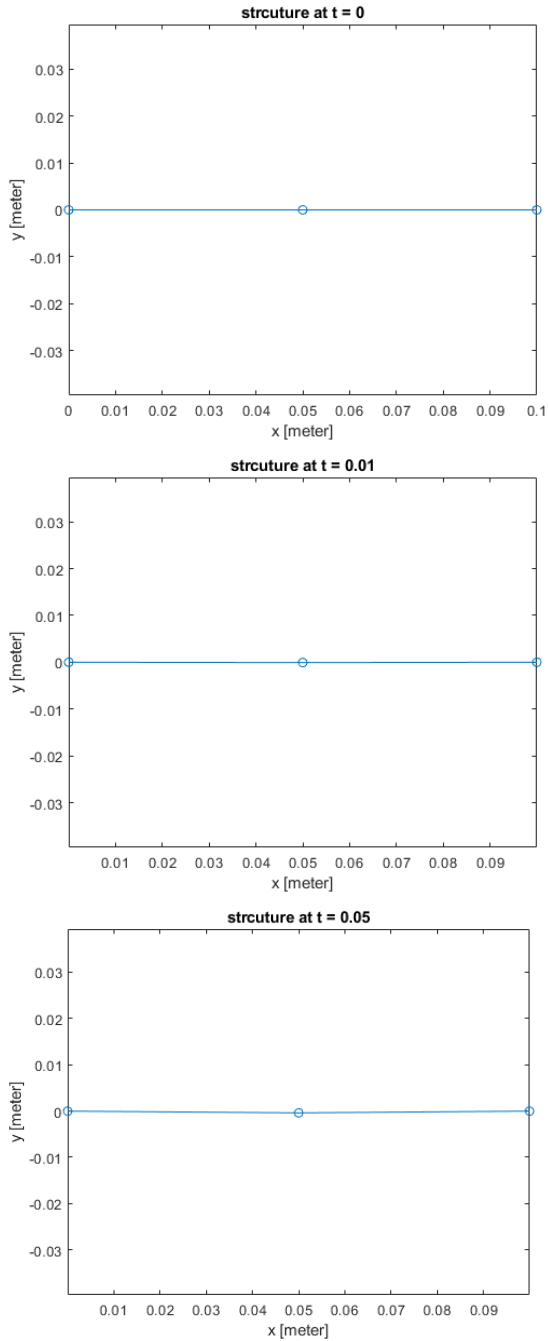


Fig.1 Structure at different time by implicit method

Explicit method:

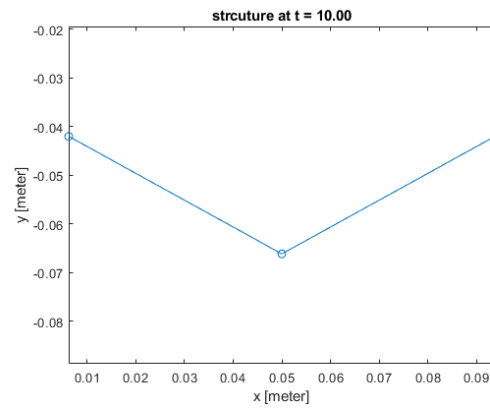
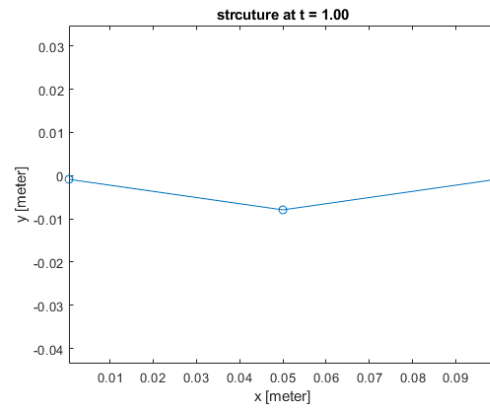
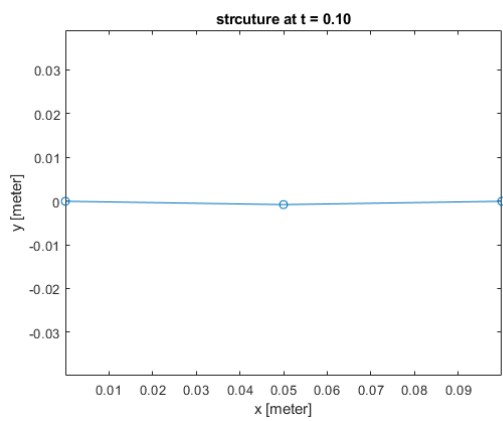
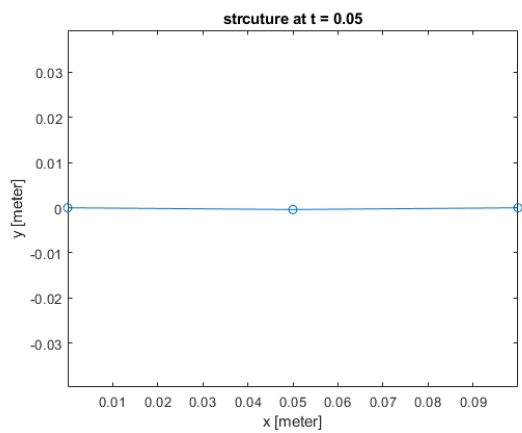
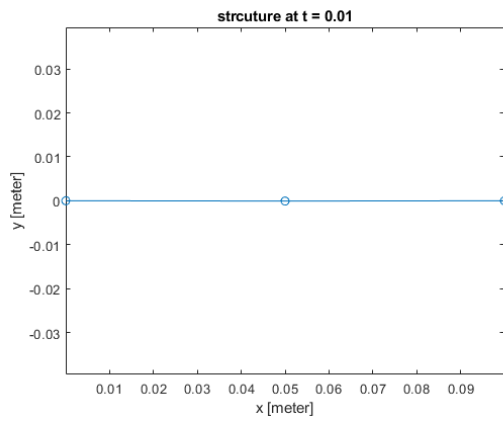
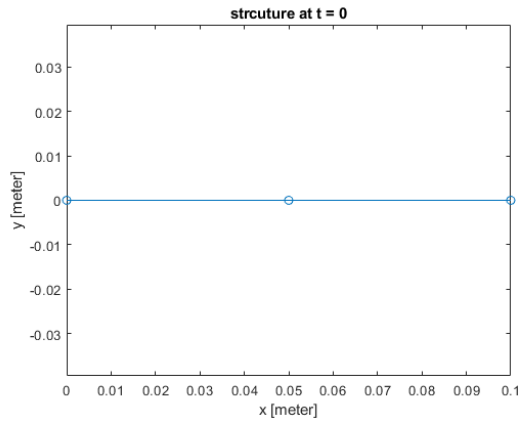


Fig.2 Structure at different time by explicit method

Q2

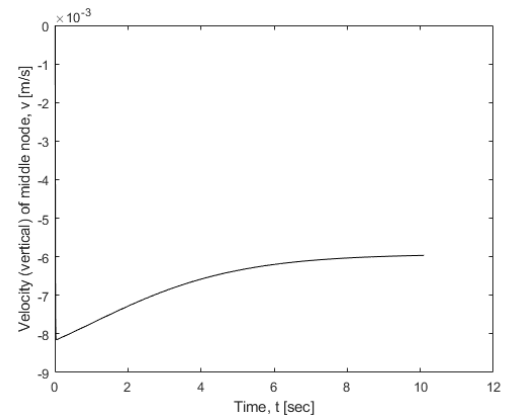


Fig.3 Velocity of middle node by implicit method

## II. ASSIGNMENT 2

Q1

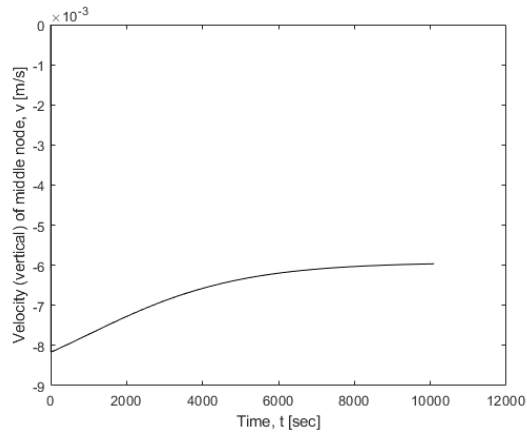


Fig.4 Velocity of middle node by implicit method

The two plots are the velocity of the structure calculated by implicit method (top) and explicit method (bottom), the terminal velocity are 0.006967m/s and 0.005964m/s respectively

Q3

All the nodes will fall at the same speed simultaneously. As shown in the plot, the structure at the time 10 is kept horizontal.

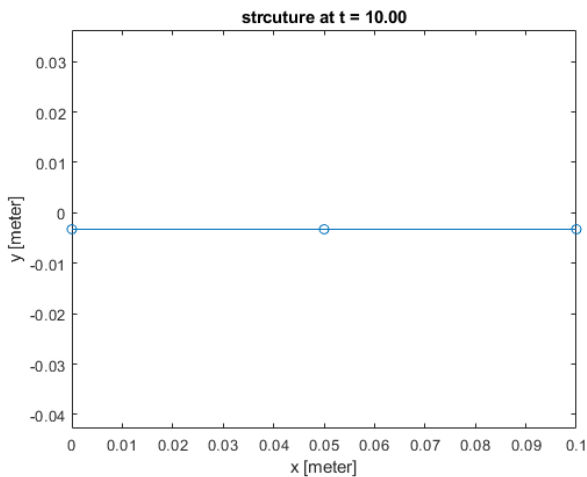


Fig.5 Structure at t=5s with same radii

Q4

The explicit method generates the result directly which is simple for calculating, but it requires a smaller time step. By changing the time step into  $10^{-4}$  s in the experiment, the result is not converged and unstable which may not be able to generate the correct result. Though the implicit method is more complicated, it can solve for the correct result with much wider time steps compared to the explicit method. The implicit method also can generate the result faster due to the larger timestep despite the complexity of iteration.

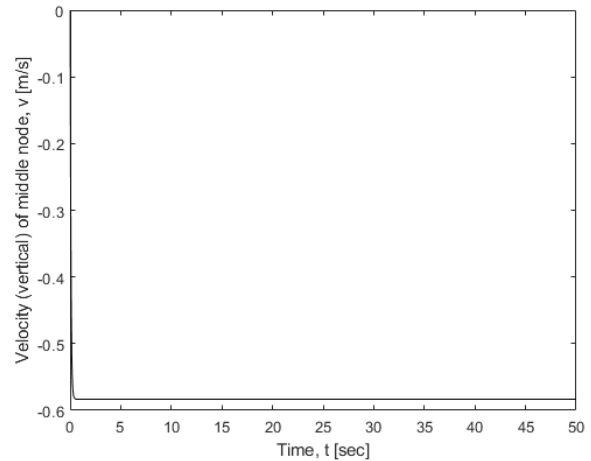


Fig.6 Velocity of middle node

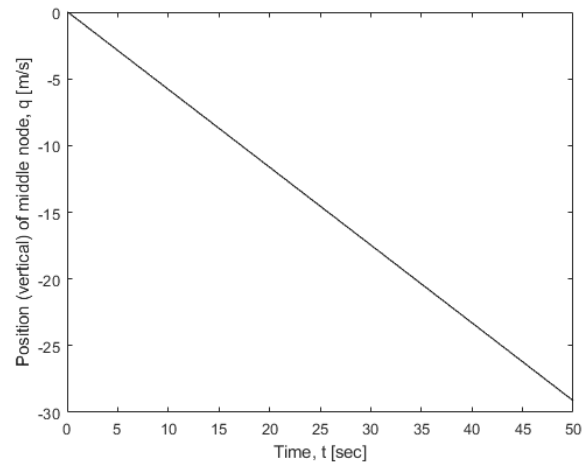


Fig.7 Vertical position of middle node

The terminal velocity is 0.5834 m/s.

Q2

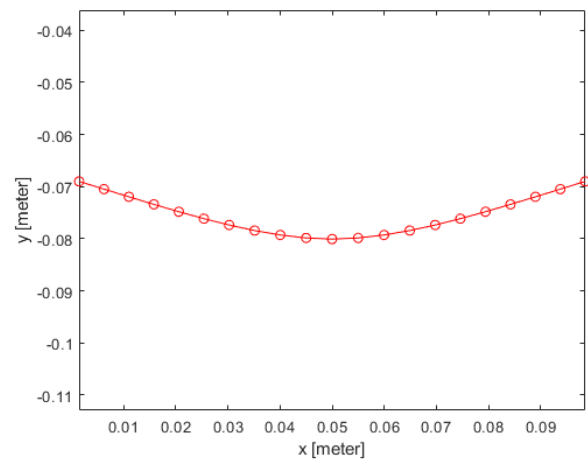


Fig.8 Final deformed shape of the beam

Q3

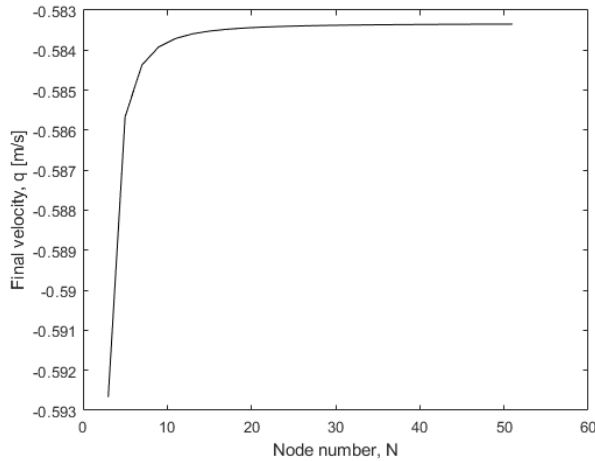


Fig.9 Terminal velocity vs. the number of nodes

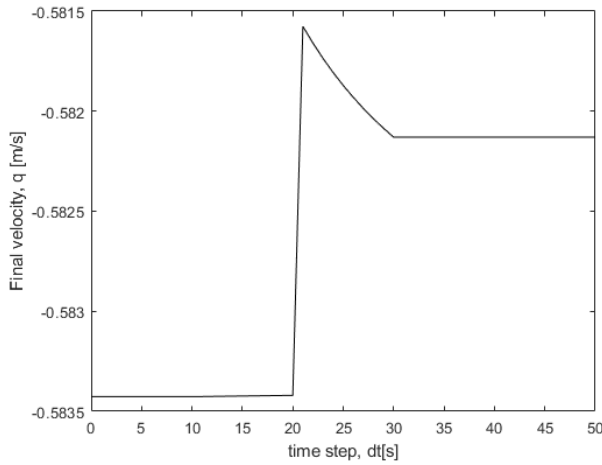


Fig.10 Terminal velocity vs. the time step size

According to the figures, the increased node will increase the final vertical velocity of the structure. The final speed converged at about 0.5834m/s as the number of nodes reached 18 or larger. For the timestep wise, the result keeps consistent until the time step is 20s. The final velocity become unstable when time step is larger than 20s, the difference is about 0.001m/s which is acceptable. The result is accurate since the Newton's method able to solve the optimal result.

### III. ASSIGNMENT 3

Q1

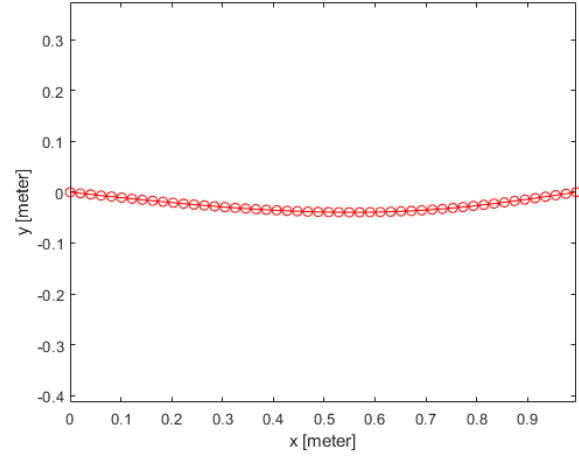


Fig.11 Final structure of the beam

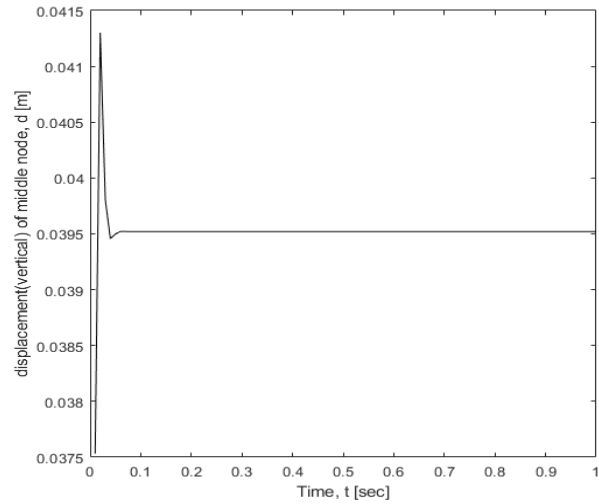


Fig.12 Maximum vertical displacement vs time

The maximum vertical displacement is 0.03952m according to the plot. The calculated result based on Euler beam theory is 0.03804m. The error is 3.89%.

### Q3

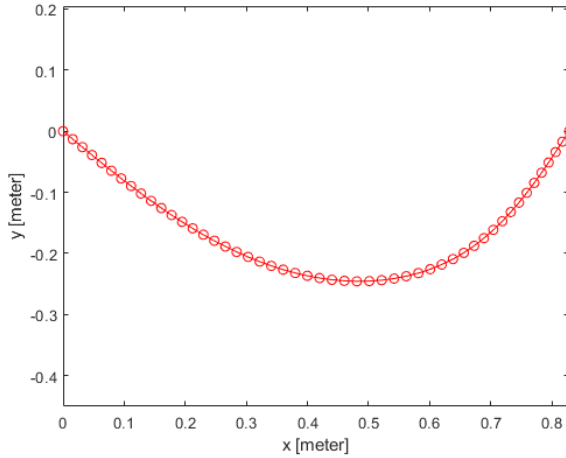


Fig.13 Final structure of the beam

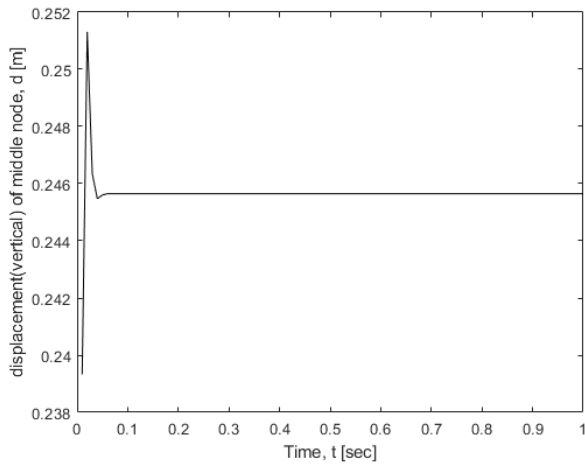


Fig.14 Maximum vertical displacement vs time

The maximum vertical displacement is 0.2456m according to the plot. The calculated result based on Euler beam theory is 0.3804m. The error is 55.89% which is large and unacceptable. The simulation can work with any amount of load while the Euler beam theory can only use for small load.

### REFERENCES

- [1] M. Khalid. Jawed and S. Lim, *Discrete simulation of slender structures*, ch 4