MAE 263F: Homework2_He

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***Abstract*— This electronic document is a report of Homework1 for 263F.**

I. Problem Statement

The question is showing in Fig.1 below.

Assignment: An elastic rod with a total length $l = 20$ cm is naturally curved with radius $R_n = 2$ cm. The location of its N nodes at $t = 0$ are

$$\mathbf{x}_k = [R_n \cos((k-1)\Delta\theta), \quad R_n \sin((k-1)\Delta\theta), \quad 0],$$

where $\Delta\theta = \frac{l}{R_n}\frac{1}{N-1}$. The twist angles θ^k $(k = 1, \ldots, N-1)$ at $t = 0$ are 0. The first two nodes and the first twist angle remain fixed throughout the simulation (i.e. one end is clamped). The physical parameters are: density $\rho = 1000$ kg/m^3, cross-sectional radius $r_0 = 1$ mm, Young's modulus $E = 10$ MPa, shear modulus $G = \frac{E}{3}$ (corresponding to an incompressible material), and gravitational acceleration $g = [0, 0, -9.81]^T$. Choose an appropriate time step size Δt and number of nodes N.

- Write a computer program that simulates the deformation of this rod under gravity from $t = 0$ to $t = 5$ s.
- Plot the z-coordinate of the last node ($\mathbf{x}_N$) with time. The solution can be found at the end of this Chapter.

Figure. 1 Question Statement

II. Answer

A. *Problem1*

The program that simulates the deformation of this rod under gravity from t = 0 to t = 5 s is in GitHub repository. The images below show the initial discrete elastic rob structure and the shape of the rod after 4.91 seconds of simulation.

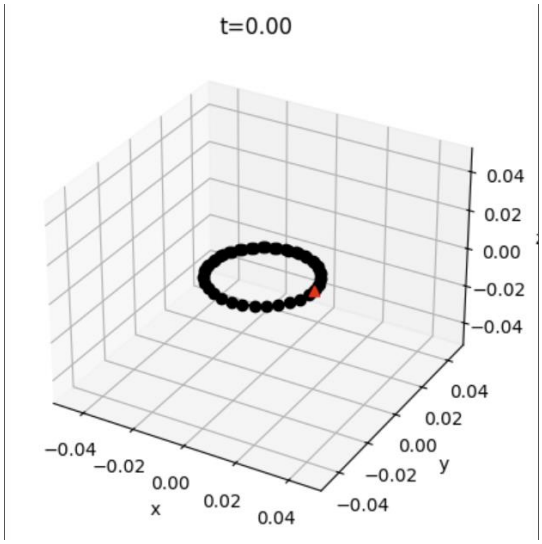

Figure. 2 Discrete Elastic Rob Structure at t=0 s

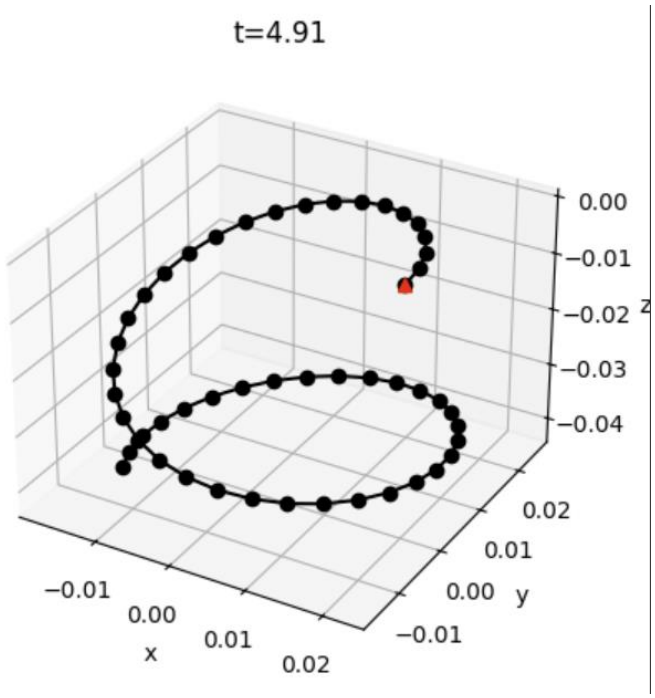

Figure. 3 Discrete Elastic Rob Structure at t=4.91 s

B. *Problem2*

The z-coordinate of the last node (x_N) with time is shown below in Fig.4.

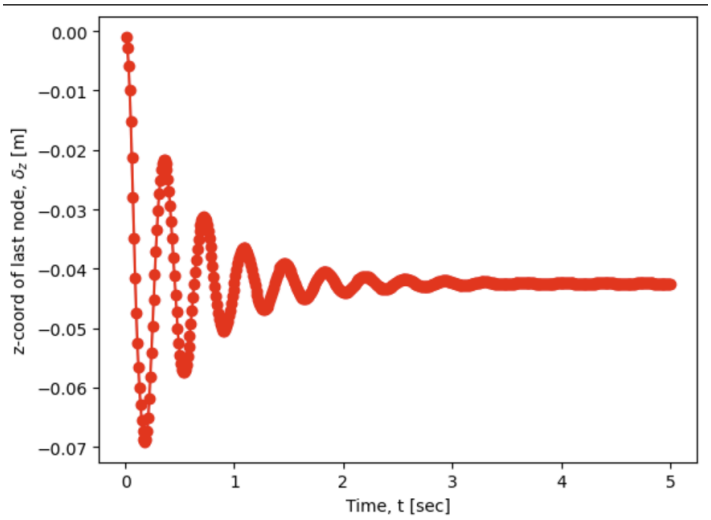

Figure. 4 z-coordinate of the last node (x_N) with time

REFERENCES

[1] M. K. Jawed and S. Lim, “Discrete simulation of slender structures,” *BruinLearn,* 2024.