Homework 5 Report

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***Abstract*— This homework is to practice and observe the simulation of a plate model and to compare it to the Euler-Bernouli Theory. The simulation makes a meshed plate model to make a beam with a fixed end and analyzes the deformation of the beam with the displacement of the tip of the plate.**

I. INTRODUCTION

This homework covers the simulation of making meshed plates to analyze shells and surfaces in 3 dimensions using bending and stiffness of shell. The code will use modified code from the simple discrete elastic plates. It will use 20 nodes (4 fixed and 16 free), 37 edges, and 17 hinges. The time step and viscosity will be adjusted to reach the steady-state of the load displacement as it will oscillate. The beam which will be simulated with the following.

Measurement	Value
Length	$0.1\ m$
Width	$0.01\ m$
Thickness	$0.002\ m$
Density	$1000\ kg/m^3$
Young's Modulus	$70\ MPa$

Table 1: Given Values of the Beam

This is to compare the simulation tests of cantilever Beam with that of the theoretical calculations of the textbook to see how accurate the results are. Equations 1, 2, 3 give some additional functions to solve the Euler-Bernouli beam calculation in Equation 4 to find the displacement of the tip of the beam.

$$A_{cross} = wh \quad [1]$$

$$I = \frac{wh^3}{12} \quad [2]$$

$$q = \rho A g \quad [3]$$

$$\delta_{EB} = \frac{ql^4}{8YI} \quad [4]$$

The simulation will have oscillations until it reaches a steady-state, so timesteps and the viscosity of the simulation would be adjusted for a faster convergence.

II. RESULTS

Figure 1 shows the displacement of the end of the beam until it reaches the stead- state of the load for part 1 of measurements and Figure 2 shows the snapshots of the coil during the simulation. The code examines the node at the end of the beam and records the displacement of the z value over the time of the simulation. The steady state can be observed in the convergence in the displacement of the plot. The final value of the z value is outputted to show the resulting displacement.

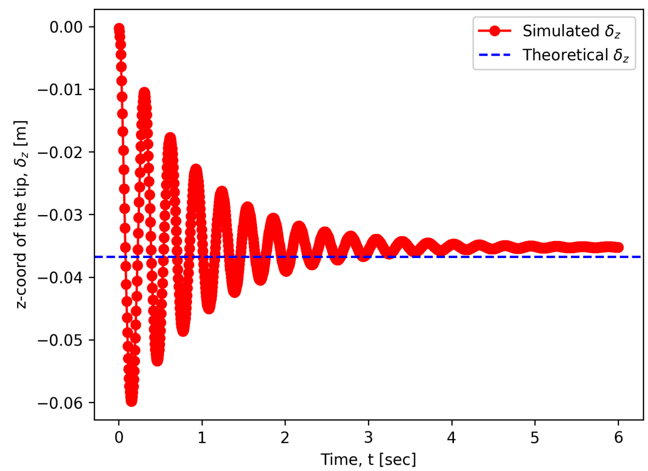

Figure 1: Z displacement of End Tip of the beam vs Time.

	Value
Simulation Steady-State	-3.525 e-02 m
Euler-Bernouli Theoretical	-3.675 e-02 m
Normalized Difference	0.0294

Table 2: The Final values of the Displacement of the Beam tip

$$E_n = \frac{a - b}{\sqrt{a^2 + b^2}} \quad [5]$$

Comparing the Euler-Bernoulli displacement calculated with Equation 4, it seems that the simulation got a similar result in its steady-state. This shows the comparable nature of the steady-state of the simulation to the theoretical result, only having a smaller displacement value in comparison. The normalized difference of the value being 0.0294 makes the simulation accurate to the theoretical value from equation 5. This shows that the behavior of the beam can be modeled in simulation to test in other applications to analyze different results and behavior of the beam, such as using varied specific loads on different areas of the beam.