AERO 4630 - Aerospace Structural Dynamics

Project 4

Assigned: Friday, March 22 2019
Due: Friday April 5 2019 at 17:00, uploaded as PDF on Canvas

Office Hours: Davis 335, Wednesdays 1300-1400 hrs

Problem 1: Vibrations of a plate

Let's analyze the vibrations of a plate. Consider a plate of dimensions $L = 1m$, $W = 1m$ and $H = 0.001m$. The material properties are the same as the cantilever beam from the last project. Let's put our origin at the $x = 0, y = 0, z = 0$. We are still using the same equation of motion. So we don't have to non-dimensionalize anything again.

(1a) Let's consider the case where the plate is clamped at the left face $x = 0$ and subject to a downward ($-z$ direction) force of $100N$ on a small patch on the top towards the right side $0.98L \leq x \leq L, 0.49W \leq y \leq 0.51W, z = H$. Once the plate is bent, we let go of the force and see the plate vibrate. Plot the z displacement of following points of the plate as a function of time on a single plot: $(L, 0, H)$, $(L, 0.25W, H)$, $(L, 0.5W, H)$, $(L, 0.75W, H)$, (L, W, H). Obtain the amplitude and frequency of vibration of each point. Repeat this for $(0.5L, 0, H)$, $(0.5L, 0.25W, H)$, $(0.5L, 0.5W, H)$, $(0.5L, 0.75W, H)$, $(0.5L, W, H)$ and plot these together on a single plot.

(1b) Repeat the above problem for $L = 2m$, $W = 2m$. How does the frequency and amplitude change?

(1c) Let's consider a different case now for $L = 1m$, $W = 1m$. Let's clamp two faces, $x = 0$ and $y = W$ and apply the force of $100N$ at a corner $0.98L \leq x \leq L, 0 \leq y \leq 0.02W, z = H$. Obtain the plots for all the points listed above (in the same format). Obtain the amplitude and frequency of vibrations of each point.

(1d) Let's clamp all the side faces $x = 0$, $x = L$, $y = 0$ and $y = W$ (for $L = 1m$, $W = 1m$). Apply the same force of $100N$, but this time in the middle $0.49L \leq x \leq 0.51L, 0.49W \leq y \leq 0.51W, z = H$. Plot the z displacement vs time for following points in a single plot: $(0.5L, 0.5W, H)$, $(0.25L, 0.5W, H)$, $(0.75L, 0.5W, H)$, $(0.5L, 0.25W, H)$ and $(0.5L, 0.75W, H)$.

Repeat the plots for $(0.25L, 0.25W, H)$, $(0.25L, 0.75W, H)$, $(0.75L, 0.25W, H)$, $(0.75L, 0.75W, H)$. Is there a difference in amplitudes and frequencies of all these points? If so, comment on the differences.

Now change the dimensions again to $L = 2m$, $W = 2m$. How do the frequency and amplitudes of each point change?