LESSON 9: FREE VIBRATION EXPERIMENTS
September 16, 2016

EXPERIMENTS ON PREVIOUS OBJECTIVES

Reading: Chopra 2.2

In Class:
From HW 6, Problem 2

- A single-legged water tower supports a weight of 75,000 lbs, at a height of 50 feet. If the moment of inertia of the steel tower is 10,000 in\(^4\), determine the natural frequency of the tower in units of rad/s and the natural period of vibration in units of seconds. Then, if Godzilla were to impart a 10 inch initial horizontal displacement to the water tank with an initial velocity of 50 in/s, plot the displacement (units: inches) and acceleration (in g’s) responses of the tower (plot to a scale so that approximately 5 cycles are shown), over time, assuming no damping. Then, determine the maximum base moment on the steel tower.

Homework (Due Monday)
The Physical Experiment:
Initial displacement: Unknown.

1. Compute the theoretical natural frequency and period of the system, based on the given weights and dimensions. Account for half of the steel column mass, associated with the moving mass.
2. Make a realistic SAP model of the problem: do not make the steel weightless. Put in the actual thicknesses and E values for the materials. Account for the weight of the nylon, bolts, and IPhone. Use SAP to determine the natural frequency and period of the system.
3. After the receiving the experimental data from Prof. Kurtz, plot acceleration versus time. Determine the natural period and compare it with the previous estimates. Determine the damping ratio and the damping coefficient, c.
4. Plot displacement versus time by numerically integrating the acceleration data twice, in Excel. The results will probably be terrible. This will show that integration amplifies measurement errors.
5. Since the maximum displacement is probably impossible to determine from the data, accurately (i.e., the results of problem 4 are ridiculous), determine the maximum force on the mass utilizing the fact that it must equal cu + mu. Now, based on this maximum force, determine what the maximum displacement must have been.