22.403 Mechanical Engineering Lab II

**Final Design Project, Weekly Progress Report, Fall 2012**

Project Title: Cantilever Beam Experiment \_, Date: 11/14/12

Group: 805D \_, Names: Joshua Bevan, Anthony Schifiliti and Matthew Spinazola

**Tasks performed in the previous week *(you may attach your calculations, drawings, equipment list, etc. to this sheet for submission)*:**

* Became familiar with beam set up
* Set up beam with accelerometers and eddy current probe
* Opened lab view to determine how data will be recorded
* Research the application of filters for the eddy current probe
* Research the effects of the accelerometers mass on natural frequency
* Research manufacturers sensitivities for accelerometers
* Additions were made to the experimental procedure

**Work plan for next week:**

* Test system using the attached procedure
* Compare result to expected values
* Investigate ways to improve results

**Influence of Accelerometer Masses on System Natural Frequency**

The natural frequency of a massless beam with a point mass on its end is given by Equation (1).

(1)

The same beam with a point mass located at an arbitrary point ‘x’ is similiar to Equation (1) as the massless beam from x to L has no influence, as given in Equation (2).

(2)

If it is desired to find an equivalent tip mass that produces the same natural frequency as that of a mass at an arbitrary point Equations (1) and (2) can be related to each other to find the equivalent mass as shown in Equation (3).

(3)

Assuming operating conditions allow the superposition principle to be applied, a beam with multiple masses at arbitrary locations can be modeled as an equivalent beam with the sum of equivalent masses at the beam end.

If the beam has mass, then it must also be converted to an equivalent tip mass. The beam can be broken into infinitesimal masses, converted to equivalent infinitesimal tip masses, and then integrated along its length to determine the equivalent tip mass as shown in Equations (4) and (5).

(4)

(5)

Therefore the equivalent tip mass is:

(6)

Using the calculated equivalent tip mass from Equation (6) in Equation (1) the new system natural can be calculated. This was calculated for two accelerometers of 10g each placed at x=0.17 and 0.28m on the beam. Figure 1 plots the beam acceleration with and without the accelerometers present. As might be expected the presence of the additional masses lowers the natural frequency of the beam from 32.6 to 28.5 Hz, leading to lower peak accelerations.

**Figure 1: Influence of two 10g point masses placed at x=0.17 and 0.28m on beam acceleration**

**Objectives**

The objectives of this experiment are the following:

* Determine the natural frequency of the cantilever beam.
* Determine the damping on the beam.
* Evaluate the tip displacement of the beam with three measuring devices (two accelerometers and an eddy current probe).
* Determine positions for accelerometers to effectively use their 5 volt useful range.
* Determine position for eddy current probe to ensure its useful range of ±1/32 in and 200 V/in sensitivity.
* Determine how the mass of the two accelerometers affect the natural frequency of the system.
* Determine the location of the node positions for the first two modes. Compare to expected values.
* Determine the linear range of the eddy current probe.

**Experimental Procedure**Determine sensitivity for accelerometers:

1. To determine the sensitivity of the accelerometers they need to be placed on a surface of a known acceleration e.g. a shaker.
2. Record the voltages produced by the accelerometers at the known acceleration of the shaker.
3. Average the data obtained to determine the sensitivity.

Calibration of eddy current probe (static):

1. Before deflecting the beam (displacement of 0 on the micrometer) record the output.
2. Using the micrometer displace the beam in regular intervals recording the output at every interval.
3. Plot the output voltage against the displacement. The slope of the data (while linear) is the sensitivity of the eddy current probe.

Applying force to tip:

1. Attach the three transducers to the 3 channels of the DAS.
2. Make sure the eddy current probe is near the beam at the specified location. Attach accelerometers to the beam their specified locations.
3. Extend the micrometer face until almost touching beam at rest.
4. Set the micrometer at the first desired displacement by retracting the micrometer face the desired displacement from the location at rest.
5. Displace the tip of the beam until touching the micrometer to get an exact displacement.
6. Release the beam and allow it to vibrate.
7. Record the output from the three transducers with labview, repeat runs as needed.
8. Compare experimental values with theoretical values.
9. View the results in the frequency domain. Determine if a filter is need for the eddy current probe, and if so what type and what settings.

Apply force to tip only measuring with the eddy current probe:

1. Remove accelerometers from the beam.
2. Repeat steps 3-8 above.
3. Compare results without the accelerometers to the previous results with the accelerometers. Calculate the natural frequency with the mass of the accelerometers added to the mass of the beam.

Measurements with accelerometers on the expected node positions:

1. Move accelerometers to the nodes of the first two modes.
2. Displace beam and record data as previously done.
3. Note if the expected node positions are the actual node positions (if not find them).

Determination of Linear Range for eddy current probe:

1. Displace the eddy current probe using the micrometer.
2. Plot data in Microsoft Excel.
3. Continue collecting data until values no longer linear.