

ME 458 Noise Control Laboratory #7

Layered Damping Materials

Objectives:

1. Perform basic vibration measurements,
2. Investigate layered damping materials,
3. Determine loss factor using free vibration decay
4. Determine damping loss factor using an impact hammer and FFT analysis
5. Predict natural frequency of a simple beam

Background: Thin sheet metal structures are notorious for radiating lots of noise. Engine valve covers and oil pans are good examples. An effective technique for minimizing noise radiation (under certain conditions) is to add an elastomeric damping layer to the structure. In this experiment, we will measure the loss factor of three cantilevered beams with different damping treatments. Damping of the beams is achieved via two different methods: free layer damping and constrained layer damping.

Equipment: Each beam is equipped with a piezoelectric accelerometer mounted near the tip of the beam to measure its vibration. The accelerometer output is measured with an oscilloscope and/or a frequency analyzer.

Procedure:

- 1) Determine the resonance frequency of the three beams (undamped, free layer damping, and constrained layer damping) using the impact hammer. Plot the frequency response of the beams. Calculate the natural frequency of the beam from its dimensions (using the NASA tables).
- 2) Determine the damping ratio and loss factor using the Q factor method (width of the peak between half power points). Look up the appropriate formulas in your ME54 textbook.
- 3) Determine the critical damping ratio and the loss factor using the log decrement method for each beam. Look up the appropriate formulas in your ME54 textbook.

Comment on the effectiveness of the damping methods. Compare the measured vibration values to the expected attenuation at resonance (change in sound or vibration level due to addition of damping), calculated by:

$$\Delta L = 20 \log \frac{\eta}{\eta_b}$$

where: η = loss factor after treatment η_b = loss factor before treatment
 ΔL = change in level (Insertion Loss) (dB)

System Diagram (block diagram showing all electrical connections):

Reporting Requirements: Thoroughly document your test procedure, instrumentation, calculations, results, observations and conclusions in a full-length, professional quality report. Under what conditions is a damping layer effective and justified? What are the relative advantages and disadvantages of constrained layer versus free layer damping?