EXPERIMENT 2

IDENTIFICATION OF HIGH FREQUENCY MODES OF AN ALUMINIUM BEAM IN "FREE-FREE" CONDITION USING ELECTRO-MECHANICAL IMPEDANCE (EMI) TECHNIQUE

OBJECTIVES

This experiment aims to identify the high frequency modes of an aluminium beam in "free-free" condition (which otherwise cannot be captured by the conventional vibration techniques) using the electro-mechanical impedance (EMI) technique in measurement cum simulation mode. To learn more about the EMI technique, click http://ssdl.iitd.ac.in/vssdl/piezo.pdf.

EXPERIMENTAL METHODOLOGY

This experimental setup is shown in Fig. 1. It consists of a thin aluminium beam of dimensions 299×18.2×2.15 mm with a pair PZT sensors bonded on either side at the midpoint, as shown in the figure. "Free-free" conditions are ensured by hanging the beam vertically through a cello tape, whose high flexibility ensure "free-free" conditions. The two PZT patches are connected with each other such that the positive electrode of one patch joins the positive electrode of the other, so that they are excited in phase when an alternating voltage is applied across the combination. In this arrangement, only axial vibrations are induced and flexural vibrations are ruled out. The wires from the combination are connected an LCR meter.

The user may virtually acquire and download the plots of the conductance (*G*) and the susceptance (*B*) against frequency. The user may plot *G* v/s frequency in excel. The peak in the plot is the resonance frequency of the beam. Typical expected plot is shown in Fig. 2.

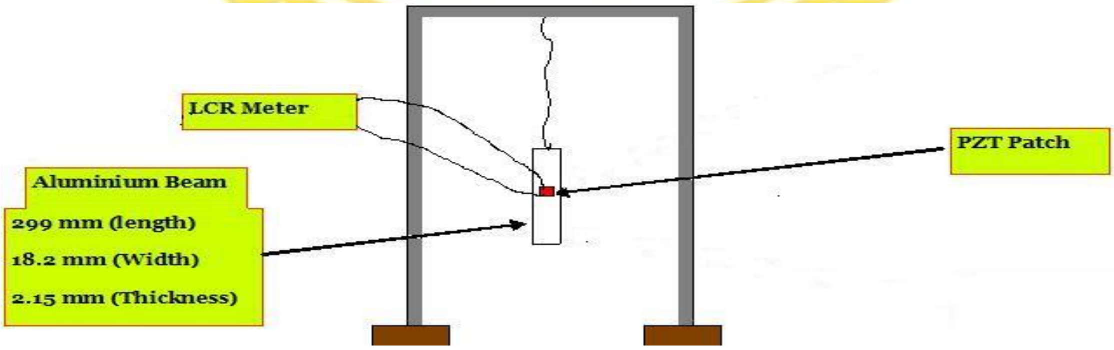

Fig. 1 Experimental set up

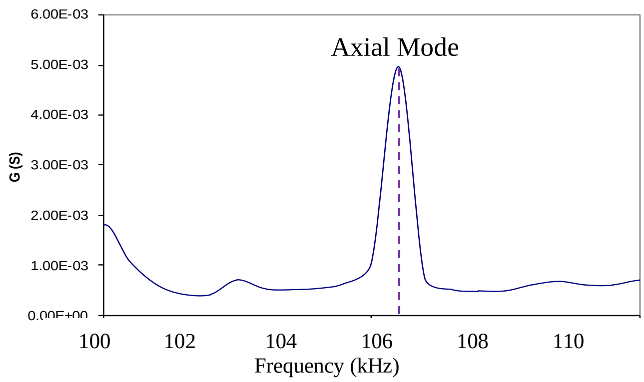

Fig. 2 Expected plot of G vs frequency.

From the frequency plot, the user can identify the natural frequency of the beam in axial mode as the frequency corresponding to which peak in the G-plot. The user may compare the frequency obtained through this experiment with the theoretical frequency given below (Paz, 2004).

$$f_n = \frac{2n-1}{4L_{half}}\sqrt{\frac{E}{\rho}} \tag{1}$$

where E denotes the Young's modulus of elasticity of the beam, ρ the material density and L_{half} the half length of the beam. The user may compute the first ten frequencies by substituting n = 1, 2..., 10 and conclude as to which frequency is identified.

REFERENCES

1. Chopra, A. (2001), Dynamics of Structures, Prentice Hall of India limited, New Delhi.

2. Paz, M. (2004), Structural Dynamics: Theory and Computations, 2nd ed., CBS Publishers and Distributors, New Delhi.

3. Bhalla, S. and Soh C. K. (2004), "High Frequency Piezoelectric Signatures for Diagnosis of Seismic/ Blast Induced Structural Damages", NDT &E International, Vol. 37, No. 1 (January), pp. 23-33.

4. Literature of piezoelectric materials **http://ssdl.iitd.ac.in/vssdl/piezo.pdf**