

**EXPERIMENT 10**  
**SHEAR LAG EFFECT IN ELECTRO-MECHANICAL IMPEDANCE (EMI) TECHNIQUE**

**OBJECTIVES**

This simulation based experiment is designed to teach the concept of shear lag in piezo-based sensing/actuation operating through the medium of a bond layer. The effect of shear lag on electro-mechanical impedance (EMI) signatures is studied with the aid of analytical models.

**INTRODUCTION**

The phenomenon of difference in the strain induced in the PZT patch from that in the host structure during sensing/ actuation is called as shear lag effect. Figure 1 illustrates the process of actuation of a PZT patch by application of external voltage. As can be seen from the figure, the displacement induced on the surface of the host structure ( $u_o$ ) is lesser than that in the PZT patch ( $u_p$ ). For more information about shear lag effect, the user may refer the doctoral thesis of Dr. Sumedha Moharana (<http://web.iitd.ac.in/~sbhalla/thesispdf/sumedha.pdf>). To learn more about the EMI technique, visit: <http://ssdl.iitd.ac.in/vssdl/piezo.pdf>.

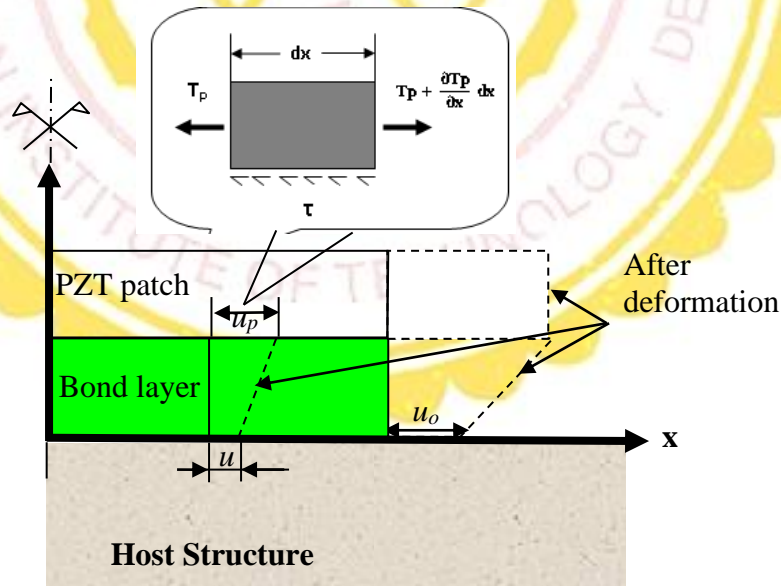


Fig. 1 Illustration of shear lag effect during actuation

## EXPERIMENTAL PROCEDURE

The simulations in this experiment are based on the analytical model developed by Dr. Sumedha Moharana. The user can visualize the shear lag effect using an animation. The simulated signatures for various bonding conditions then be downloaded and plotted in excel to make observations about the effect of shear lag on EMI signatures.

## REFERENCES

1. Literature on piezoelectric sensors: <http://ssdl.iitd.ac.in/vssdl/piezo.pdf>
2. Bhalla, S. and Moharana, S. (2013), "A Refined Shear Lag Model for Adhesively Bonded Piezo-Impedance Transducers" Journal of Intelligent Material Systems and Structures, Vol. 24, No. 1 (Jan), pp. 33-48. DOI: 10.1177/1045389X12457837
3. Moharana, S. and Bhalla, S. (2014), "A Continuum Based Modelling Approach for Adhesively Bonded Piezo-Transducers for EMI Technique" International Journal of Solids and Structures, Vol. 51, No. 6 (Mar), pp. 1299-1310. DOI: 10.1016/j.ijsolstr.2013.12.022
4. Moharana (2012), "Modelling of Piezo-Structure Elasto Dynamic Interaction Through Bond Layer for Electro-Mechanical Impedance Technique", Ph. D Thesis,, Department of Civil Engineering, IIT Delhi. <http://web.iitd.ac.in/~sbhalla/thesispdf/sumedha.pdf>