AE351 - IITK
LAB 3 - Beam Deflection and Strains

Lab Objectives: Experimentally measure the strain and deflection in a beam subjected to transverse loading. Determine the strain and the deflection variation along the beam using Euler-Bernoulli beam theory and compare the results with experimental measurements.

Procedure:

1. Go through the 'Notes on beam deflection and strains' detailed in the next section.

2. The experimental setup includes:
   d. A beam of rectangular cross section with carefully mounted (15) strain gages on its top surface
   e. Strain indicator (with Wheatstone bridge circuits) to record strain gage data
   f. Deflection dial gages to measure beam deflection

3. Mount the beam with simply supported boundary conditions. Measure beam dimensions and the location of strain gages with respect to the supports. Apply a concentrated load as specified by your lab instructor. Record all dial gage readings and the strain values using strain indicator equipment and tabulate your data.

4. Theoretically calculate strains at each of the strain gage locations using Euler-Bernoulli beam theory and compare your results with experimentally measured strain values. Generate graphs that show both your experimental measurements (as data points) and theoretical predictions (as solid lines/curves). Calculate the percent errors and discuss possible reasons for the discrepancies.

5. Perform the analysis steps mentioned above in 4 for the beam deflection.

6. Remove all dial gages. Simulate symmetric four point bend condition by applying two concentrated loads of the same magnitude symmetrically with respect to the supports. Tabulate strain data recorded using strain indicator equipment and repeat the analysis steps mentioned in 4.

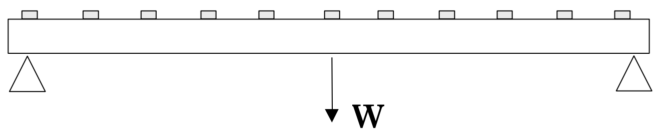
$$\sigma_x(x,y) = \frac{M(x)\,y}{I} \qquad \varepsilon_x(x,y) = \frac{M(x)\,y}{EI}$$

Prepare a complete lab report using the Lab Format guidelines provided.

Notes on the Beam Deflection and Strains

Experiment #1

The experiment consists of a simply supported Beam of rectangular cross section subjected to a concentrated load. The load is applied by hanging dead weight at the specified location of the beam. A total of 15 strain gages have been mounted on the top surface of the beam.



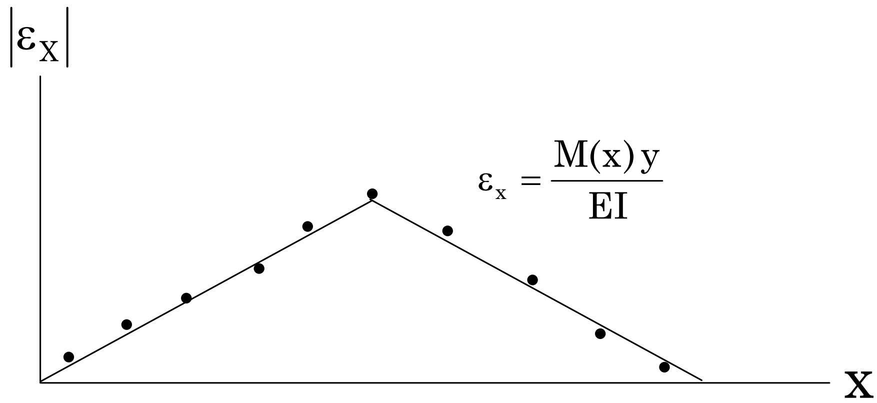
The strain gage locations from the neutral axis (y) are constant. Therefore, from Euler-Bernoulli beam theory the theoretical strain distribution on the top of the beam can be given by,

$$\varepsilon_x(x) = M(x)\left[\frac{y}{EI}\right] = C_2\ M(x)$$

where $C_2 = y/EI$ is a constant that can be calculated. As part of this experiment, you should generate a table such as shown below, which lists the measured and predicted strains at each gage location.

Strain Gage Number	x (inches)	M(x) (in-lb)	ε_x (μ) [Measured]	ε_x (μ) [Predicted]	Percent Difference
1					
2					
3					
4					
5					

Also, you should plot ε_x vs. x, to graphically compare the theoretical and experimental results. In your graph, use data points for your experimental measurements and a solid line for you theoretical prediction as shown below.



Experiment #2

This experiment consists of a beam with rectangular cross section subjected to a symmetric four point bend loading. As described in the Beam Experiment #1, measure strain values, tabulate your data, compare theoretical and experimental measurements by plotting graphs and perform error analysis as described in earlier experimental details.