Experiment No. 2 – Flexural Stresses in Beams

Objective:

The objective of this lab is to determine the flexural stresses in a simply supported beam subjected to two concentrated loads. Experimental results must be verified by the use of conventional beam theory.

Protective laboratory practices and personal equipment:

- Undergraduate students and teaching assistants are required to wear *substantial footwear* (footwear made of a solid material which completely encloses the foot.) Open toe or open heel sandals or shoes are not acceptable.
- No food or drinks are allowed in the lab.
- Students are required to remain within the designated area confined to the "Mechanics of Materials" lab (CBY E07).

Equipment:

- An aluminium beam of 2,438-mm length with a hollow rectangular cross-section (Fig. 1);
- Two supporting frames;
- Weights to apply external load; and,
- Instrumentation to measure deformation (five strain gauges attached along the depth of the beam, Fig. 2).

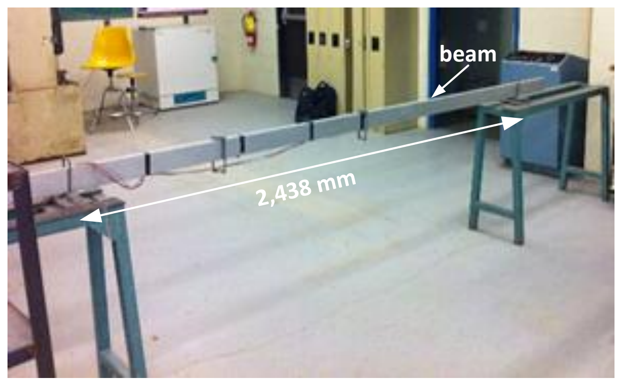

Figure 1: Aluminum beam

Procedure:

1. Calculate the moment of inertia I_z of the beam's cross section (Fig. 3).
2. Measure the location of each strain gauge.
3. Before applying the load, read the initial strain values for each gauge (for P = 0 lb).
4. Apply two concentrated loads of 20 lb at 1/3 of the span length from the supports (Fig. 4), and read the corresponding strains for each gauge.
5. Increase the loads in 20-lbs increments up to 80 lb. Record readings in Table 1.

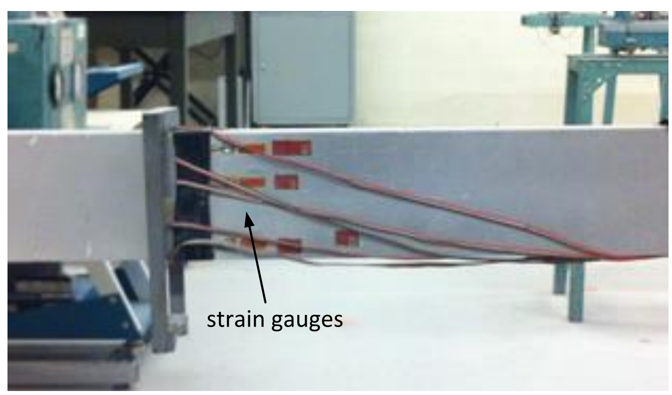

Figure 2: Strain gauges along depth of beam

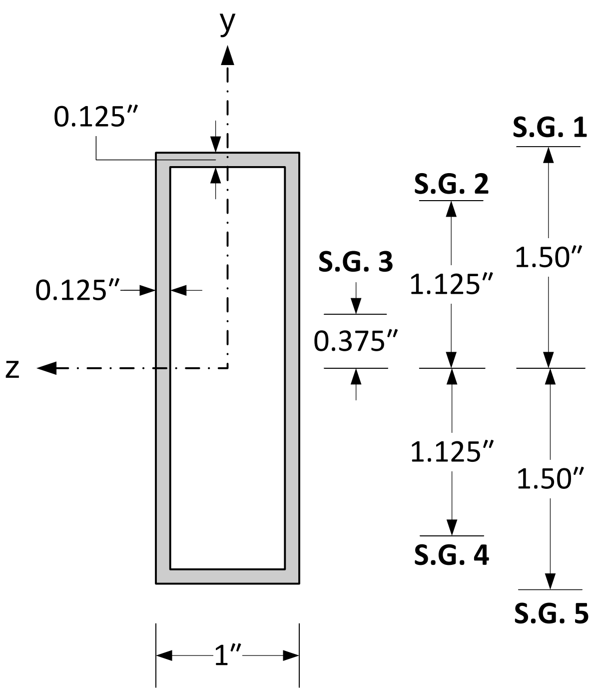

Figure 3: Rectangular hollow cross section and location of strain gauges

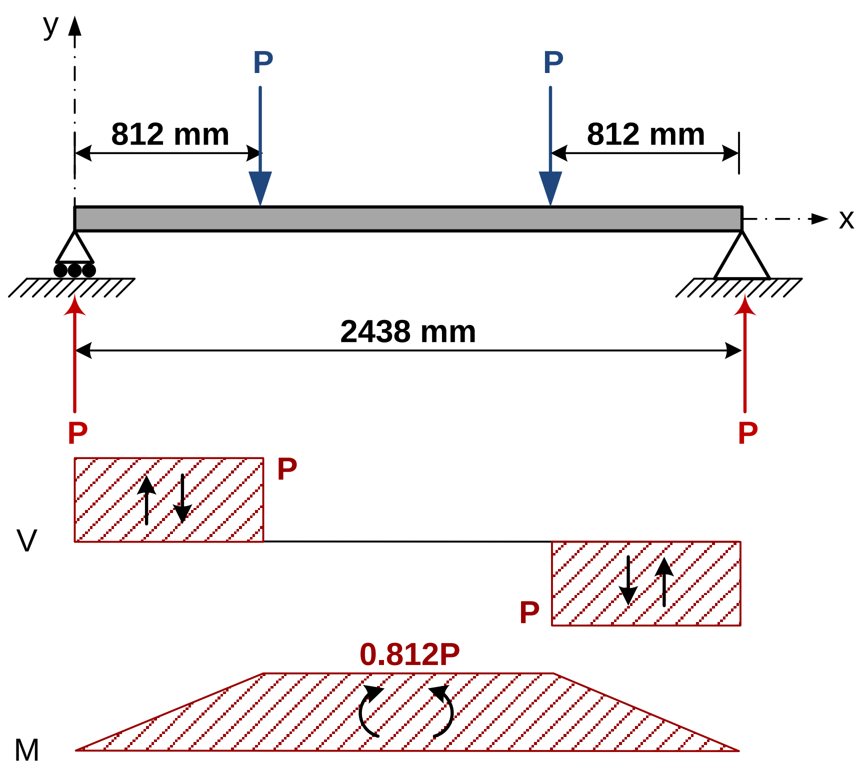

Figure 4: Applied loading and shear force and bending moment diagrams

Observations:

Table 1: Strain gauge readings.

Load		Strain ($\times 10^{-6}$)				
lb	**N**	**S.G. 1**	**S.G. 2**	**S.G. 3**	**S.G. 4**	**S.G. 5**
0						
20						
40						
80						
40						
20						
0						

Report:

The report should include the following:

1. A graph showing the distribution of experimental strains along the height of the cross section. Experimentally determine the location of the neutral axis ($\varepsilon_x = 0$) and compare it with the theoretical assumption.
2. For each loading case, draw the bending moment diagrams and calculate the stresses σ_x corresponding to the gauge locations. Note that the stresses σ_x are given by:

$$\sigma_x = -\frac{M \cdot y}{I_z}$$

   where *M* is the bending moment, *y* is the location along the depth of the section where the stress is being calculated, and I_z is the moment of inertia with respect to the bending axis.

3. Estimate the Young's modulus of the beam from the measured strains ε_x and calculated stresses σ_x ($E = \sigma_x / \varepsilon_x$) and compare it to the known value for aluminum (E = 70 GPa).

Follow the organization and formatting provided in the “Guide for writing laboratory reports.” All values in the report should be reported in SI units. Note: 1 in = 25.4 mm, 1 lb = 4.45 N.

You are required to submit a pdf file through Blackboard Learn. The deadline for submission for your group will be posted on Blackboard Learn.