Experiment No. 3 – Deflection of Beams

Objective:

The objective of this lab is to determine the deflection of a simply supported beam and verify the conventional elastic theory of beam deflection.

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:

- A steel beam with a rectangular cross-section (Fig. 1);
- Two supports;
- Weights to apply external load; and,
- Instrumentation to measure the beam deflection.

Figure 1: Beam setup

Procedure:

1. Measure the cross-sectional dimension of the beam and calculate its moment of inertia with respect to z (see Fig. 2). Note that $I_z = bh^3/12$.
2. Before applying a load, record the initial deflection.
3. Apply a concentrated load *P* at mid span (loading case 1 in Fig. 3) and read the corresponding deflection for at least three different values of the load. Record readings in Table 1. Note that *L* = 660 mm.

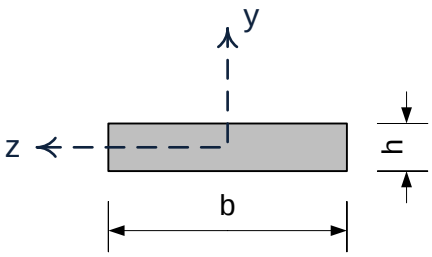

Figure 2: Beam's rectangular cross section

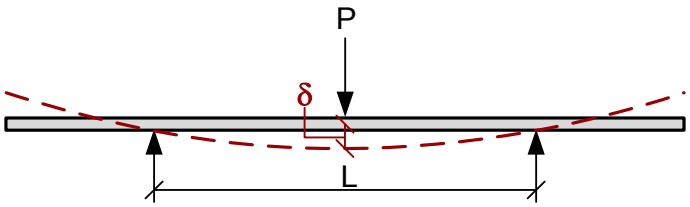

Figure 3: Load condition case 1

4. Apply two overhanging loads *P* (a = 250 mm) and measure the mid-span deflection for different values of *P* (loading case 2 in Fig. 4). Record readings in Table 2.

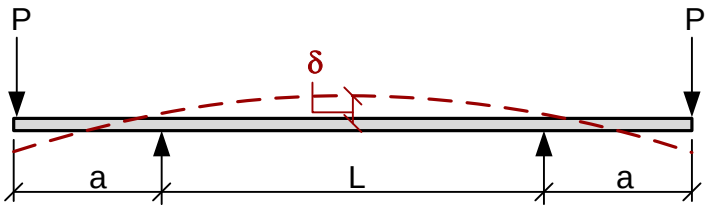

Figure 4: Load condition case 2

Observations:

Table 1: Readings from load condition case 1 (Fig. 3)

Load (lb)	Load (N)	Deflection (mm)
0		
6.35		
11.35		
16.35		
11.35		
6.35		
0		

Table 2: Readings from load condition case 2 (Fig. 4)

Load (lb)	Load (N)	Deflection (mm)
0		
3.35		
5.35		
7.35		
5.35		
3.35		
0		

Report:

The report should include the following:

1. Graphs to show the relationship between applied load *P* and deflection δ for both loading cases 1 and 2.

2. Theoretical calculation of the mid-span deflection compared with the measured data. The Young's modulus of steel is E = 200 GPa. Note that the mid-span deflection δ for loading case 1 is given by:

$$\delta = \frac{Pl^3}{48EI}$$

with l = 660 mm, whereas the mid-span deflection δ for loading case 2 is given by:

$$\delta = \frac{Pal^2}{8EI}$$

where a = 250 mm and l = 660 mm.

3. Discussion on the results particularly when there is any discrepancy between measured and predicted results. Report the % error.

$$\%\ \text{error} = \frac{|\text{experimental result} - \text{theoretical result}|}{\text{theoretical result}} \times 100$$

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.