Answer Key: Civil Engineering Licensure Exam – Mock Exam (Day 38: Beam Deflections and Elastic Stability)

February 24, 2025

Answer Key

Section A: Multiple Choice Solutions

1. Deflection of a simply supported beam: **(a)** $\delta = \frac{PL^3}{48EI}$
2. Slope at the free end of a cantilever beam: **(a)** $\theta = \frac{PL^2}{2EI}$
3. The moment-area method is used to determine: **(a) The deflection of a beam**
4. Critical buckling load for a pin-ended column: **(a)** $P_{cr} = \frac{\pi^2 EI}{L^2}$
5. A beam deflects the most at: **(a) The location of the maximum bending moment**

Section B: Problem-Solving Solutions

1. Maximum deflection for a simply supported beam:

$$\delta = \frac{PL^3}{48EI} = \frac{(20 \times 10^3)(6^3)}{48(50 \times 10^6)}$$

$$= \frac{4320000}{2400000000} = 1.8 \text{ mm}$$

2. Maximum deflection of a cantilever beam:

$$\delta = \frac{5wL^4}{384EI} = \frac{5(5 \times 10^3)(3^4)}{384(40 \times 10^6)}$$

$$= \frac{2025000}{1536000000} = 1.32 \text{ mm}$$

3. Critical buckling load:

$$P_{cr} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 (200 \times 10^9)(8 \times 10^{-6})}{(4)^2}$$

$$= \frac{1580.8 \times 10^3}{16} = 98.8 \text{ kN}$$

4. Approximate deflection at midspan (Moment-area method):

$$\delta_{\max} \approx \frac{wL^4}{185EI}$$

   Using $w = 6$ kN/m and $L = 4$ m, deflection is estimated.

5. Slenderness ratio:

$$\lambda = \frac{L_{\text{eff}}}{r} = \frac{3000}{50} = 60$$