Solutions to Concrete and Steel Structures Problems

Civil Engineering Licensure Exam - Day 48

March 7, 2025

Section A: Multiple Choice Questions (MCQs)

1. The primary function of reinforcement in concrete structures is to:
Answer: (a) Resist tensile forces
Video Explanation: Why Concrete Needs Reinforcement

2. The effective depth of a reinforced concrete beam is measured from:
Answer: (a) The top fiber to the centroid of reinforcement
Video Explanation: What is Effective Depth of a Concrete Section?

3. The lateral-torsional buckling in a steel beam is prevented by:
Answer: (a) Providing lateral bracing
Video Explanation: Elastic and Plastic Moment Capacity of Steel Beam

4. The yield strength of structural steel typically used in beams and columns is:
Answer: (a) 250 MPa
Video Explanation: Steel Reinforcement — Design of Concrete Structure

5. Shear reinforcement in reinforced concrete beams is primarily provided using:
Answer: (a) Stirrups
Video Explanation: Steel Reinforcement — Design of Concrete Structure

Section B: Problem-Solving

1. A reinforced concrete beam has a width of 300 mm and an effective depth of 500 mm. If the tensile reinforcement consists of three 20 mm diameter bars, determine the total area of steel reinforcement.
Solution:

$$A_{\text{bar}} = \frac{\pi d^2}{4}$$

$$A_{\text{bar}} = \frac{\pi(20)^2}{4} = 314.16\,\text{mm}^2$$

$$A_s = 3 \times 314.16 = 942.48\,\text{mm}^2$$

Video Explanation: Steel Reinforcement — Design of Concrete Structure

2. A simply supported steel beam of span 8 m carries a uniform load of 30 kN/m. Determine the maximum bending moment.

Solution:

$$M_{\text{max}} = \frac{wL^2}{8}$$

$$M_{\text{max}} = \frac{30 \times 8^2}{8} = 240\,\text{kN} \cdot \text{m}$$

Video Explanation: Maximum Bending Moment of a Simply Supported Beam with a UDL

3. A steel column has a slenderness ratio of 50 and a critical buckling load of 600 kN. Determine the effective length if the radius of gyration is 100 mm.

Solution:

$$L_{\text{eff}} = \lambda \times r = 50 \times 0.1 = 5\,\text{m}$$

Video Explanation: Slenderness Ratio — Design of Steel Structures

4. A concrete column has a gross area of 400 cm² and carries an axial load of 1200 kN. Determine the axial stress in the column.

Solution:

$$\sigma = \frac{P}{A}$$

$$\sigma = \frac{1200 \times 10^3}{0.04} = 30\,\text{MPa}$$

Video Explanation: Axial Stress in Steel Columns

5. A reinforced concrete beam has a factored shear force of 100 kN. Determine the required spacing of stirrups assuming $f_y = 415$ MPa and the stirrup bar diameter is 12 mm.

Solution:

The shear resistance of the stirrups is given by:

$$V_s = \frac{A_v f_y d}{s}$$

where: - A_v is the area of two stirrup legs, - $f_y = 415$ MPa, - $d = 500$ mm (effective depth), - s is the required spacing.

The area of one 12 mm bar is:

$$A_v = 2 \times \frac{\pi (12)^2}{4} = 226.19 \text{ mm}^2$$

Solving for s:

$$s = \frac{A_v f_y d}{V_s}$$

$$s = \frac{226.19 \times 415 \times 500}{100 \times 10^3} = 469.86 \, \text{mm}$$

Video Explanation: Shear Reinforcement Spacing Calculation