# Solutions to Structural Analysis Problems

Civil Engineering Licensure Exam – Mock Quiz

February 24, 2025

## Problem 1: Simply Supported Beam with an Off-Center Point Load

A simply supported beam of length 8 m carries a point load of 20 kN at 3 m from the left support. Determine the reactions at the supports and draw the shear force and bending moment diagrams.

**Solution:**

Let $A$ and $B$ be the left and right supports, respectively. The distances are: - $a = 3$ m (distance from $A$ to the load) - $b = 5$ m (distance from $B$ to the load)

Using the equations of equilibrium:

$$R_B = \frac{P \times a}{L} = \frac{20\,\text{kN} \times 3\,\text{m}}{8\,\text{m}} = 7.5\,\text{kN}$$

$$R_A = P - R_B = 20\,\text{kN} - 7.5\,\text{kN} = 12.5\,\text{kN}$$

The shear force diagram (SFD) and bending moment diagram (BMD) can be constructed using these reactions.

**Reference:** Shear and Moment Diagram of Mid-Span Point Load

## Problem 2: Propped Cantilever Beam with Uniform Distributed Load

A propped cantilever beam of length 6 m is subjected to a uniform distributed load of 4 kN/m. Determine the reactions at the supports using the force method.

**Solution:**

For a propped cantilever beam with a uniform distributed load $w$:

1. Calculate the fixed support reaction ($R_A$) and moment ($M_A$) at $A$. 2. Determine the reaction at the propped support ($R_B$).

The detailed calculations involve setting up compatibility equations and solving for the unknown reactions.

**Reference:** Propped Cantilever Beam with Uniformly Distributed Load

## Problem 3: Continuous Beam Analysis Using Moment Distribution Method

Using the moment distribution method, determine the bending moment at the midpoint of a continuous beam of two spans (5 m each) subjected to a uniform load of 3 kN/m.

**Solution:**

The moment distribution method involves:

1. Calculating fixed-end moments for each span. 2. Distributing moments at each support based on stiffness. 3. Iterating the distribution until moments converge.

The bending moment at the midpoint can then be determined from the final moments at the supports.

**Reference:** Moment Distribution Method Example

## Problem 4: Three-Hinged Arch with Central Load

A three-hinged arch with a span of 12 m carries a concentrated load of 15 kN at midspan. Determine the horizontal reaction at the supports.

**Solution:**

For a three-hinged arch with a central load $P$:

1. The vertical reactions at the supports are $R_A = R_B = \frac{P}{2} = 7.5\,\text{kN}$. 2. The horizontal reaction ($H$) can be found using the geometry of the arch and equilibrium equations.

**Reference:** Three-Hinged Arches - Continuous and Point Loads

## Problem 5: Frame Analysis Using Slope-Deflection Method

For a frame subjected to lateral forces, use the slope-deflection method to determine the moment at the fixed support if the column is subjected to a horizontal displacement of 10 mm.

**Solution:**

The slope-deflection method involves:

1. Writing slope-deflection equations for each member. 2. Applying equilibrium and compatibility conditions. 3. Solving for rotations and displacements. 4. Calculating moments using the obtained rotations and displacements.

**Reference:** Slope Deflection Method - Sidesway Frame Analysis