Solutions to Influence Lines and Moving Loads Problems

Civil Engineering Licensure Exam – Mock Exam

February 24, 2025

Problem 1: Influence Line for Reaction at Support A

Draw the influence line for the reaction at support A of a simply supported beam of length 8 m.

Solution:

For a simply supported beam, the influence line for the reaction at support A is a straight line that starts at 1.0 at support A (left end), decreases linearly to 0 at support B (right end). This indicates that when a unit load moves across the beam from A to B, the reaction at A decreases linearly from its maximum value to zero.

Reference: Influence Line for Beams (Shear and Reaction) + SHORTCUT

Problem 2: Influence Line for Shear Force at 4 m from Left Support

A simply supported beam of length 10 m carries a unit load moving across it. Determine the influence line equation for the shear force at 4 m from the left support.

Solution:

To construct the influence line for shear force at a point 4 m from the left support (let's call this point C):

- When the unit load is between the left support (A) and point C (0 x ¡ 4 m), the shear force at C is positive and equal to:

$$V_C = \frac{L - x}{L} = \frac{10 - x}{10}$$

- When the unit load is just to the right of point C (4 m ¡ x 10 m), the shear force at C is negative and equal to:

$$V_C = -\frac{x}{L} = -\frac{x}{10}$$

At x = 4 m, the shear force experiences a jump discontinuity, indicating a change from positive to negative shear.

Reference: Influence Line Diagrams for Simply Supported Beams

Problem 3: Maximum Bending Moment Due to Moving Concentrated Load

A moving concentrated load of 15 kN crosses a simply supported beam of span 12 m. Determine the maximum bending moment in the beam.

Solution:

For a simply supported beam subjected to a moving concentrated load, the maximum bending moment occurs when the load is at mid-span. The maximum bending moment $M_{\max}$ is calculated as:

$$M_{\max} = \frac{P \times L}{4} = \frac{15\,\text{kN} \times 12\,\text{m}}{4} = 45\,\text{kN} \cdot \text{m}$$

Reference: Proof of Maximum Bending Moment for a Simply Supported Beam

Problem 4: Maximum Reaction Due to Uniformly Distributed Moving Load

A beam carries a uniformly distributed moving load of 5 kN/m over its entire span of 6 m. Determine the maximum reaction at one of the supports.

Solution:

For a simply supported beam with a uniformly distributed moving load covering the entire span, the reactions at both supports are equal and can be calculated as:

$$R = \frac{w \times L}{2} = \frac{5\,\text{kN/m} \times 6\,\text{m}}{2} = 15\,\text{kN}$$

Reference: Simply Supported Beam Carrying Uniformly Distributed Load Over Entire Span

Problem 5: Maximum Bending Moment in Middle Span of Three-Span Continuous Bridge

A three-span continuous bridge carries a moving truck with axle loads of 20 kN and 30 kN spaced 4 m apart. Determine the location of the truck for maximum bending moment in the middle span.

Solution:

To achieve the maximum bending moment in the middle span of a three-span continuous bridge, position the truck such that its heavier axle (30 kN) is

located at the point of maximum positive moment in the middle span, typically at mid-span. The lighter axle (20 kN) should be placed accordingly, maintaining the 4 m spacing. This positioning ensures that the combined effect of both axles produces the maximum bending moment in the middle span.

Reference: How to Design 3 Span Continuous PSC Box Girder Bridge