Solutions to Structural Connection Problems

Civil Engineering Licensure Exam – Mock Exam

February 24, 2025

Problem 1: Shear Strength of a Bolted Joint

Determine the shear strength of a bolted joint using standard calculation methods.

Solution:

The shear strength (V) of a bolted joint can be calculated using:

$$V = n \times A_b \times F_v$$

where: - n = number of bolts - A_b = cross-sectional area of a bolt - F_v = allowable shear stress of the bolt material

Reference: How to calculate the capacity of a bolt subjected to shear force

Problem 2: Strength of a Fillet Weld

Calculate the load-carrying capacity of a fillet weld subjected to shear.

Solution:

The strength (P) of a fillet weld can be determined by:

$$P = L \times \frac{h}{\sqrt{2}} \times F_w$$

where: - L = length of the weld - h = throat size of the weld - F_w = allowable shear stress of the weld material

Reference: Fillet Weld, Groove Weld, and Base Metal Load Capacity

Problem 3: Bearing Capacity of a Bolted Connection

Assess the bearing capacity of a bolted connection in a steel plate.

Solution:

The bearing capacity (P_b) is given by:

$$P_b = d \times t \times F_u$$

where: - d = diameter of the bolt - t = thickness of the connected plate - F_u = ultimate tensile strength of the plate material

Reference: Bearing, Tearout, and Shear Load Capacity Calculations

Problem 4: Design of a Single-Line Fillet Weld

Design a single-line fillet weld to withstand a specified load.

Solution:

The required weld size can be calculated by:

$$h = \frac{P}{L \times F_w}$$

where: - P = applied load - L = length of the weld - F_w = allowable shear stress of the weld material

Reference: Single-Line Fillet Weld Design (AISC and Blodgett)

Problem 5: Shear and Bearing Strength of a Bolted Connection

Evaluate both the shear and bearing strengths of a bolted connection.

Solution:

Shear strength (V):

$$V = n \times A_b \times F_v$$

Bearing strength (P_b):

$$P_b = d \times t \times F_u$$

where: - n = number of bolts - A_b = cross-sectional area of a bolt - F_v = allowable shear stress of the bolt material - d = diameter of the bolt - t = thickness of the connected plate - F_u = ultimate tensile strength of the plate material

Reference: Shear Bearing Strength of Bolted Connection