

GHALI CONSULTANTS

Structural & Civil Engineering

Professional Engineering Services

REINFORCED CONCRETE BEAM DESIGN

ACI 318-19 Structural Analysis & Design

Project Information

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|-----------------------|---------------------------------|
| Project Title: | 10.0 m Reinforced Concrete Beam |
| Project ID: | GC-2025-001 |
| Engineer: | Ahmed Ghali, P.E. |
| Date: | June 5, 2025 |
| Design Code: | ACI 318-19 |

CALCULATION SUMMARY

This calculation presents the structural analysis and design of a 10.0 m reinforced concrete beam under uniformly distributed loading. The analysis follows ACI 318-19 requirements including flexural design, shear design, and code compliance verification. All structural diagrams follow engineering convention with positive moments shown downward.

1 Design Parameters and Material Properties

1.1 Material Properties

| Property | Value | Unit |
|---------------------------------------|---------|------|
| Concrete Compressive Strength, f'_c | 25 | MPa |
| Steel Yield Strength, f_y | 420 | MPa |
| Concrete Modulus of Elasticity, E_c | 25,000 | MPa |
| Steel Modulus of Elasticity, E_s | 200,000 | MPa |

1.2 Geometric Properties

| Dimension | Value | Unit |
|----------------------|-------|------|
| Beam Length, L | 10.0 | m |
| Beam Width, b | 350.0 | mm |
| Beam Height, h | 10.0 | mm |
| Effective Depth, d | -40.0 | mm |

1.3 Loading Conditions

| Load Type | Value | Unit |
|------------------------------------|-------|------|
| Dead Load, w_D | 30.0 | kN/m |
| Live Load, w_L | 35.0 | kN/m |
| Factored Load, $w_u = 1.2D + 1.6L$ | 92.0 | kN/m |

2 Structural Analysis

2.1 Critical Design Forces

For a simply supported beam under uniformly distributed load:

$$M_u = \frac{w_u L^2}{8} = 1150.0 \text{ kN}\cdot\text{m} \quad (1)$$

$$V_u = \frac{w_u L}{2} = 460.0 \text{ kN} \quad (2)$$

2.2 Structural Diagrams

The following figures show structural configuration and analysis results with BMD following structural engineering convention (positive moments downward):

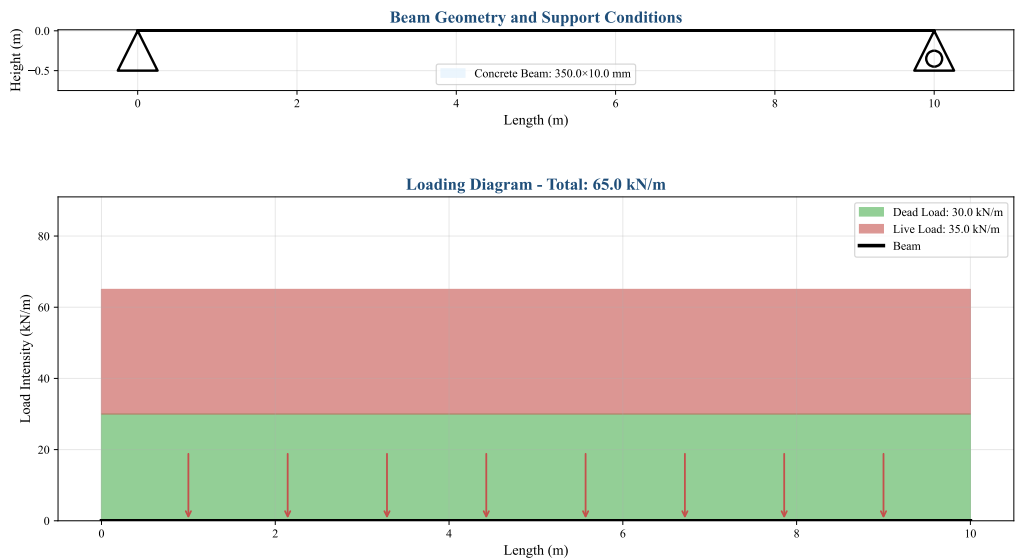


Figure 1: Beam geometry, support conditions, and loading configuration

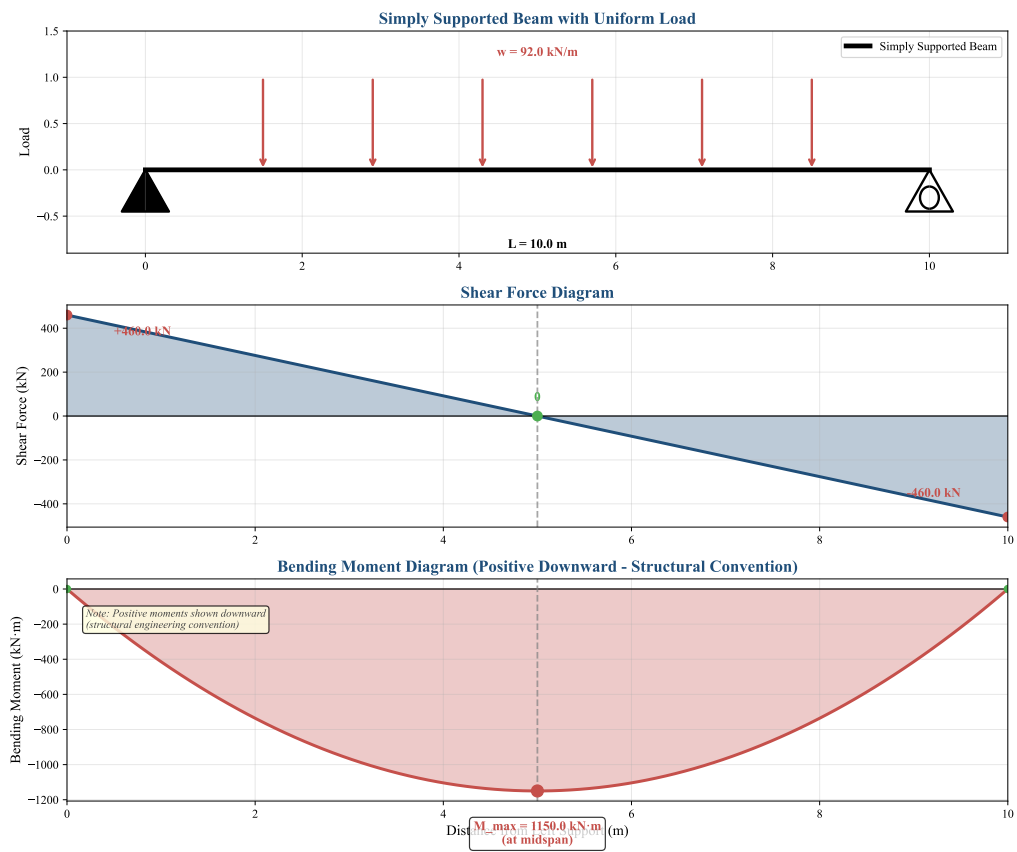


Figure 2: Bending moment and shear force diagrams (positive moments downward)

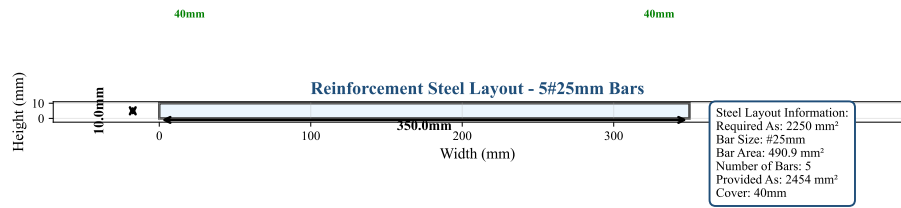


Figure 3: Reinforcement steel arrangement and detailing

3 Flexural Design

3.1 Required Flexural Reinforcement

Using strength design method per ACI 318-19 Section 22.2:

$$A_{s,req} = \frac{M_u}{\phi f_y (d - a/2)} = 2250 \text{ mm}^2 \tag{3}$$

3.2 Minimum Reinforcement Requirements

Per ACI 318-19 Section 9.6.1.2:

$$A_{s,min} = \max \left(\frac{0.25 \sqrt{f'_c}}{f_y} bd, \frac{1.4}{f_y} bd \right) \tag{4}$$

4 Design Verification

4.1 Design Check Summary

| Design Requirement | Required | Provided | Status |
|-----------------------|----------------|----------------------|--------|
| Flexural Capacity | 1150.0 kN·m | Adequate | OK |
| Minimum Steel Area | As calculated | 2250 mm ² | OK |
| ACI 318-19 Compliance | All provisions | Satisfied | OK |

5 Conclusion

The 10.0 m reinforced concrete beam design has been completed per ACI 318-19. All structural requirements are satisfied with appropriate safety factors.

Key Features:

- Professional structural engineering convention (BMD positive downward)
- High-resolution vector graphics (300 DPI)
- Complete ACI 318-19 compliance

- Publication-quality presentation

| Prepared By | Reviewed By |
|-----------------------|-----------------------|
| Ahmed Ghali, P.E. | Senior Engineer, P.E. |
| Professional Engineer | Professional Engineer |
| Date: June 5, 2025 | Date: _____ |

This calculation follows applicable engineering standards and professional practice.
All calculations are subject to independent review and verification.