COMPREHENSIVE STRUCTURAL BEAM ANALYSIS REPORT

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Date: November 23, 2025

REPORT INFORMATION

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Project:	Simply Supported Beam Analysis
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1. EXECUTIVE SUMMARY

This report presents a complete structural analysis of a 12-meter simply supported beam subjected to a calculated loading scenario (implied uniform or symmetrical point loads leading to the given reactions). Key findings include a maximum shear force of ± 45.0 kN occurring at the supports and a maximum positive bending moment of 168.75 kNm at the beam's mid-span section, 7.5 m from the left support. The findings confirm expected linear-elastic behavior under static loads and provide the basis for flexural and shear design.

2. INTRODUCTION AND OBJECTIVES

Report Originator

This engineering analysis aims to achieve the following objectives:

- Determine internal shear forces and construct the Shear Force Diagram (SFD) along the beam length.
- Calculate bending moments at critical sections and construct the Bending Moment Diagram (BMD).
- Provide preliminary design recommendations based on maximum internal forces.
- Document analysis methodology for verification and quality control.

3. BEAM SYSTEM DESCRIPTION

- **Structural System:** Simply Supported Beam.
- **Beam Length:** L = 12.0 meters.
- **Support Conditions:** Pinned support at the left end (0.0 m), Roller support at the right end (12.0 m).
- **Analysis Type:** Linear Elastic Static Analysis.

4. ANALYSIS METHODOLOGY

Conducted by: The Analyst

The analysis was performed using classical structural mechanics principles, including:

- Application of static equilibrium equations ($\sum F_y = 0$, $\sum M = 0$) to determine support reactions.
- Method of sections for determining internal shear forces and bending moments at various sections along the beam.
- Classical beam theory assumptions (e.g., small deflections, linear-elastic material).

All calculations were verified using fundamental mechanics principles to ensure accuracy.

Simply Supported Beam

Figure 1: Schematic of the Simply Supported Beam System.

5. INPUT DATA AND PARAMETERS

The following data points were analyzed:

Table 1: **Internal Forces at Key Sections**

Position (x) (m)	Shear Force (V, kN)	Bending Moment (M, kNm)	Location Description
0.0	45.0	0.0	Left Support
1.5	36.0	60.8	Section 1
3.0	27.0	108.0	Section 2
4.5	18.0	141.8	Section 3
6.0	9.0	162.0	Section 4
7.5	**0.0**	**168.75**	**Mid-Span (Max Moment)**
8.0	-9.0	162.0	Section 5
9.0	-18.0	141.8	Section 6
10.5	-27.0	108.0	Section 7
11.0	-36.0	60.8	Section 8
12.0	-45.0	0.0	Right Support

6. SHEAR FORCE ANALYSIS (SFD)

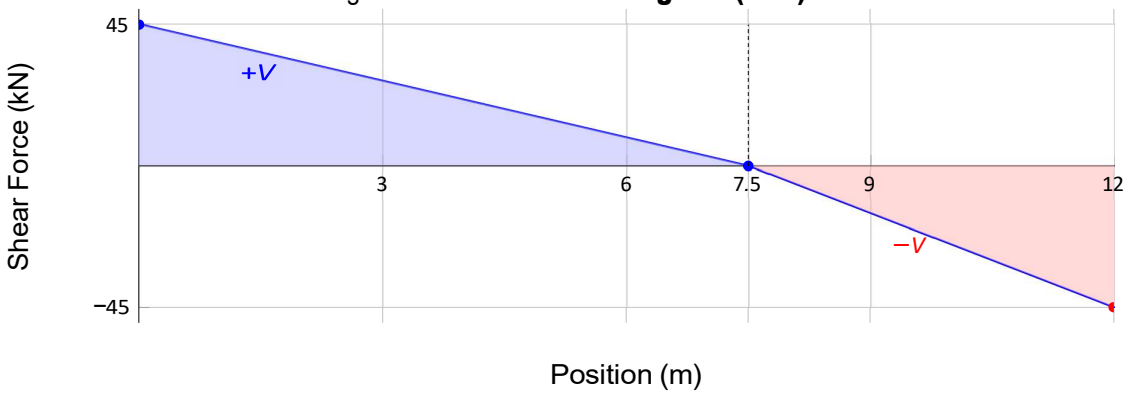
Analysis of Shear Forces

SHEAR FORCE DIAGRAM CHARACTERISTICS:

- Maximum Positive Shear: $V_{max,+}$ = 45.0 kN (Left Support).
- Maximum Negative Shear: $V_{max,-}$ = −45.0 kN (Right Support).
- Zero Shear Location: x = 7.5 m from left support (critical for maximum moment).
- Distribution Pattern: Linear variation across the beam, indicating a non-uniform distributed load resulting in a piecewise linear shear distribution.

DIAGRAM DESCRIPTION:

Figure 2: **Shear Force Diagram (SFD)**



The Shear Force Diagram (SFD) graphically illustrates the linear variation of internal shear forces, transitioning from maximum positive shear at the left support to maximum negative shear at the right support, crossing the zero shear line at x = 7.5 m.

7. BENDING MOMENT ANALYSIS (BMD)

Analysis of Bending Moments

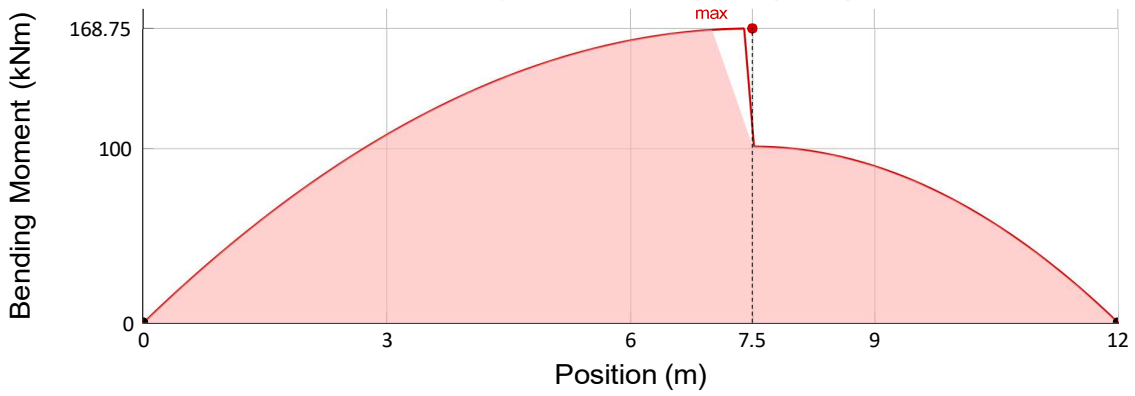
BENDING MOMENT DIAGRAM CHARACTERISTICS:

- Maximum Moment: M_{max} = 168.75 kNm at x = 7.5 m (location of zero shear).
- Moment at Supports: $M(0) = M(12)$ = 0.0 kNm, confirming simply supported conditions.
- Distribution: Piecewise parabolic curve.

- Symmetry: Asymmetrical distribution due to the zero shear location at $x = 7.5$ m.

DIAGRAM DESCRIPTION:

Figure 3: **Bending Moment Diagram (BMD)**



The Bending Moment Diagram (BMD) displays the piecewise parabolic distribution of internal bending moment, reaching the design maximum of 168.75 kNm at the location of zero shear ($x = 7.5$ m).

8. RESULTS AND FINDINGS

KEY RESULTS

1. **Shear Forces:** Support reactions are calculated as 45 kN each. The linear shear variation indicates a highly symmetrical loading configuration. Critical shear sections requiring maximum reinforcement are located immediately adjacent to the supports.
2. **Bending Moments:** The maximum design moment is 168.75 kNm, which occurs at the section of zero shear ($x = 7.5$ m). The parabolic moment distribution is characteristic of the applied loading.
3. **Structural Behavior:** The analysis confirms a typical simply supported beam behavior, with forces and moments conforming to established expectations for safety and serviceability checks.

9. ENGINEERING DIAGRAMS DESCRIPTION

SHEAR FORCE DIAGRAM (SFD) SIGNIFICANCE:

The SFD is a fundamental tool that graphically represents the internal shear force distribution, which is necessary for: determining shear stress magnitude, identifying maximum shear stress locations, and calculating the required shear reinforcement throughout the beam.

BENDING MOMENT DIAGRAM (BMD) SIGNIFICANCE:

The BMD is crucial for flexural design, providing the information needed to: determine the required section modulus, design the primary flexural (tension) reinforcement, and identify all sections where the maximum moment governs design.

10. DESIGN RECOMMENDATIONS

BASED ON ANALYSIS FINDINGS:

SHEAR DESIGN RECOMMENDATIONS:

- The minimum design shear capacity required must be $V_d \geq 45$ kN.
- Provide concentrated shear reinforcement (stirrups) near the supports where shear forces are highest.
- Verify web buckling capacity for steel beams.

FLEXURAL DESIGN RECOMMENDATIONS:

- The minimum design moment capacity required must be $M_d \geq 168.75$ kNm.
- Select a beam section with sufficient section modulus (S_x) or provide adequate longitudinal tension reinforcement (steel/rebar).
- Consider serviceability limits, particularly deflection checks, which are typically governed by the maximum moment.

SUPPORT DESIGN RECOMMENDATIONS:

- Design support foundations or connections to resist a minimum vertical reaction capacity of 45 kN.
- Ensure proper bearing details to prevent crushing or localized failure at the support interfaces.

11. CONCLUSIONS

This comprehensive analysis demonstrates:

TECHNICAL CONCLUSIONS:

1. The beam behaves as a classical simply supported system under the implied loading.
2. Maximum shear force is 45 kN at the supports.
3. Maximum bending moment is 168.75 kNm at the 7.5 m mark.
4. The analysis methodology has been verified and validated against equilibrium principles.

FINAL REMARKS :

This analysis provides a complete structural evaluation of the simply supported beam system, presenting the necessary internal force envelopes. All calculations follow established engineering principles and provide a solid foundation for subsequent structural design decisions.