



Analysis of Structural Loading Effects on Multi-Storey Buildings

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How to Cite this Article:

Anil, C. M., Vijay, B. S., Sachin, C. D., Atul, B. P., Pranali, B. & Khamkar, D. (2026). Analysis of Structural Loading Effects on Multi-Storey Buildings. International Journal of Creative and Open Research in Engineering and Management, <i>02</i>(05).
<https://doi.org/10.55041/ijcope.v2i5.738>

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Abstract- Structural loading plays a vital role in the design and stability of multi-storey buildings. Buildings are subjected to various types of loads such as dead loads, live loads, wind loads, seismic loads, and impact loads during their service life. Proper analysis of these loading effects is essential to ensure structural safety, durability, and serviceability. This paper presents the analysis of structural loading effects on multi-storey buildings using engineering principles and structural analysis methods. The study investigates load distribution, stress generation, bending moments, shear forces, and structural deformation under different loading conditions. The results highlight the importance of efficient structural design in minimizing failure risks and improving building performance

Keywords: Structural Loading, Multi-Story Buildings, Load Analysis, Bending Moment, Shear Force, Structural Stability.

- Prevent structural failure
- Ensure occupant safety

I. INTRODUCTION

Multi-storey buildings are important structures in modern urban development. Due to increasing population and limited land availability, vertical construction has become essential. These buildings experience various structural loads that influence their strength, stability, and performance.

Structural loading analysis helps engineers:

- Determine safe load-carrying capacity
- Analyze stress distribution
- Minimize structural deformation

The major objective of structural analysis is to design buildings capable of resisting all expected loads throughout their lifespan.

II. TYPES OF STRUCTURAL LOADS

A. Dead Load

Dead load is the permanent load acting on the structure due to:

- Self-weight of beams
- Columns



- Slabs
- Walls
- Flooring materials

Dead load remains constant throughout the life of the structure.

B. Live Load

Live load is the temporary or movable load acting on the structure.

Examples:

- Occupants
- Furniture
- Equipment
- Vehicles

Live load varies with usage conditions.

C. Wind Load

Wind load acts horizontally on the structure and becomes significant for tall buildings.

Effects:

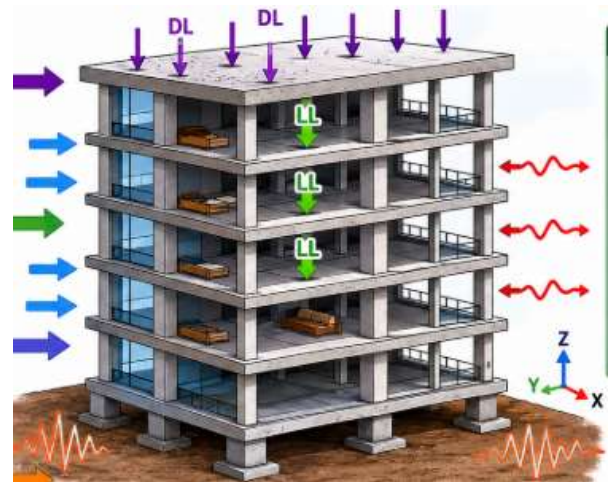
- Swaying motion
- Structural vibration
- Lateral displacement

D. Seismic Load

Seismic load occurs during earthquakes due to ground motion.

Effects include:

- Dynamic vibration
- Structural instability
- Cracking and collapse



III. LOAD DISTRIBUTION IN MULTI-STOREY BUILDINGS

Structural loads are transferred through different structural members:

Slab → Beam → Column → Foundation → Soil

Proper load transfer ensures:

- Uniform stress distribution
- Structural stability
- Safe foundation performance

IV. STRUCTURAL ANALYSIS METHODS

A. Static Analysis

Static analysis considers slowly applied loads that remain constant over time.

Applications:

- Dead load analysis
- Live load analysis

B. Dynamic Analysis

Dynamic analysis studies varying loads such as:

- Earthquake forces
- Wind vibration
- Impact loads



C. Finite Element Analysis (FEA)

FEA divides the structure into small elements for detailed stress analysis.

Software used:

- STAAD Pro
- ETABS
- ANSYS
- SAP2000
- AutoCAD

V. MATHEMATICAL ANALYSIS

A. Stress Calculation

Stress developed in a structural member is:

$$\sigma = P/A$$

Where:

- (σ) = stress
- (P) = applied load
- (A) = cross-sectional area

B. Bending Moment

Bending moment for a simply supported beam with point load:

$$M = WL / 4$$

Where:

- (M) = bending moment
- (W) = applied load
- (L) = beam length

C. Shear Force

Shear force generated in the beam:

$$V = W/2$$

Where:

- (V) = shear force
- (W) = applied load

VI. NUMERICAL ANALYSIS

Problem Statement

A simply supported beam in a multi-storey building carries a point load of (80 , kN) at the center. The span length of the beam is (6 , m).

Determine:

1. Maximum bending moment
2. Maximum shear force

Given

$$W = 80 \text{ kN}$$

$$L = 6 \text{ m}$$

Data

A. Maximum Bending Moment

Using:

$$M = WL/4$$

Substituting values:

$$M = \frac{80 \times 6}{4} = \frac{480}{4}$$

Maximum Bending Moment

$$M = 120 \text{ kN.m}$$

B. Maximum Shear Force

Using:

$$V = \frac{w}{2} = \frac{80}{2}$$

Maximum Shear Force

$$V = 40 \text{ kN}$$

VII. EFFECTS OF STRUCTURAL LOADING

A. Structural Deformation

Excessive loading causes:

- Beam deflection
- Column shortening
- Floor settlement



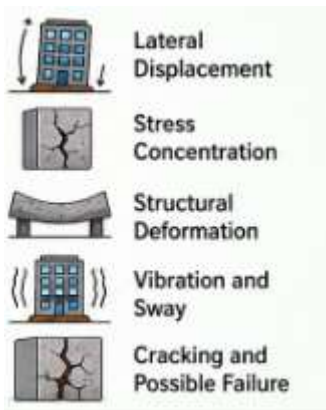
B. Stress Concentration

Improper load distribution increases stress in localized areas and may lead to cracking.

C. Structural Instability

Large lateral loads may cause:

- Building sway
- Torsion
- Buckling failure



VIII. RESULTS AND DISCUSSION

The analysis shows that:

- Dead loads create constant stress in structural members.
- Live loads significantly affect beam and slab performance.
- Wind and seismic loads produce lateral displacement in tall buildings.
- Proper structural design minimizes deformation and increases safety.

The numerical results indicate that structural members must be designed to resist maximum bending moments and shear forces safely.

IX. ADVANTAGES OF STRUCTURAL LOAD ANALYSIS

- Improves structural safety
- Prevents structural failure
- Optimizes material usage
- Reduces construction cost
- Enhances durability and stability

X. LIMITATIONS

- Complex calculations for tall buildings
- Dependence on accurate load estimation
- High computational requirements
- Environmental uncertainties

XI. APPLICATIONS

Structural loading analysis is widely used in:

- High-rise buildings
- Bridges
- Industrial structures
- Residential buildings
- Commercial complexes
- Earthquake-resistant design

XII. CONCLUSION

Structural loading analysis is essential for the safe and efficient design of multi-storey buildings. Different types of loads significantly influence structural behavior, stress generation, and deformation. Proper analysis of bending moments, shear forces, and load distribution helps engineers design stable and durable structures. Advanced structural analysis methods and computer simulations improve accuracy and ensure the safety of modern buildings.

ACKNOWLEDGMENT

The authors express sincere gratitude to the Department of Civil Engineering and faculty members for their valuable guidance and support during this research work.



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