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ANALYSIS AND DESIGN OF MULTISTOREY CAR PARKING BUILDING USING ETABS SOFTWARE.

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ABSTRACT

Rapid urbanization and increasing vehicle ownership in metropolitan cities have created severe parking shortages, especially in densely populated commercial areas. Multistorey car parking structures provide an effective solution for efficient land utilization and traffic management. This study focuses on the analysis and design of a G+9 multistorey reinforced concrete car parking and commercial building using ETABS software. The structure was modeled and analyzed under dead load, live load, wall load, wind load, and seismic load conditions as per IS 456:2000, IS 875, and IS 1893:2016. Structural response parameters such as storey drift, displacement, base shear, overturning moment, shear force, bending moment, and axial force were evaluated. Results indicate that the proposed structure satisfies stability, strength, and serviceability requirements within permissible code limits. The study also demonstrates the effectiveness of ETABS in analyzing complex multistorey structures with ramps and mixed-use occupancy. The proposed parking facility offers an economical and sustainable solution for urban parking demands.

KEYWORDS: ETABS, Multistorey Parking, Structural Analysis, Seismic Analysis, Storey Drift, RCC Structure

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INTRODUCTION

Urban areas across India are facing significant challenges due to rapid population growth and increased vehicle ownership. Conventional surface parking systems are inadequate in congested commercial zones because of limited land availability. Multistorey car parking systems have emerged as an efficient solution to maximize parking capacity while minimizing land consumption.

Multistorey parking structures consist of vertically stacked parking floors that provide efficient vehicle accommodation within a compact footprint. These structures are commonly integrated with commercial spaces and modern urban infrastructure. However, the structural design of such buildings is complex because they must resist gravity loads, vehicular loads, wind loads, and seismic forces while maintaining safety and serviceability.

ETABS (Extended Three-Dimensional Analysis of Building Systems) is widely used for structural modeling and analysis of multistorey buildings. The software enables engineers to evaluate structural performance under different loading conditions and optimize the design according to codal provisions.

The present study investigates the structural behavior of a G+9 multistorey car parking and commercial building using ETABS software.

Research Paper

LITERATURE REVIEW

Several researchers have studied the structural performance of multistorey parking buildings using advanced analysis software.

1. Sharma et al. (2024) emphasized that ETABS provides accurate analysis results for multistorey RCC buildings under seismic and wind loads, making it suitable for modern structural design.
2. Kulkarni et al. (2024) demonstrated that ETABS effectively evaluates stresses, bending moments, deflections, and seismic response in multi-level parking buildings.
3. Rao and Reddy (2023) highlighted the importance of ETABS in analyzing multistorey commercial buildings and concluded that software-based design is more efficient and economical than manual calculations.
4. Ahmed and Ali (2022) reported that multistorey parking structures improve urban mobility and parking efficiency when designed according to codal provisions
5. Patil et al. (2020) analyzed and designed a G+2 multistorey parking building and concluded that structured parking systems effectively reduce traffic congestion and optimize land use.

Objectives:

- To plan and design a multistorey car parking structure as per NBC and IS codes.
- To model and analyze the G+9 parking building using ETABS software.
- To evaluate structural response parameters such as storey drift, displacement, base shear, and overturning moment.
- To ensure safety, stability, and serviceability of the structure under seismic and wind loading.
- To study the effect of wall loads on structural performance.

MATERIALS AND METHODS

Building Details

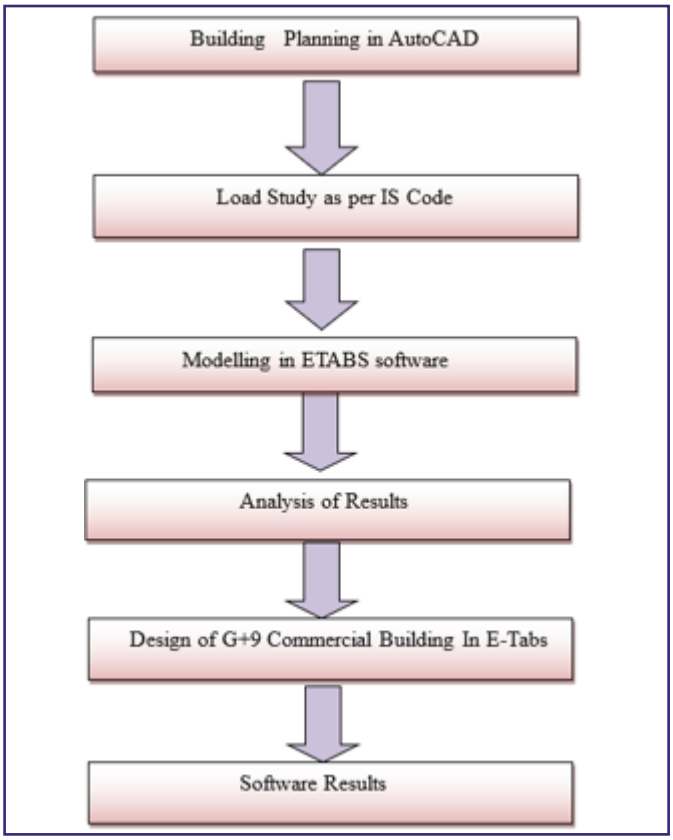
Type of structure: G+9 RCC multistorey parking and commercial building
Plan area: 4609.10 m²
Ramp width: 6 m
Number of cars accommodated: 215
Column size: 300 mm × 450 mm
Floor system: Reinforced concrete slab and beam system

Design Codes

The following Indian Standard codes were adopted:
IS 456:2000 – Plain and Reinforced Concrete
IS 875 Part 1 – Dead Loads
IS 875 Part 2 – Live Loads
IS 875 Part 3 – Wind Loads
IS 1893:2016 – Earthquake Resistant Design

Structural Modeling

The building was modeled in ETABS by defining:
Grid system and storey data
Material properties
Beam, column, and slab sections
Load patterns and load combinations
Seismic and wind load parameters
The structure was analyzed under various load combinations to determine structural behavior.



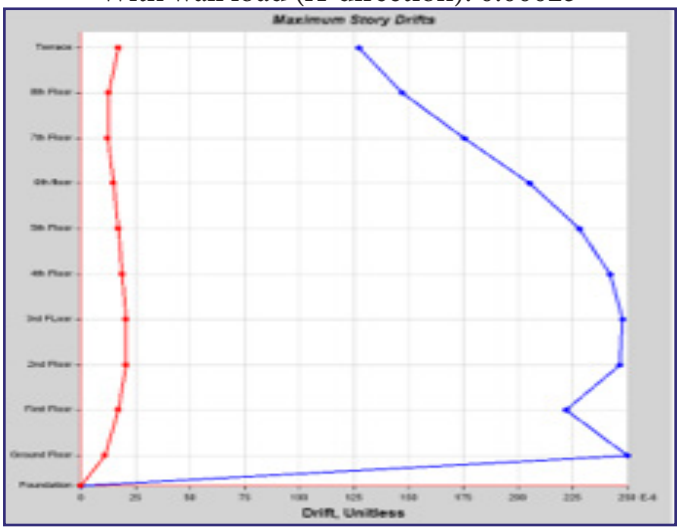
RESULTS

Storey Drift

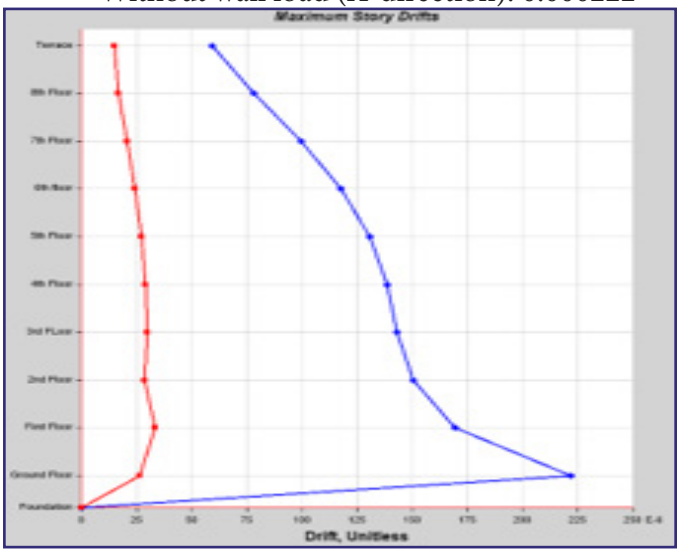
The maximum storey drift values obtained from ETABS were within the permissible limits specified by IS 1893. The structure showed better lateral stiffness when wall loads were included.

MAXIMUM STOREY DRIFT

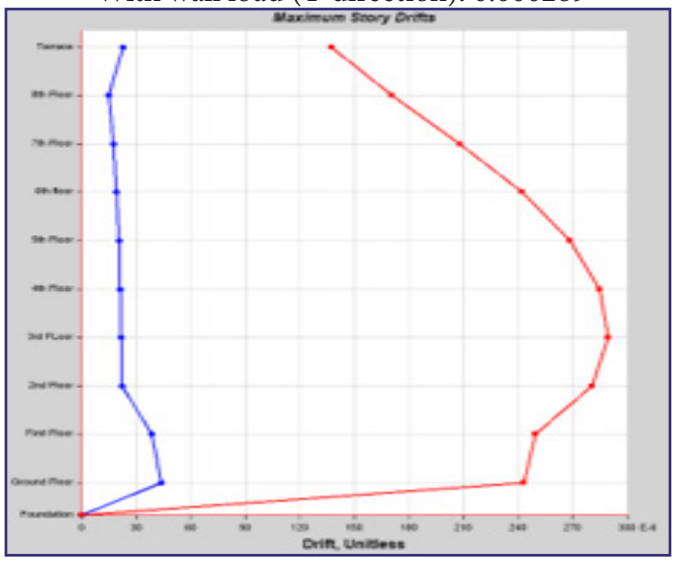
- With wall load (X-direction): 0.00025



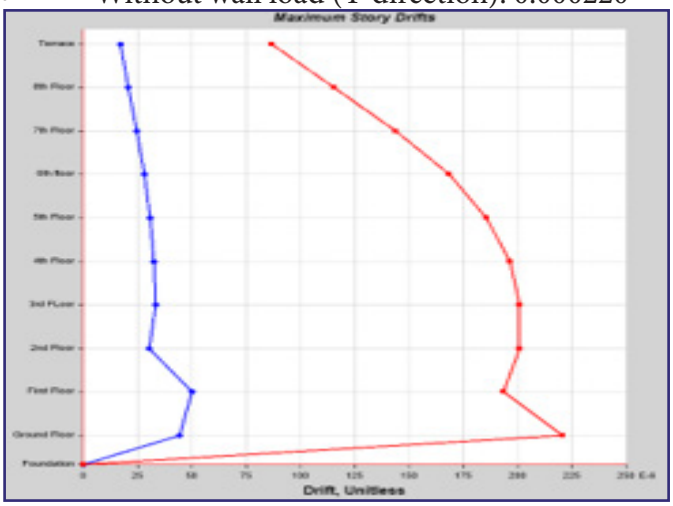
- Without wall load (X-direction): 0.000222



- With wall load (Y-direction): 0.000289



- Without wall load (Y-direction): 0.000220



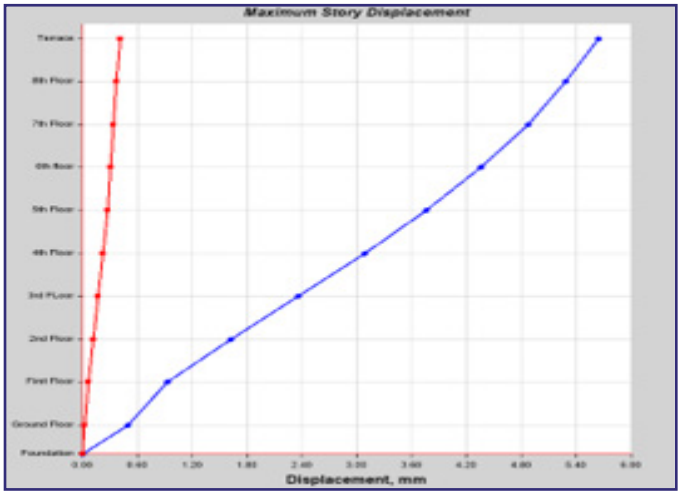
The results indicate that the structure performs safely under seismic loading.

Storey Displacement

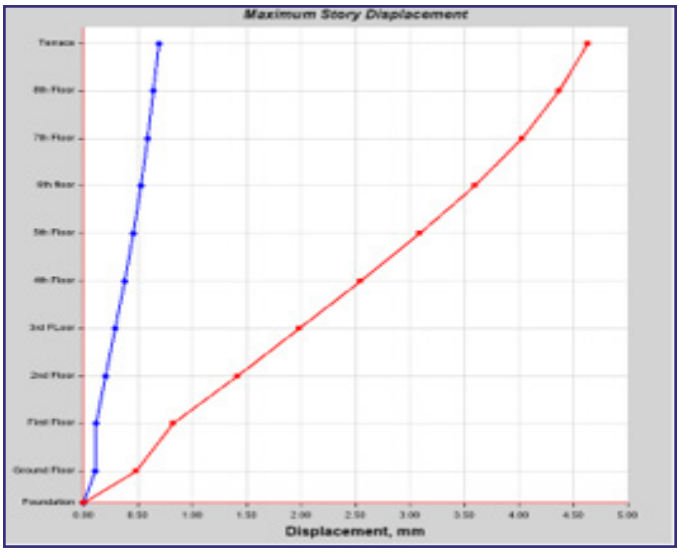
Storey displacement increased gradually with height, with maximum displacement occurring at the terrace level.

Maximum Storey Displacement

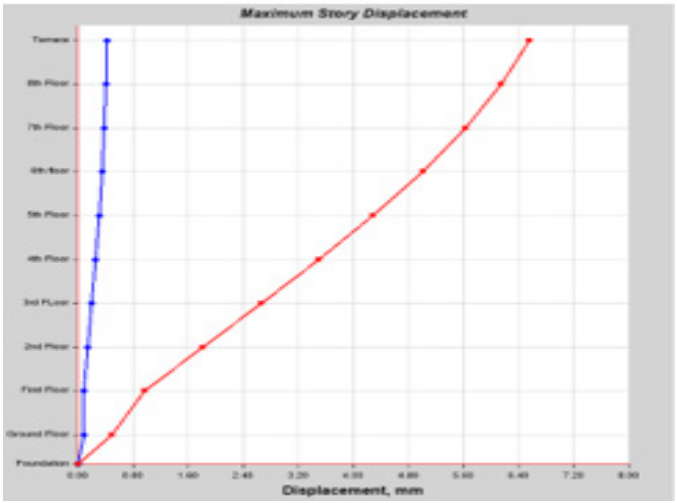
- X-direction with wall load: 5.647 m



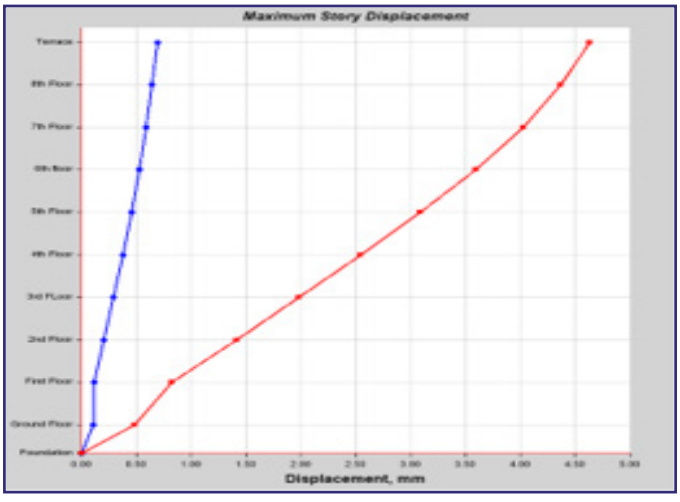
- X-direction without wall load: 3.411 mm



- Y-direction with wall load: 6.556 mm



- Y-direction without wall load: 4.632 mm



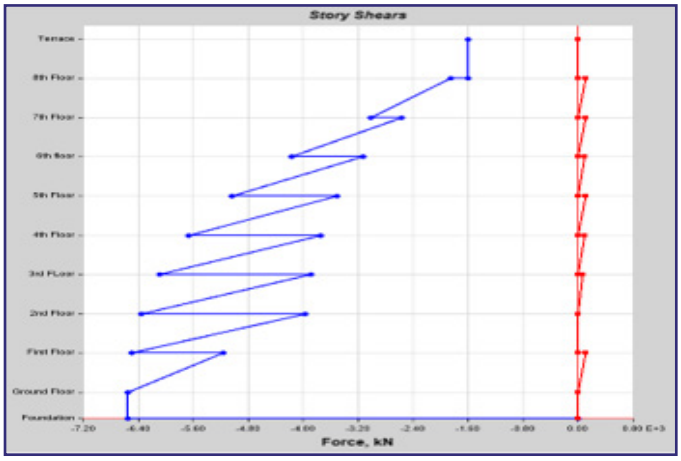
The displacement values remained within acceptable serviceability limits.

Base Shear

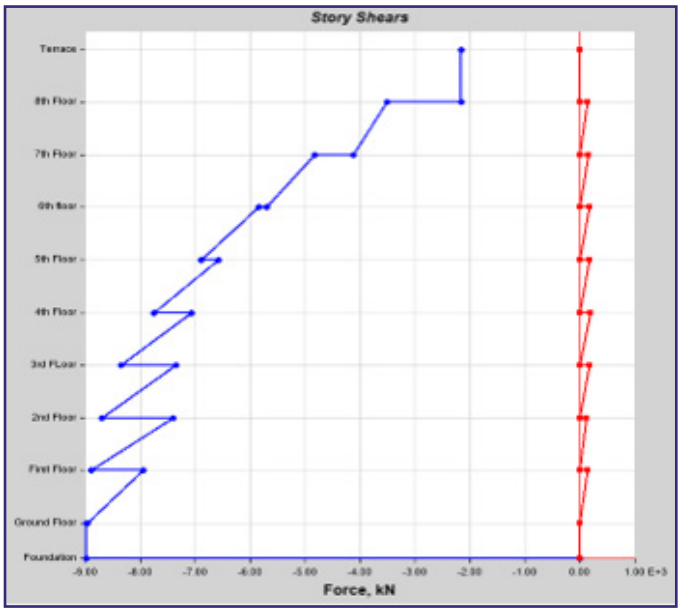
The structure developed adequate resistance against lateral seismic forces.

Maximum Base Shear

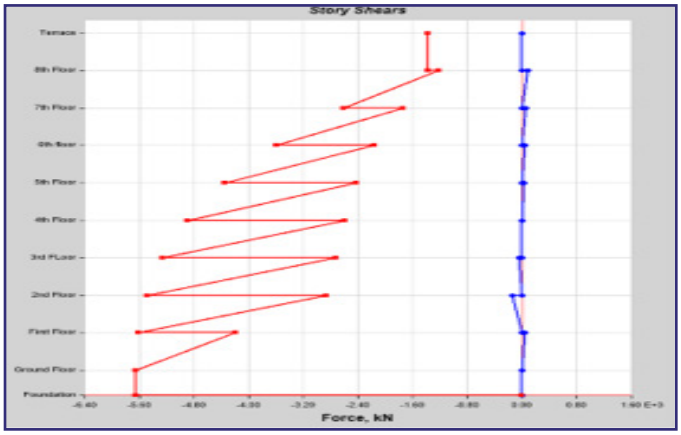
- X-direction with wall load: 6558.67 kN



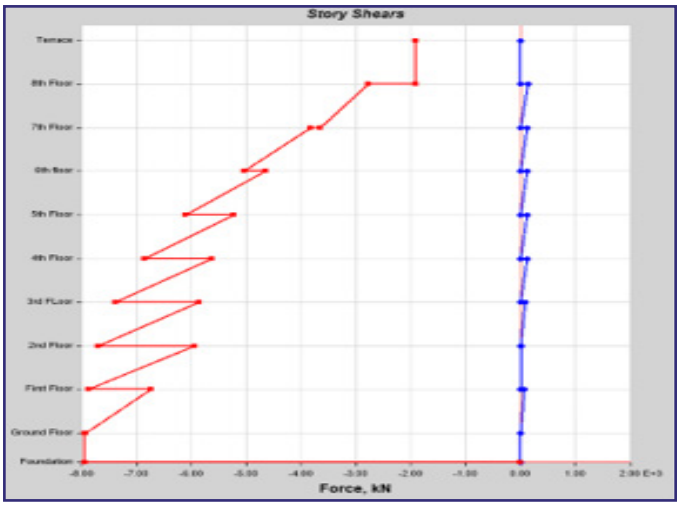
- X-direction without wall load: 8976.92 kN



- Y-direction with wall load: 5658.34 kN



- Y-direction without wall load: 7938.45 kN

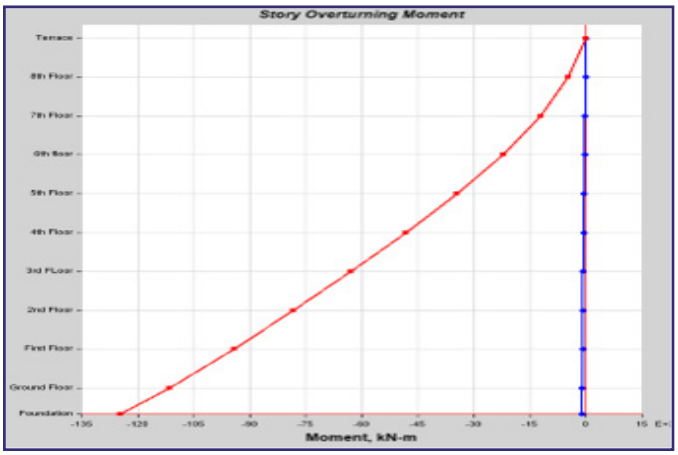


Overturning Moment

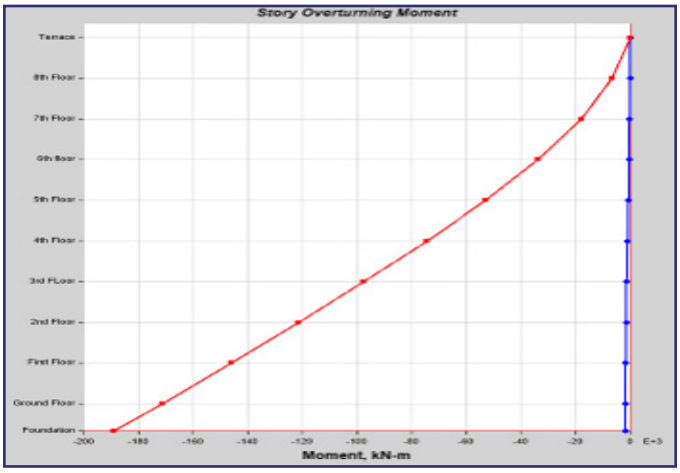
The overturning moments increased toward the base of the structure, which is typical in multistorey buildings subjected to seismic forces.

Maximum Overturning Moment

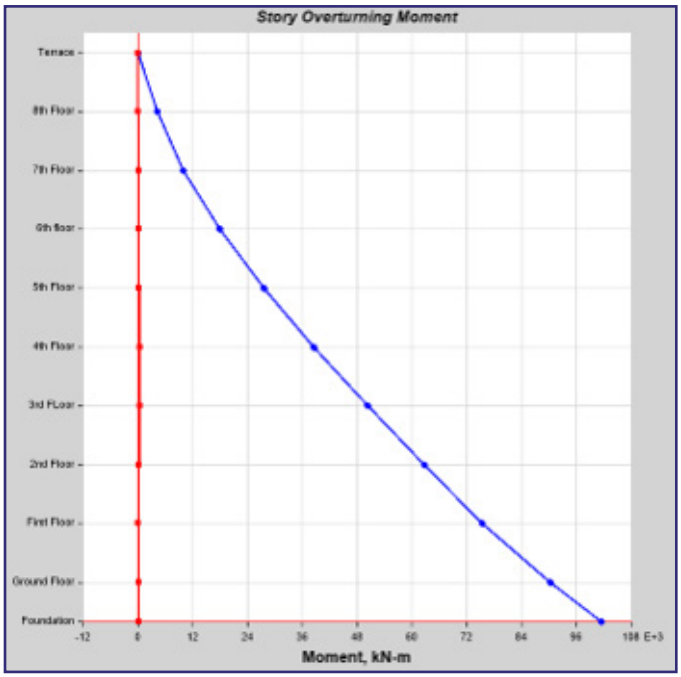
- X-direction with wall load: 124785.59 kN-m



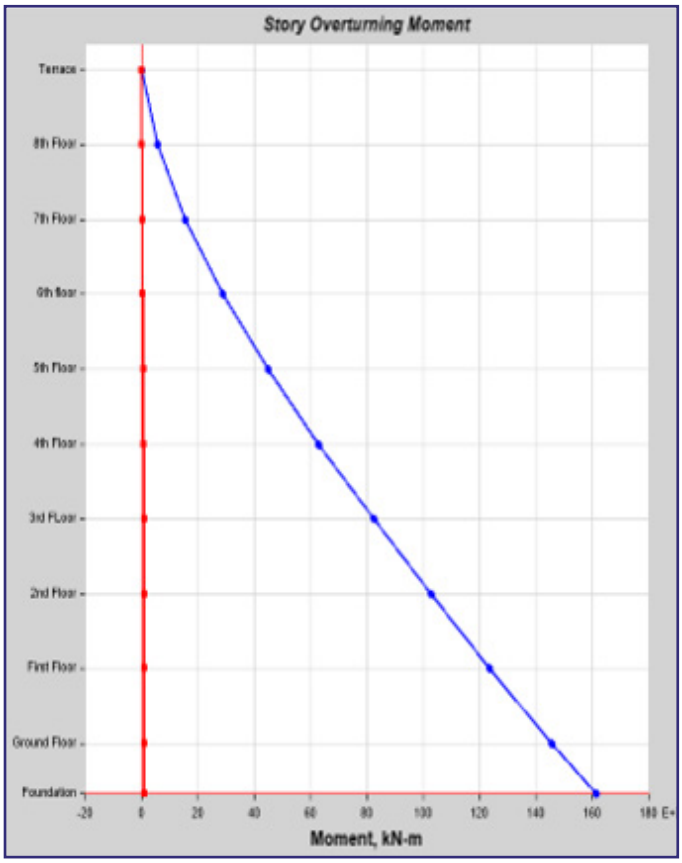
- X-direction without wall load: 189284.91 kN-m



- Y-direction with wall load: 101545.14 kN-m



- Y-direction without wall load: 161452.43 kN-m



CONCLUSIONS

The present study successfully analyzed and designed a G+9 multistorey car parking and commercial building using ETABS software. The

structural response parameters such as storey drift, displacement, base shear, and overturning moment were within the permissible limits specified by Indian Standard codes.

The study demonstrates that:

- ETABS is an efficient tool for analyzing complex multistorey structures.
- Multistorey parking buildings provide effective land utilization in urban areas.
- Inclusion of wall loads improves lateral stiffness and seismic performance.
- The proposed structure is safe, stable, and economical.

FUTURE SCOPE

Future studies may include:

1. Nonlinear seismic analysis and pushover analysis.
2. Soil–structure interaction studies.
3. Use of steel and composite structural systems.
4. Dynamic analysis under moving vehicular loads.
5. Sustainable and green building concepts.
6. Fire and progressive collapse analysis.

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