

# Analysis and Design of Multistorey Commercial Building Using ETABS

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## ABSTRACT

The rapid pace of urbanization and the increasing demand for high-rise structures necessitate the adoption of advanced analytical tools and robust design methodologies to ensure structural safety, serviceability, and economy. The present study deals with the **analysis and design of a multi-storey reinforced concrete (RCC) commercial building (B+G+5)** using ETABS, (extended Three-Dimensional Analysis of Building Systems) a widely accepted structural analysis software.

A real-life project located in Bankura, West Bengal has been considered for the study. The structural system comprises a **reinforced concrete moment-resisting frame integrated with shear walls**, designed to effectively resist both gravity and lateral loads. The modelling and analysis have been carried out in accordance with relevant Indian Standard Codes, namely **IS 456:2000, IS 875 (Part 1–3), IS 1893 (Part 1):2016, and IS 13920:2016**.

The structure has been analyzed under various loading conditions including dead load, live load, wind load, and seismic load. A comprehensive analytical approach has been adopted by performing both **linear static analysis** and **dynamic analysis using the Response Spectrum Method**, to accurately capture the seismic response of the structure. Critical performance parameters such as **storey displacement, inter-storey drift, base shear, and modal mass participation** have been evaluated to assess the global structural behaviour.

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## INTRODUCTION

Structural engineering plays a vital role in the planning, analysis, and design of safe and economical structures. With the rapid growth of urbanization and increasing demand for multi-storey buildings, the use of advanced software tools has become essential for accurate structural analysis and design.

ETABS (Extended Three-Dimensional Analysis of Building Systems) is one of the most widely used software in the field of structural engineering. It provides an integrated platform for modelling, analysis, and design of building systems under various loading conditions such as dead load, live load, wind load, and seismic load.

In the present study, a real life RCC Commercial Building (B+G+5) located at Bankura, West Bengal has been analysed and designed using ETABS software. The structure is designed in accordance with relevant Indian Standard Codes such as IS 456:2000, IS 875, IS 1893:2016, and IS 13920:2016.

The project focuses on evaluating the behaviour of the structure under different loading conditions, especially seismic forces, as the region falls under Seismic Zone III. The analysis includes both static and dynamic methods (Response Spectrum Method), ensuring that the structure performs safely under earthquake forces.

ETABS is an advanced and integrated software package developed specifically for the analysis and design of building structures. It provides a powerful platform for three-dimensional modelling, analysis, and design, making it highly efficient for handling complex structural systems.

The software is capable of performing:

- Linear and nonlinear analysis
- Static and dynamic analysis
- Response Spectrum and seismic analysis

- Time History Analysis.
- Pushover Analysis.

ETABS uses an object-based modelling approach, which allows engineers to create models quickly and accurately. It provides detailed outputs such as bending moments, shear forces, axial forces, stresses, strains, and deflections, which are essential for structural design.

## LITERATURE REVIEW

### General

Literature review is an essential part of any research work, as it provides an understanding of previous studies related to the analysis and design of multi-storey buildings. Various researchers have studied the behaviour of reinforced concrete structures under different loading conditions using analytical and numerical methods.

The development of advanced software such as ETABS has significantly improved the accuracy and efficiency of structural analysis. Many studies have focused on the application of ETABS in analysing multi-storey buildings subjected to gravity, wind, and seismic loads.

### Review of Previous Studies

Several researchers have contributed to the field of structural analysis and design of multi-storey buildings:

- Moin Khan (2024) conducted a study on the analysis and design of a multi-story residential building using ETABS. The study focused on evaluating structural behavior under dead load, live load, and seismic load conditions. It was observed that the displacement and drift values were within permissible limits, and the structure was found to be safe as per IS codes.
- S. Mahesh et al. (2018) studied the comparison between manual design and ETABS analysis of multi-story buildings. The results showed that ETABS provides more accurate and time-efficient results compared to conventional methods.
- P. B. Lamb (2017) analyzed high-rise buildings under seismic loading using response spectrum analysis. The study highlighted the importance of dynamic analysis in earthquake-prone regions.
- K. S. Jagadish and B. V. Venkatarama Reddy discussed the importance of proper material selection and structural configuration in achieving economical and safe designs.
- IS 1893:2016 emphasizes the need for dynamic analysis methods such as response spectrum analysis for structures located in seismic zones III, IV, and V.
- Design Methodology & Analysis Procedures

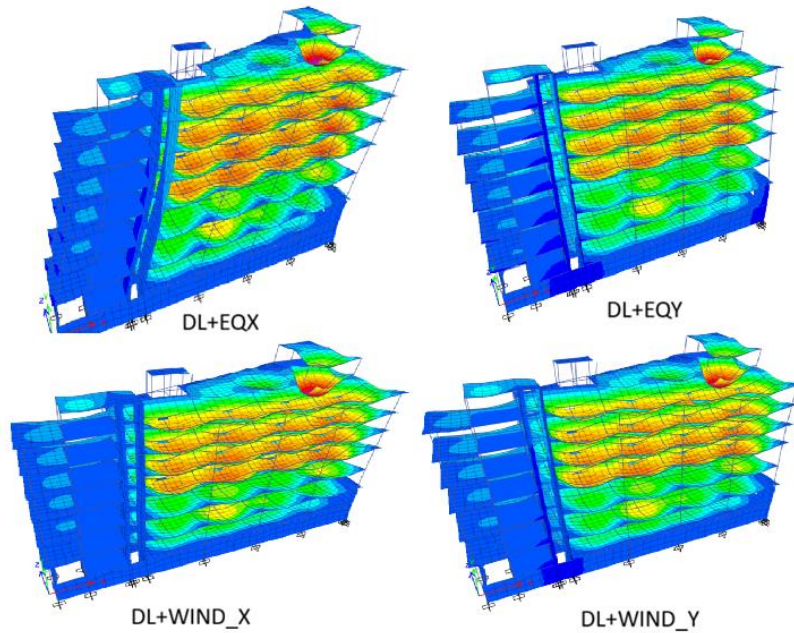
### Introduction

This chapter describes the systematic methodology adopted for the structural analysis and design of the proposed commercial building located in Bankura, West Bengal. The design approach is based on relevant Indian Standard codes and incorporates load calculations, modelling, analysis, and design using ETABS software. The objective is to ensure structural safety, stability, and serviceability under various loading conditions.

### Loading Diagram

The loading diagram represents how different loads act on the structure and are transferred through structural members to the foundation.

- Vertical Loads: Dead Load + Live Load
- Lateral Loads: Seismic Load / Wind Load



### Implementations and Results

This chapter presents the implementation of the structural model in ETABS and the results obtained from the analysis. It focuses on how the analytical model was executed and the structural response under various loading conditions.

#### Model Implementation in ETABS

The building model was implemented in ETABS based on the methodology described in Chapter 3.

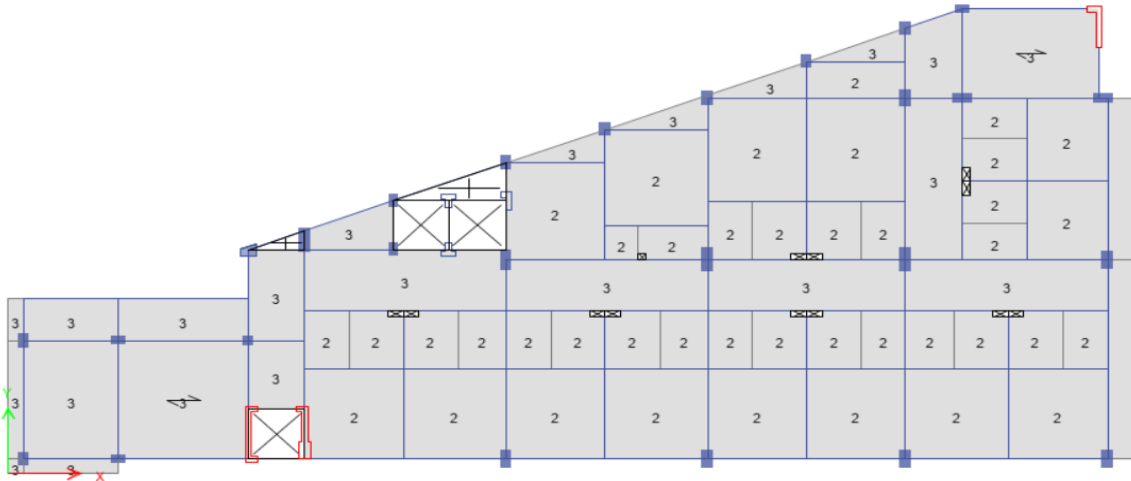
#### Key Implementation Steps:

- Creation of grid system and storey data
- Modeling of beams, columns, and slabs
- Assignment of material and section properties
- Application of support conditions
- Load application and load combination generation

#### Load Application Verification

After assigning loads, verification was carried out to ensure correctness:

- Dead load applied automatically (self-weight)
- Live load assigned on slabs
- Wind load applied as per IS 875 (Part 3)
- Seismic load applied as per IS 1893:2016 (Part 1)



## DISCUSSION OF RESULTS

### General Overview

The structural analysis of the Hotel and Commercial Building was performed using ETABS software in accordance with relevant Indian Standards, including IS 456:2000, IS 875 (Part 1–3):2015, IS 1893:2016, and IS 13920:2016. This chapter presents the interpretation and discussion of the results obtained from the analysis. The primary objective is to evaluate the structural behavior under various loading conditions and assess the safety, stability, and performance of the building.

### Load Behavior and Structural Response

The structure was analyzed under different types of loads, namely dead load, live load, wind load, and seismic load. Based on the results:

- Dead load contributes the maximum portion of the total vertical load.
- Live load adds variability but remains lower than dead load.
- Seismic loads (EQX and EQY) significantly influence the lateral behavior of the structure.
- Wind loads have a comparatively smaller effect on the overall structural response.

It is observed that the structure behaves predominantly as a gravity load-resisting system in the vertical direction and as a seismic force-resisting system in the lateral direction.

### Column Behavior

Columns are primarily subjected to:

- High axial loads due to dead and live loads
- Biaxial bending moments due to seismic effects

Therefore, column design must be carried out considering axial load and biaxial bending interaction, ensuring compliance with IS 456:2000 and ductile detailing provisions of IS 13920:2016.

## CONCLUSION

### Summary of Findings

The present study focused on the structural analysis and design of a Hotel and Commercial Building located in Bankura, West Bengal, using ETABS software. The analysis was carried out in accordance with relevant Indian Standards, including IS 456:2000, IS 875 (Part 1–3):2015, IS 1893:2016, and IS 13920:2016.

Based on the analytical results, the following key findings are observed:

- Dead load constitutes the major portion of the total vertical load acting on the structure.
- Live load contributes additional variability but remains secondary compared to dead load.
- The load combination **1.5 (DL + LL)** produces the maximum axial force and governs the design of columns.
- Seismic load combinations, particularly
- **1.2 (DL + LL + EQY + 0.3EQX)** and
- **1.5 (DL + EQY + 0.3EQX)**,

- generate the maximum lateral forces and bending moments.
- Wind loads are found to be less critical compared to seismic loads for this structure.
- Maximum base reaction is approximately **108500 kN**, indicating significant load transfer to the foundation.
- Lateral displacement and inter-story drift are within permissible limits as per IS 1893:2016.
- The structure demonstrates adequate stiffness and stability under all load combinations.

### CONCLUSIONS

From the overall analysis and design, the following conclusions can be drawn:

- The structure is safe, stable, and structurally efficient under all considered loading conditions.
- Gravity loads primarily govern the axial design of structural members such as columns and foundations.
- Seismic loads govern the lateral design, including bending moments, displacement, and drift control.
- Wind loads have a comparatively smaller influence on the structural response for the given location.
- The use of ETABS software enables accurate modeling, analysis, and design of multi-story buildings.
- The adoption of ductile detailing provisions as per IS 13920:2016 enhances the seismic performance of the structure.
- Proper consideration of load combinations is essential for achieving an economical and safe design.

### REFERENCES

#### Indian Standard Codes

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