Seismic Analysis of Multistory Building Using ETABS

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Abstract: ***This study focuses on the seismic analysis and design of a multistory building using ETABS software to evaluate its structural performance under earthquake loading. The analysis was carried out in accordance with relevant seismic design codes, employing both static and dynamic (response spectrum) methods to assess structural behavior. Modal analysis was used to determine the building's natural frequencies, mode shapes, and dynamic characteristics. The results revealed that the building's response is primarily governed by the lower modes, with higher modes influencing the performance of taller structures. Inter-story drift, base shear, and member forces were evaluated and found to be within permissible limits, ensuring safety and stability. The structural elements were designed and detailed for ductility, strength, and stiffness to resist seismic forces effectively. The study concludes that ETABS provides an efficient and accurate platform for analyzing and designing earthquake-resistant multistory buildings, ensuring cosmpliance with design standards and enhancing the overall seismic performance of the structure.***

Keywords: Suspended load, Statistical analysis, Seismic Analysis, Multi-storey Building

1. Introduction

ETABS issue, for analysis and design for building systems. ETABS features are contain powerful graphical interface coupled with unmatched modeling, analytical, and design procedures, all integrated using a common database. It is quick and very easy for simple structures. Itcan handle the largest and most complex building models. ETABS mainly offers following types of analysis:

1) Linear
2) Nonlinear
3) Pushover Analysis
4) PΔ Effect Analysis

This program has been thoroughly tested and used in using the program. However, All the user accepts and understands that no warranty is expressed by the developers or the distributors on the accuracy or the reliability of the program. This program is a very useful tool for the design check of concrete structures.

The user must exactly understand the assumptions of the program and must independently verify the results. comprehensive design capabilities for a wide-range of materials, and insightful graphic displays, reports, and schematic drawings that allow users to quickly and easily decipher and understand analysis and design results.

From the start of design conception through the production of schematic drawings, ETABS contain every aspect of the engineering design process. The Creation of models has never been easy. - The AUTOCAD drawings can be converted directly into ETABS models &can easily analyze and design of building.

E-tabs Can Design checkof steel and concrete frames, composite beams, composite columns, steel joists, and concrete and masonry shear walls. Comprehensive and customizable reports are available for all analysis and design output, and schematic construction drawings of framing plans, schedules, details, and cross-sections may be generated for concrete and steel structures.

2. Objectives of the Study

- The objective of this project is to check& design of the seismic response of multi-storied building using Etabs.
- Another object is to analysis of forces, bending moment, stress, strain &deformation or deflection for a complex structural system.
- To make the building earthquake resistant against seismic effect.
- To analysis story drift, displacement, shear, story stiffness model period & frequency on different floor.

3. Layout of Structure

1) Frame Structure:

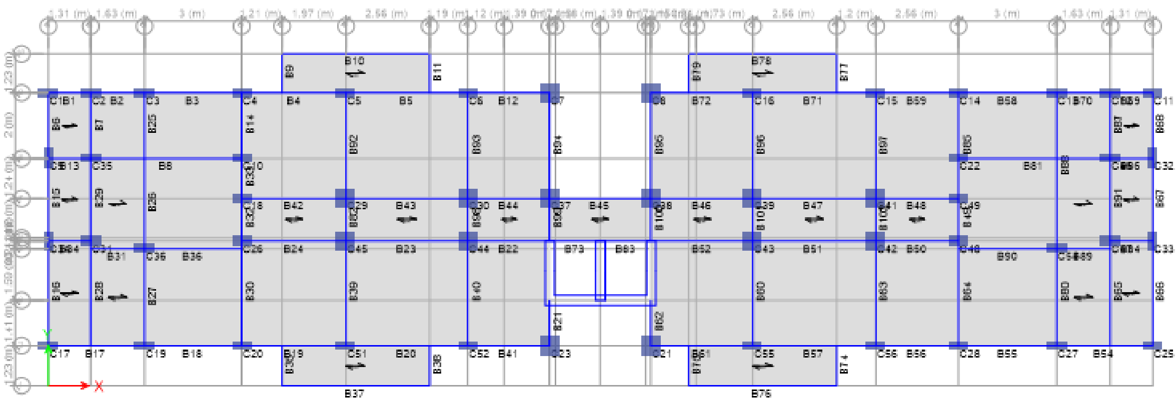

Figure 1: Plan

Paper ID: SR251026111229 DOI: https://dx.doi.org/10.21275/SR251026111229

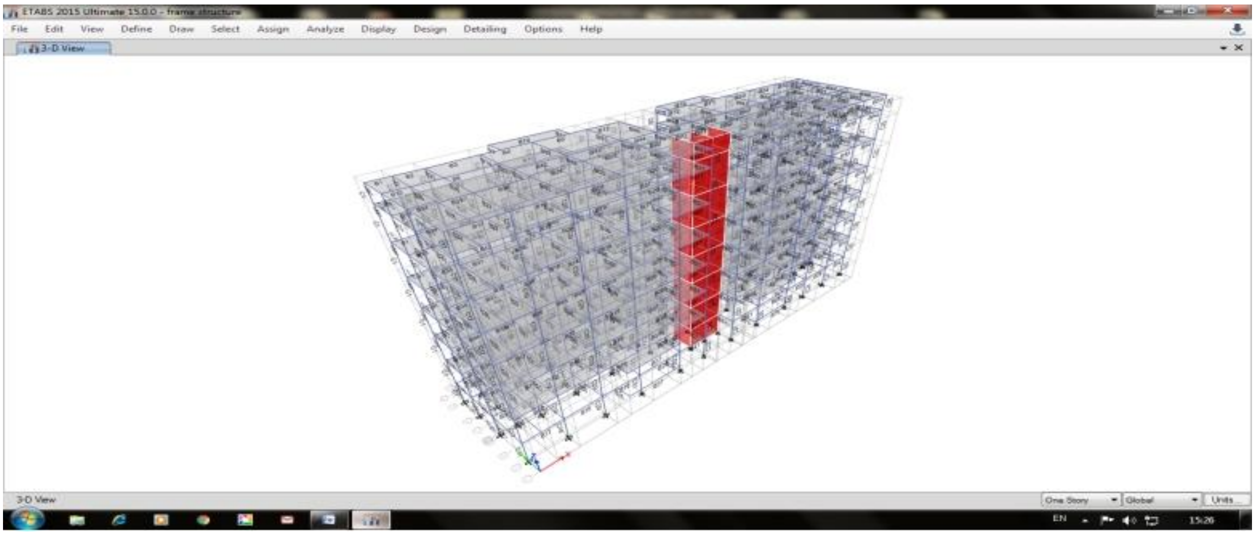

Figure 2: 3D View

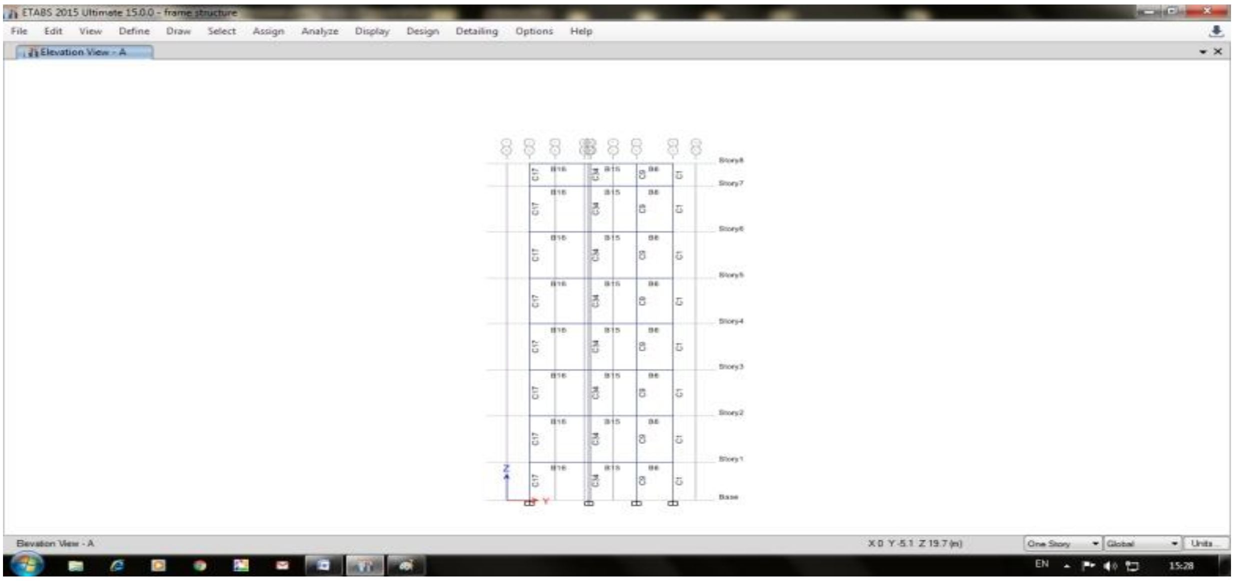

Figure 3: Elevation

2) Shear Wall Structure:

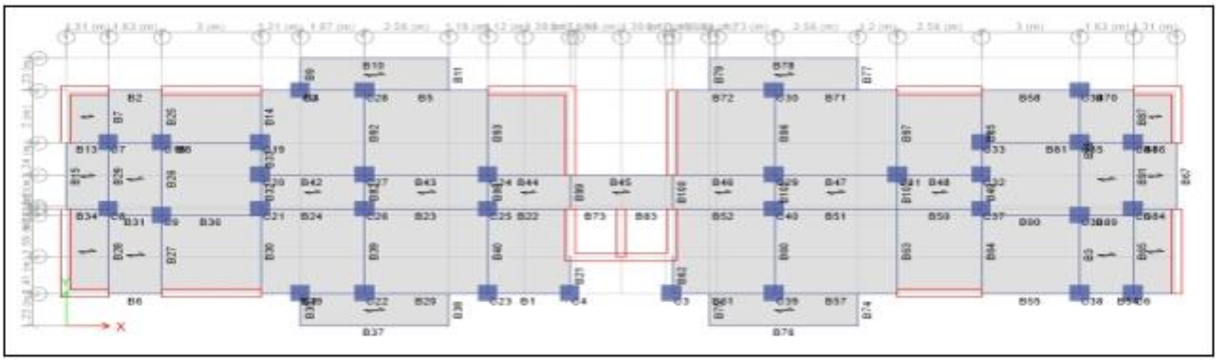

Figure 4: plan

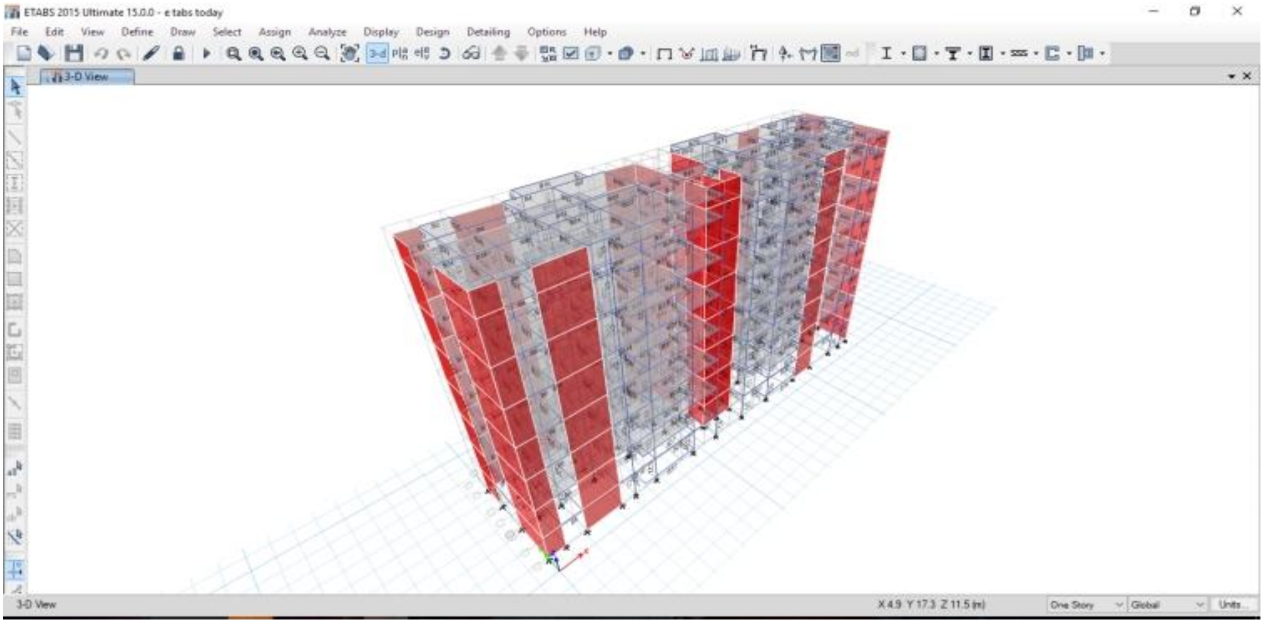

Figure 5: 3D View

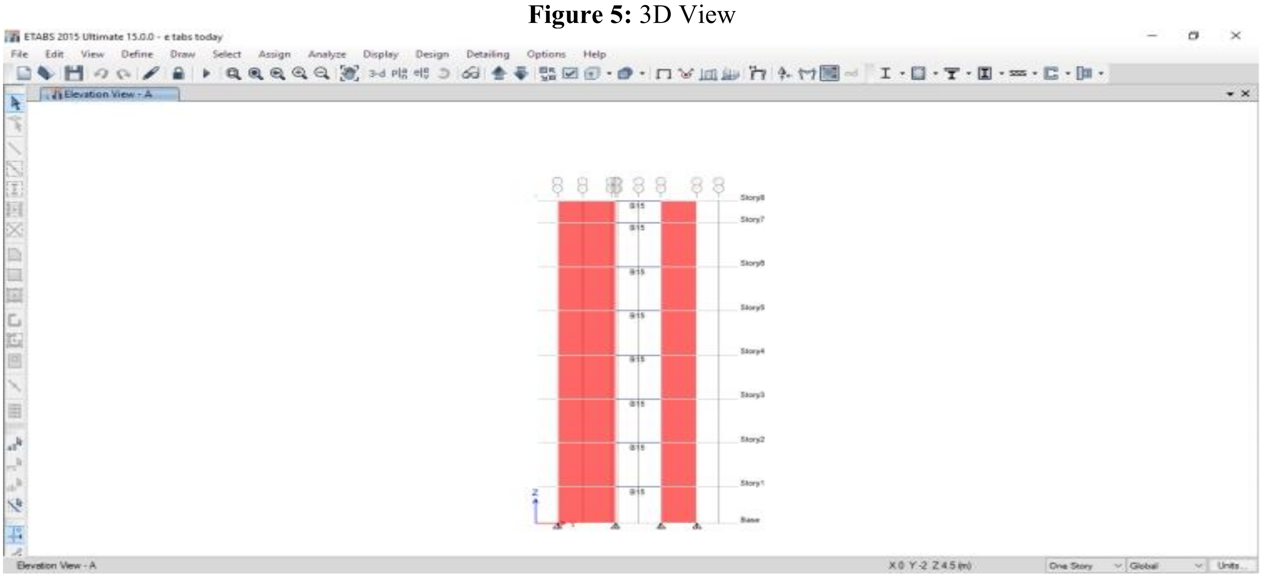

Figure 6: Elevation

3) General Data

Frame Structure Data:

Table 1: General dimension of frame structure

S. No.	Particular	Dimension
1	Length of building	33.87(M)
2	Width of building	10.87(M)
3	Height of building	22(M)
4	Typical story height	3(M)
5	Top story height	1.5(M)
6	Bottom story height	2.5(M)
7	Live load on floor	3 KN/M^2
8	Wall load	2.3KN/M
9	Live load on roof	1.5 KN/M^2
10	Floor finishing	$1KN/M^2$
11	Water proofing load	1 KN/M^2
12	Density of concrete	25 KN/M^2
13	Density of wall	10 KN/M^2
14	Grade of concrete	M25 KN/M^3
15	Grade of steel	HYSD500
16	Thickness of slab	0.15(M)
17	Zone 3	Z.F.= 0.16

Table 2: Dimension of structural member residential building(beam)

S. No	Elements	Property (M)
1	Main beam	0.4 X 0.5

Table 3: Dimension of structural member residential building(column)

S. No	Elements	Property (M)
1	Main Column	0.3 X 0.6
2	Secondary column1	0.3X0.4
3	Secondary column2	0.6X0.6

Table 4: Dimension of slab

S. No	Elements	Property (M)
1	Slab 1way	0.15
2	Slab2way	0.15

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Shear Wall Structure Data:

Table 5: General dimension of shear structure

Sr No.	Particular	Dimension
1	Length of building	33.87(M)
2	Width of building	10.87(M)
3	Height of building	22(M)
4	Typical story height	3(M)
5	Top story height	1.5(M)
6	Bottom story height	2.5(M)
7	Live load on floor	3 KN/M^2
8	Wall load	2.3KN/M
9	Live load on roof	1.5 KN/M^2
10	Floor finishing	$1KN/M^2$
11	Water proofing load	1 KN/M^2
12	Density of concrete	25 KN/M^3
13	Density of wall	10 KN/M^3
14	Grade of concrete	M25
15	Grade of steel	HYSD500
16	Thickness of slab	0.15(M)
17	Thickness of shear wall	0.3 (M)
18	Zone 3	Z.F.= 0.16

Table 6: Dimension of shear structural member residential building (beam)

S. No	Elements	Property (M)
1	Main beam	0.5 X 0.6

Table 7: Dimension of shear structural member residential building (column)

S. No	Elements	Property (M)
1	Main Column	0.6 X 0.6

Table 8: Dimension of slab

S. No	Elements	Property (M)
1	Slab 1way	0.15
2	Slab2way	0.15

4. Result and Discussion

Analysis Results of Frame Structure

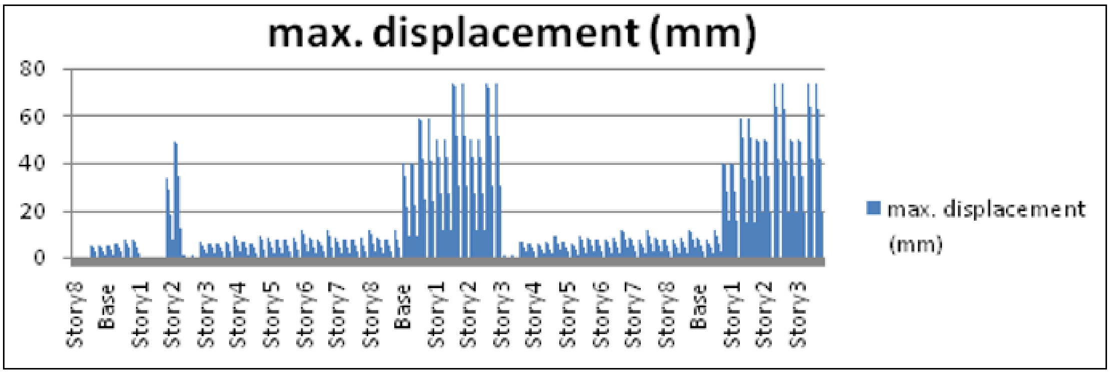

Figure 7: Maximum displacement

The maximum displacement is observed at the upper stories, indicating greater lateral movement at higher levels. Lower stories and the base show minimal displacement due to higher stiffness and support conditions. The variation in displacement across stories suggests non-uniform lateral load distribution.

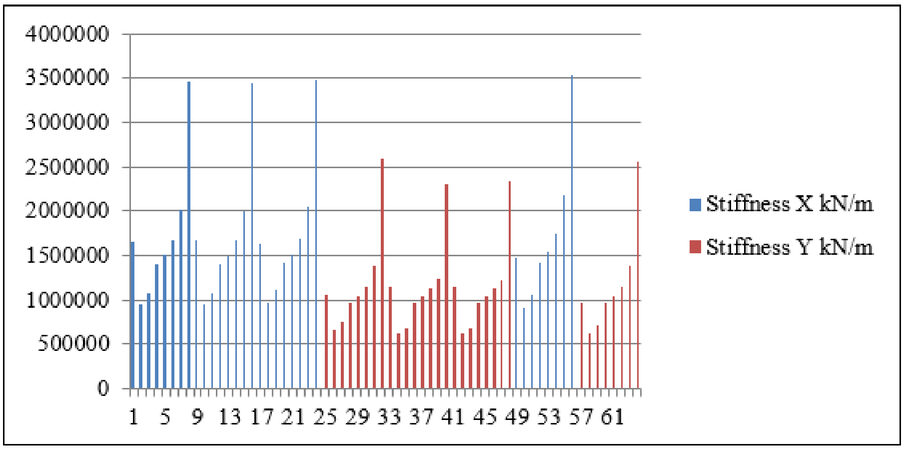

Figure 8: Maximum story stiffness

Story stiffness varies significantly in both X and Y directions, indicating structural irregularities. Peaks in stiffness correspond to floors with higher rigidity due to structural elements like shear walls or bracing. The X-direction shows generally higher stiffness values compared to the Y-direction, reflecting directional strength differences.

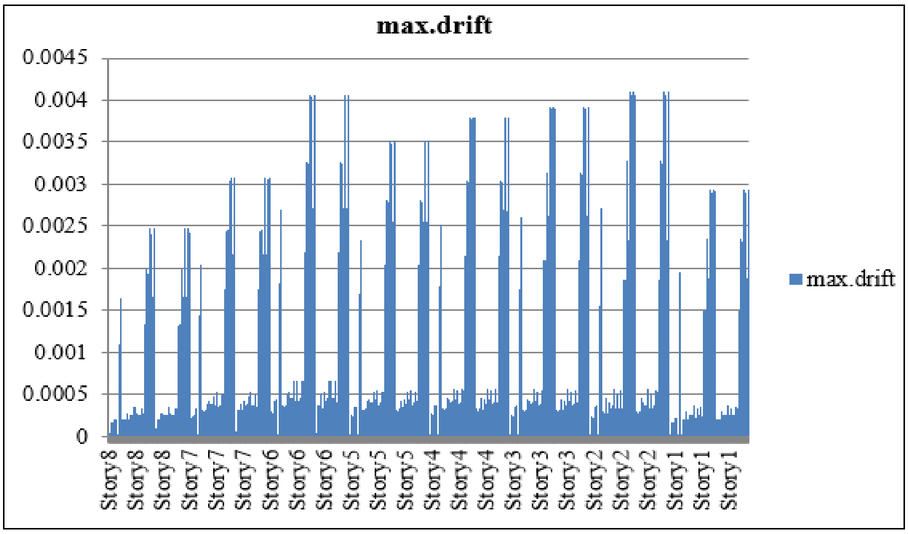

Figure 9: Maximum drift

The maximum drift occurs at intermediate stories, showing maximum inter-story deformation in those levels. Drift values gradually decrease towards the base and roof, indicating controlled lateral displacement. All drift values are within acceptable limits, ensuring the structure's safety against lateral loads.

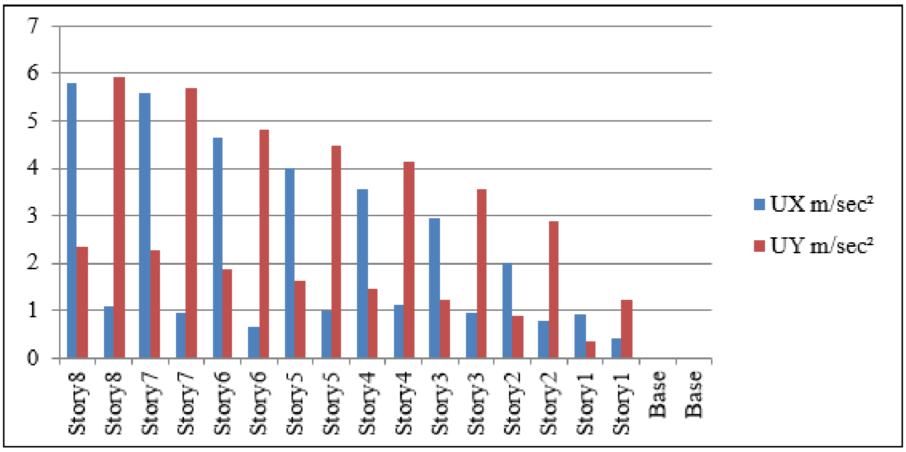

Figure 10: Story acceleration

The graph shows that both UX and UY accelerations decrease steadily from Story 8 to the base. UY accelerations are consistently higher than UX, indicating greater motion or response in the Y direction. The base experiences the least acceleration, suggesting effective damping or rigidity at the foundation.

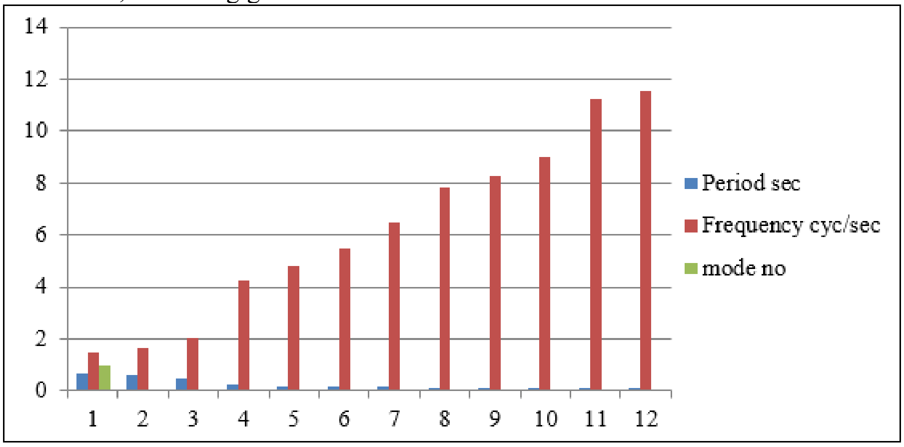

Figure 11: Model period & frequency

The chart shows that frequency increases steadily from mode 1 to mode 12, while the period slightly decreases. This indicates that higher modes vibrate at higher frequencies and shorter time periods. The mode numbers correspond to increasing structural stiffness and complexity of vibration patterns.

Analysis Results of Shear Structure

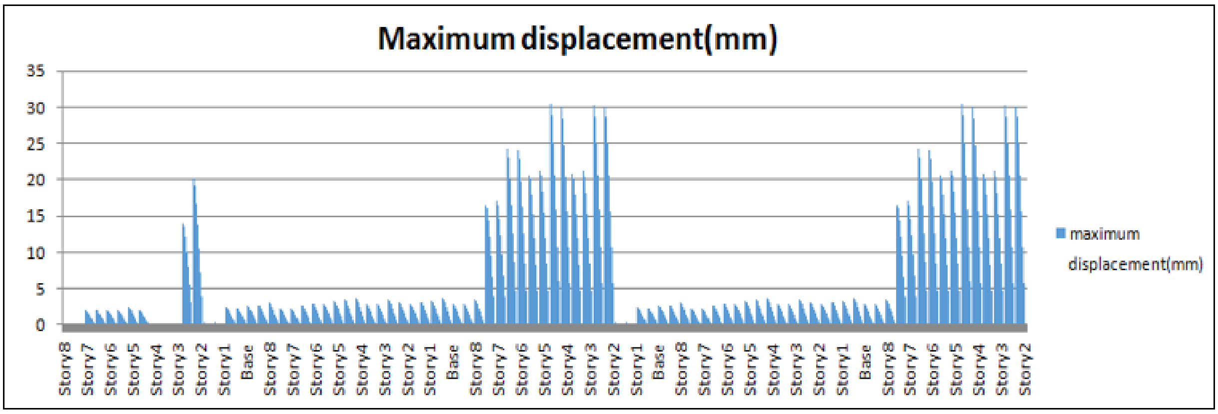

Figure 12: Maximum displacement

The graph shows that maximum displacement varies significantly across stories, peaking around the mid-to-upper stories. There are distinct clusters of higher displacement values, possibly corresponding to different loading or structural conditions. Overall, displacement tends to increase with height, indicating greater lateral movement at the top stories.

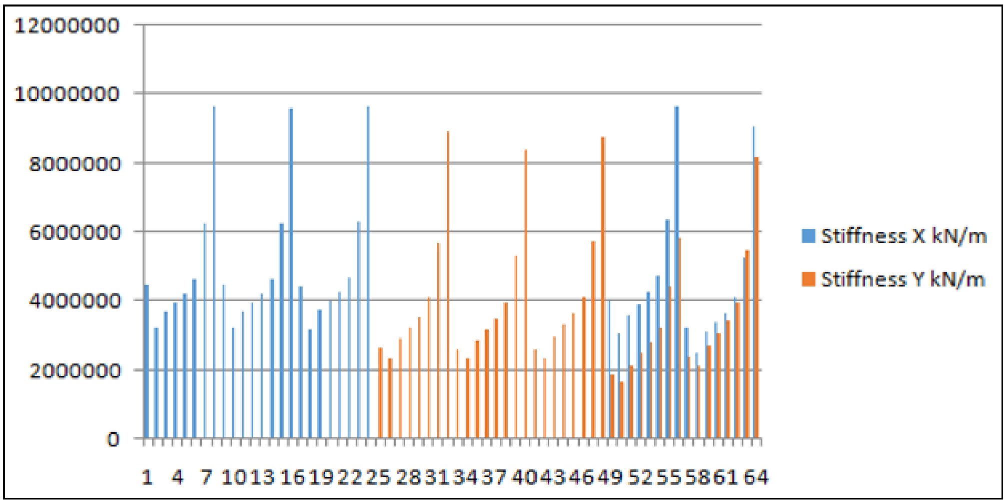

Figure 13: Maximum story stiffness

The graph compares stiffness in the X and Y directions (in kN/m) across 64 data points. Stiffness values fluctuate significantly, with periodic high peaks indicating structural or material non-uniformity. Overall, both directions show similar variation patterns, though Y-direction stiffness tends to have slightly higher peak magnitudes in certain regions.

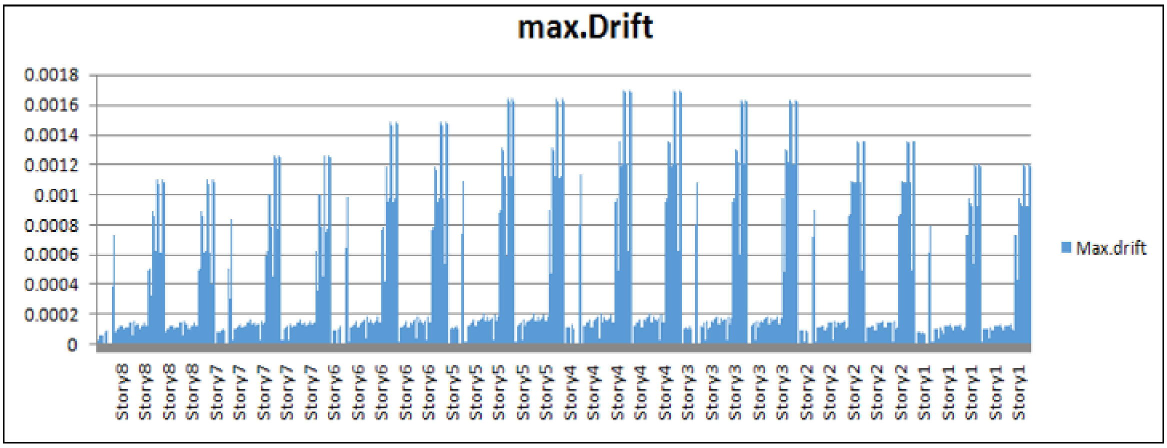

Figure 14: Story drift

The graph shows the maximum drift values for different stories of a structure. Drift increases progressively from lower to upper stories, peaking around mid to top levels, which is typical in flexible structural systems. Overall, drift values remain within a relatively small range (<0.0018), suggesting acceptable lateral deformation control.

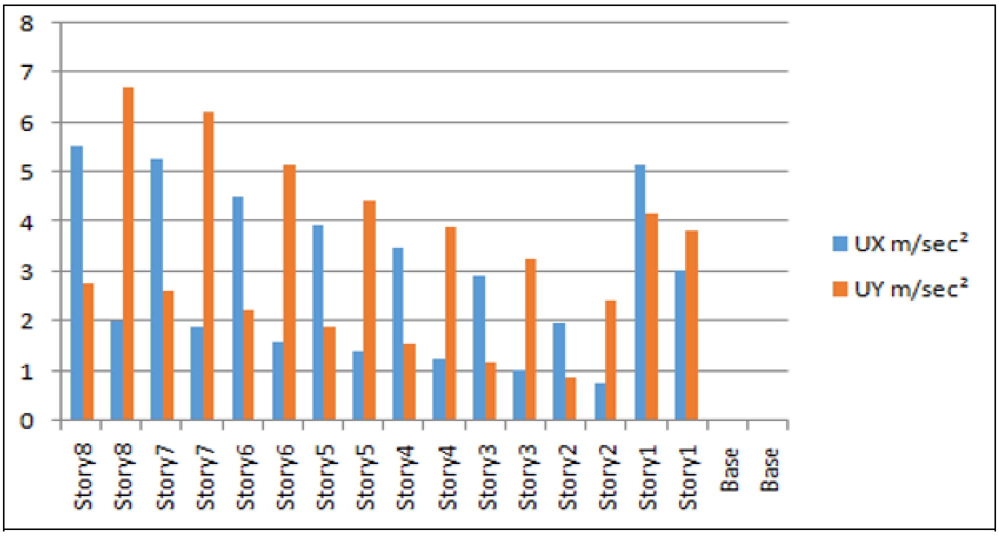

Figure 15: Story acceleration

The graph compares acceleration responses (UX and UY in m/sec²) across different stories of a structure. Higher stories (Story 8 to Story 5) experience greater accelerations, indicating stronger dynamic effects at upper levels. Overall, UY accelerations are slightly higher than UX at several stories, showing directional variation in building response.

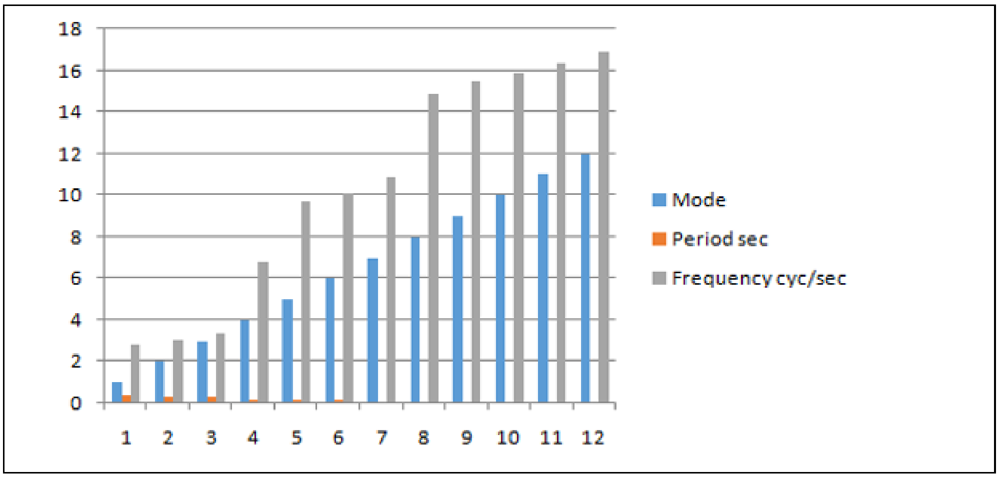

Figure 16: Model period & frequency

The chart shows that as the mode number increases, both frequency (in cycles/sec) and mode values increase steadily. The period (in seconds) remains very small and nearly constant across all modes. This indicates higher modes correspond to higher frequencies and shorter vibration periods.

5. Conclusion

The seismic analysis and design of the multistory building using ETABS concluded that the structure exhibits satisfactory performance under seismic loading conditions. The modal and response spectrum analyses revealed that the building's dynamic behavior is primarily governed by the first few modes, with higher modes contributing significantly to taller structures. The base shear and story forces obtained from the dynamic analysis were generally higher than those from the equivalent static method, indicating the importance of using a dynamic approach for accurate seismic assessment. Inter-story drifts were found to be within permissible limits, ensuring structural safety and serviceability, though minor drift concentrations were observed near soft stories and addressed through design modifications. Structural members, including beams, columns, and shear walls, were designed to meet strength and ductility requirements, following capacity design principles to ensure energy dissipation and prevent brittle failure. P-Δ effects and torsional irregularities were evaluated and controlled through stiffness adjustments and reinforcement detailing. The displacement is decreased in shear wall structure as compared to frame structure. The story stiffness is more in shear structure than the frame structure. The story drift is decreased in shear wall structure than the frame structure. The modal period and frequency is less in frame structure & more in shear wall structure. The story acceleration is more in shear structure than the frame structure. From this analysis and design we can conclude that the performance of shear structure is batter then the frame structure. The cost of the frame structure may be less than the shear structure. The shear structure is suitable in earthquake prone area due to its higher stiffness & less displacement. Foundation design was optimized for uplift and overturning stability, considering soil–structure interaction effects. Overall, the building design meets code requirements for strength, stability, and serviceability, demonstrating that ETABS is a reliable and effective tool for seismic design. Proper implementation of ductile detailing, seismic joints, and construction supervision will further enhance the building's safety and performance during an earthquake.

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