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Seismic Response of Plan Regular G+15 RC Structure and Analysis of Structure by ETABS

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Abstract: The present study evaluates the seismic performance of a G+15 reinforced concrete (RC) framed building using ETABS software in accordance with IS 1893 (Part 1): 2016. The building is modelled as a plan-regular structure located in Seismic Zone V with medium soil conditions. Modal Analysis, Equivalent Static Analysis, and Response Spectrum Analysis are carried out to assess the dynamic behaviour of the structure under earthquake loading. Important structural parameters such as natural time period, modal participation ratio, base shear, storey displacement, and storey drift are obtained and analysed. The results indicate that seismic response varies significantly along the height of the building, with maximum displacement and drift occurring at the upper storeys while remaining within the codal limits. The study demonstrates that ETABS is an effective tool for evaluating the seismic behaviour of multi-storey RC buildings and provides valuable information for designing safe and earthquake-resistant structures.

Keywords: Reinforced Concrete (RC) Building, Seismic Analysis, ETABS, Response Spectrum Analysis, Modal Analysis, Equivalent Static Analysis, Base Shear, Storey Displacement, Storey Drift, IS 1893 (Part 1): 2016.

I. INTRODUCTION

Rapid urbanization has led to the construction of high-rise reinforced concrete (RC) buildings in regions with moderate to high seismic activity. Ensuring the seismic safety of these structures is essential to minimize structural damage and protect human life during earthquakes. Seismic analysis helps engineers evaluate the behaviour of buildings under earthquake loading and design structures that satisfy the requirements of seismic design codes.

This study investigates the seismic performance of a plan-regular G+15 RC framed building using ETABS software. The building is analysed according to the provisions of IS 1893 (Part 1): 2016 for Seismic Zone V with medium soil conditions. Modal Analysis, Equivalent Static Analysis, and Response Spectrum Analysis are performed to evaluate important structural parameters such as natural time period, modal participation ratio, base shear, storey displacement, and storey drift.

The results obtained from these analyses provide an understanding of the dynamic behaviour of the building and help assess its structural performance under earthquake loading. The study also demonstrates the effectiveness of ETABS as a reliable tool for the seismic analysis and design of multi-storey RC buildings.

II. LITERATURE REVIEW

1) Several researchers have investigated the seismic behaviour of reinforced concrete buildings using different lateral load-resisting systems. Nitin Bhojkar and Mahesh Bakade (2015) reported that steel bracing significantly improves structural stiffness and reduces inter-storey drift under seismic loading. Reddy and Kumar (2018) compared shear walls and steel bracing systems and concluded that X-bracing provides better control of lateral displacement than other bracing configurations.
2) Vishal Mondal et al. (2020) evaluated different bracing arrangements in RC buildings and observed that steel bracing enhances seismic performance by reducing displacement and increasing stiffness. Kumar Anupam and Tasleem (2021) compared shear walls and bracing systems in multi-storey buildings and found that both systems effectively improve earthquake resistance.
3) Sagar Dhotre et al. (2021) and Dasare Shivani Balaji and Kariappa (2022) concluded that X-bracing offers better seismic performance than V-bracing by reducing storey drift and lateral displacement. Mohammed Shoeb and Shaik Abdulla (2023) also reported that X-bracing provides superior performance in high-rise RC buildings subjected to seismic loading.

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4) Based on the reviewed literature, it is evident that appropriate lateral load-resisting systems significantly improve the seismic behaviour of reinforced concrete buildings. The present study focuses on evaluating the seismic response of a G+15 RC building using ETABS through Modal Analysis, Equivalent Static Analysis, and Response Spectrum Analysis in accordance with IS 1893 (Part 1): 2016.

III. OBJECTIVES OF THE STUDY

The main objectives of this study are:

1) To evaluate the seismic behaviour of a G+15 reinforced concrete (RC) framed building using ETABS software.
2) To perform Modal Analysis, Equivalent Static Analysis, and Response Spectrum Analysis as per IS 1893 (Part 1): 2016.
3) To determine and analyse the fundamental time period, base shear, storey displacement, and storey drift of the building.
4) To assess the overall seismic performance and structural response of the building under earthquake loading.

IV. METHODOLOGY

A three-dimensional G+15 reinforced concrete (RC) building was modelled and analysed using ETABS software to evaluate its seismic performance. The building was designed in accordance with IS 1893 (Part 1): 2016 for Seismic Zone V with medium soil (Type II). The structural model consisted of RC beams, columns, slabs, and concentric steel bracing members. The material properties, member dimensions, and loading conditions were defined based on the project specifications. The analysis included Dead Load (DL), Live Load (LL), and seismic loads acting in both X and Y directions. A mass source was assigned by considering the dead load and 25% of the live load as per IS 1893 (Part 1): 2016. Three types of structural analyses were carried out: Modal Analysis to determine the natural time period and mode shapes, Equivalent Static Analysis to estimate the design base shear, and Response Spectrum Analysis to evaluate the dynamic response of the structure.

The seismic performance of the building was assessed by comparing important structural parameters such as fundamental time period, modal participation ratio, base shear, maximum storey displacement, and maximum storey drift. The obtained results were analysed to understand the overall behaviour of the building under earthquake loading and to evaluate its structural safety.

V. ETABS MODELLING DETAILS

The G+15 reinforced concrete building was modelled using ETABS software in accordance with IS 1893 (Part 1): 2016. The building was considered as a plan-regular structure located in Seismic Zone V with medium soil (Type II). The model consisted of RC beams, columns, slabs, and concentric steel bracing members.

The structural parameters adopted for the analysis are summarized below:

Parameter	Value
Number of Storeys	G+15
Seismic Zone	V
Zone Factor (Z)	0.36
Importance Factor (I)	1.0
Response Reduction Factor (R)	4.5
Soil Type	Type II (Medium Soil)
Bay Width	5 m
Column Size	600 × 600 mm
Beam Size	300 × 450 mm
Slab Thickness	150 mm
Concrete Grade	M30
Reinforcement Grade	Fe500
Structural Steel Grade	Fe250
Live Load	3 kN/m²
Floor Finish	1.5 kN/m²
Storey Height	3.0 m
Total Height	48 m

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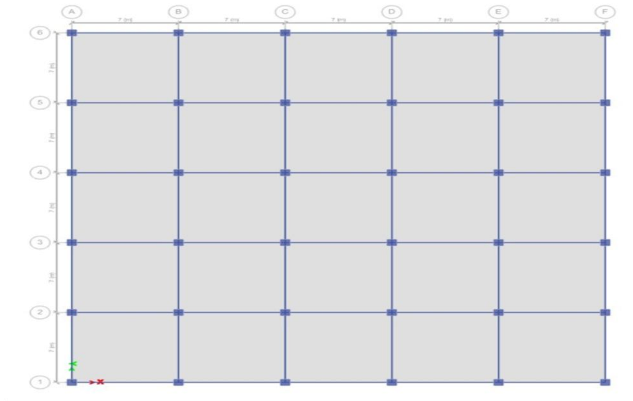

FIG.1: Plan Of Regular Model (G+15)

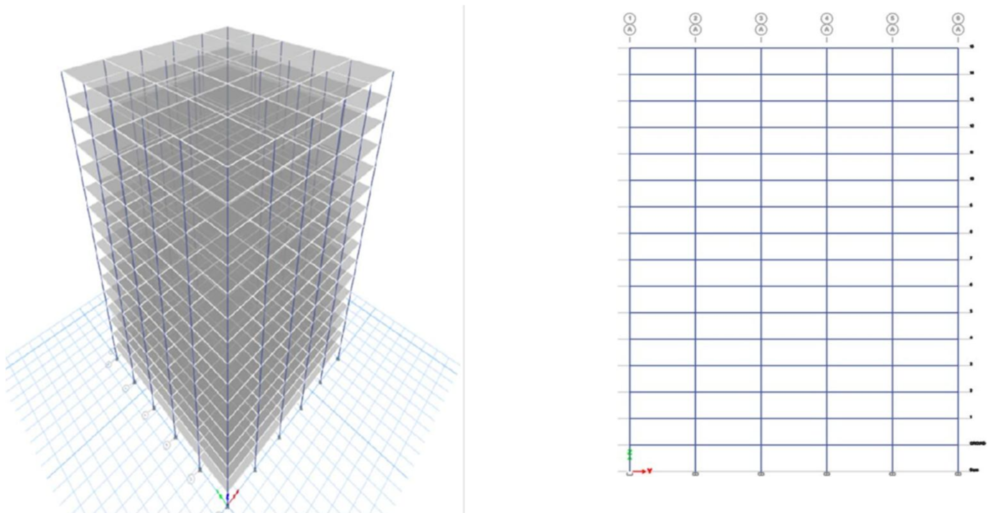

FIG.2: 3D View And Elevation Of Regular STRUCTURE (G+15)

The building was analysed using Modal Analysis, Equivalent Static Analysis, and Response Spectrum Analysis. The structural response was evaluated in terms of fundamental time period, modal participation ratio, base shear, maximum storey displacement, and maximum storey drift.

VI. RESULTS AND DISCUSSION

A. Modal Analysis

TABLE 1: MODAL TIME PERIOD

SL NO.	MODELS	IDAMENTAL TIME PERIOD (SEC)		MODES	FREQUENCY Cyc/sec
		PROGRAM CALCULATED	IS 1893:2016 (PART 1)		
1	G+15 REGULAR MODEL	3.535	1.367	MODE 1	0.283
2		3.535		MODE 2	0.283
3		3.213		MODE 3	0.311
4		1.145		MODE 4	0.873
5		1.145		MODE 5	0.873
6		1.041		MODE 6	0.96
7		0.651		MODE 7	1.536

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8		0.651	MODE 8	1.536
9		0.593	MODE 9	1.686
10		0.436	MODE 10	2.294
11		0.436	MODE 11	2.294
12		0.396	MODE 12	2.523
13		0.315	MODE 13	3.177
14		0.315	MODE 14	3.177
15		0.286	MODE 15	3.501
16		0.238	MODE 16	4.197
17		0.238	MODE 17	4.197
18		0.216	MODE 18	4.634
19		0.187	MODE 19	5.362
20		0.187	MODE 20	5.362

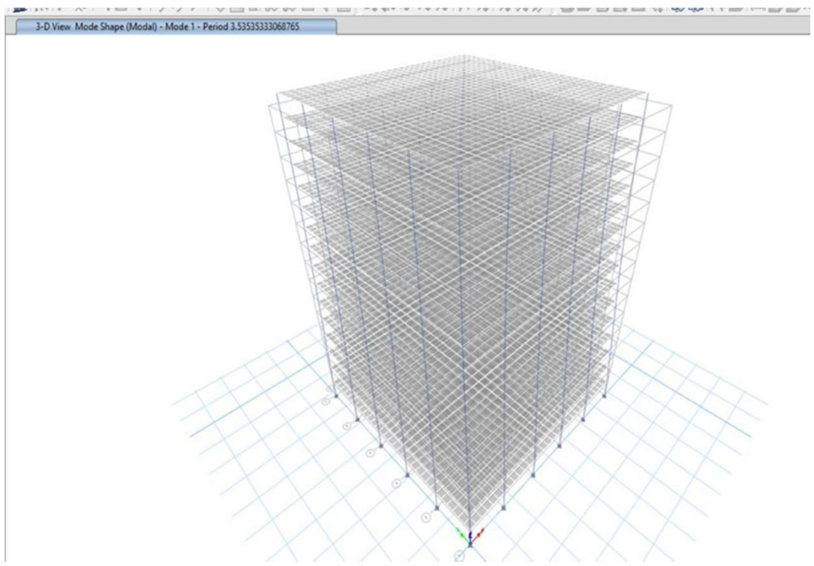

FIG.3: Mode 1 (3.535 Sec)

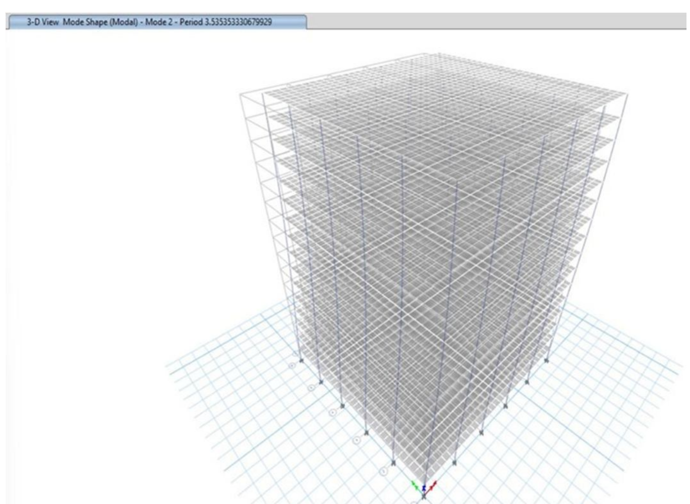

FIG.4: Mode 2 (3.535 Sec)

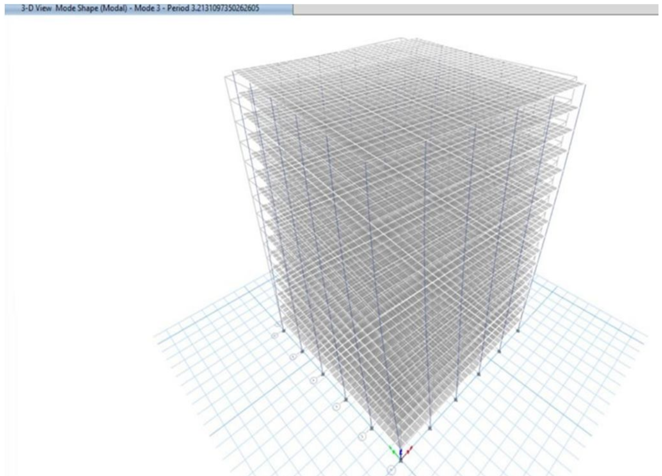

FIG.5: Mode 3 (3.2131 Sec)

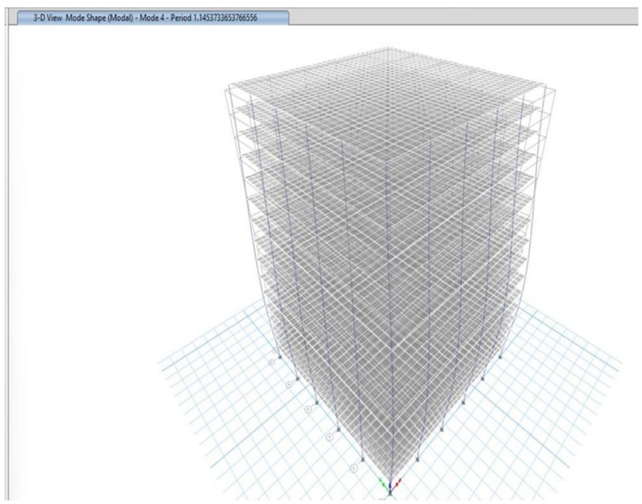

FIG.6: Mode 3 (1.4537 Sec)

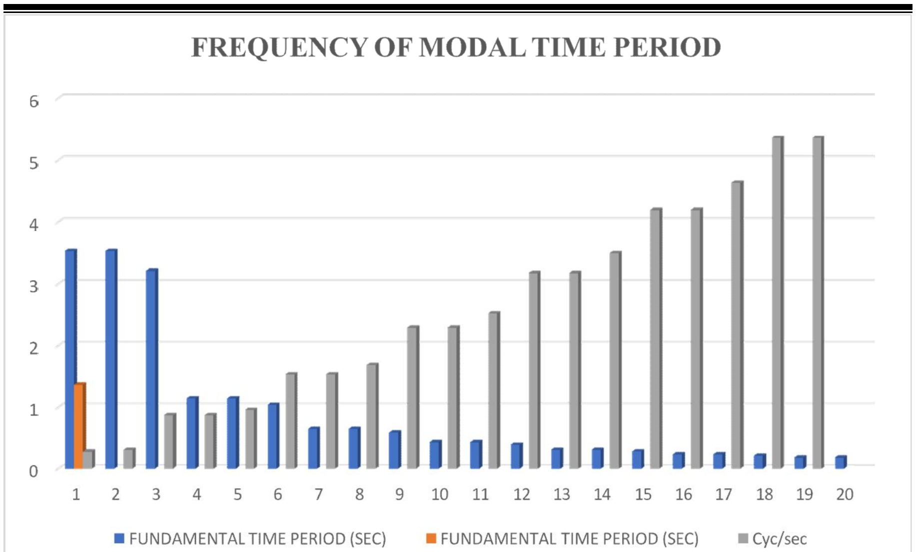

Fig.7: Frequency Of Modal Time Period

Table 2: Model Load Participation Ratio

CASE	ITEM TYPE	ITEM	STATIC %	DYNAMIC %
Modal	Acceleration	UX	100	97.77
Modal	Acceleration	UY	100	97.77
Modal	Acceleration	UZ	0	0

Modal analysis was performed to determine the dynamic characteristics of the G+15 reinforced concrete building. The analysis provided the natural time periods, mode shapes, and modal participation ratios of the structure. The fundamental time period obtained from ETABS for the first mode was 3.535 s, while the corresponding modal frequency was 0.283 Hz. The cumulative modal mass participation in both X and Y directions exceeded 97%, indicating that the selected modes adequately represent the dynamic behaviour of the building.

B. Equivalent Static Analysis

TABLE 3: BASE SHEAR (kN) for model

MODEL	STATIC BASE SHEAR	DYNAMIC BASE SHEAR	SCALE FACTOR
	EQX/EQY	RSFX/RSFY	
G+15 MODEL IN X DIRECTION	10850.2559 (i.e., EQX)	3182.3387 (i.e., RSFX)	3.409
G+15 MODEL IN Y DIRECTION	9765.2303 (i.e., EQY)	3182.3389 (i.e., RSFY)	3.068

Table 4: Corrected Dynamic Base Shear (Kn)

MODEL	ED DYNAMIC BASE SHEAR
	RSFX/RSFY
G+15 MODEL IN X DIRECTION	10850.2
G+15 MODEL IN Y DIRECTION	9765.3

Equivalent Static Analysis was carried out according to IS 1893 (Part 1): 2016 to estimate the seismic base shear. The computed base shear was 10850.26 kN in the X-direction and 9765.23 kN in the Y-direction. These values were used as reference values for scaling the Response Spectrum Analysis.

C. Response Spectrum Analysis

Response Spectrum Analysis was performed to evaluate the seismic response of the building under dynamic loading. The analysis provided the corrected dynamic base shear, storey displacement, and storey drift. The corrected dynamic base shear closely matched the equivalent static base shear after applying the required scale factor, satisfying the codal requirements.

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D. Storey Displacement

Table 5: Maximum Storey Displacement (Mm) For Regular RC Structure

STORY	MAXIMUN STORY DISPLACEMENT	
	RSX	RXY
G+15	211.616	190.419
G+14	208.071	187.229
G+13	202.873	182.552
G+12	195.896	176.273
G+11	187.204	168.452
G+10	176.893	159.174
G+9	165.053	148.52
G+8	151.775	136.572
G+7	137.148	123.411
G+6	121.263	109.117
G+5	104.202	93.764
G+4	86.037	77.419
G+3	66.862	60.165
G+2	46.912	42.213
G+1	26.927	24.23
GROUND	9.149	8.233
BASE	0	0

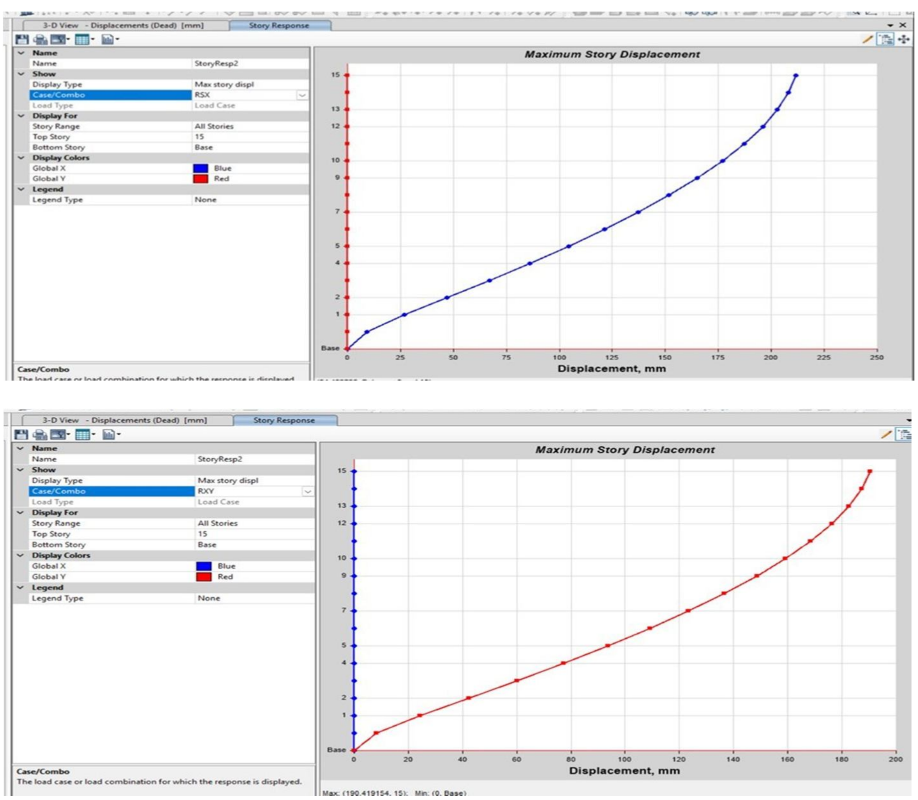

Fig.8: Maximun Story Displacement for G+15 Structure

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The maximum storey displacement was observed at the roof level. The top storey displacement was 211.616 mm in the X-direction and 190.419 mm in the Y-direction. The displacement gradually decreased towards the base, indicating the expected lateral deformation pattern under earthquake loading.

E. Storey Drift

The maximum inter-storey drift occurred at the intermediate storeys. The peak drift values were 0.006755 in the X-direction and 0.006078 in the Y-direction. The drift profile demonstrates the variation in lateral deformation along the height of the building and provides an important measure for assessing seismic performance.

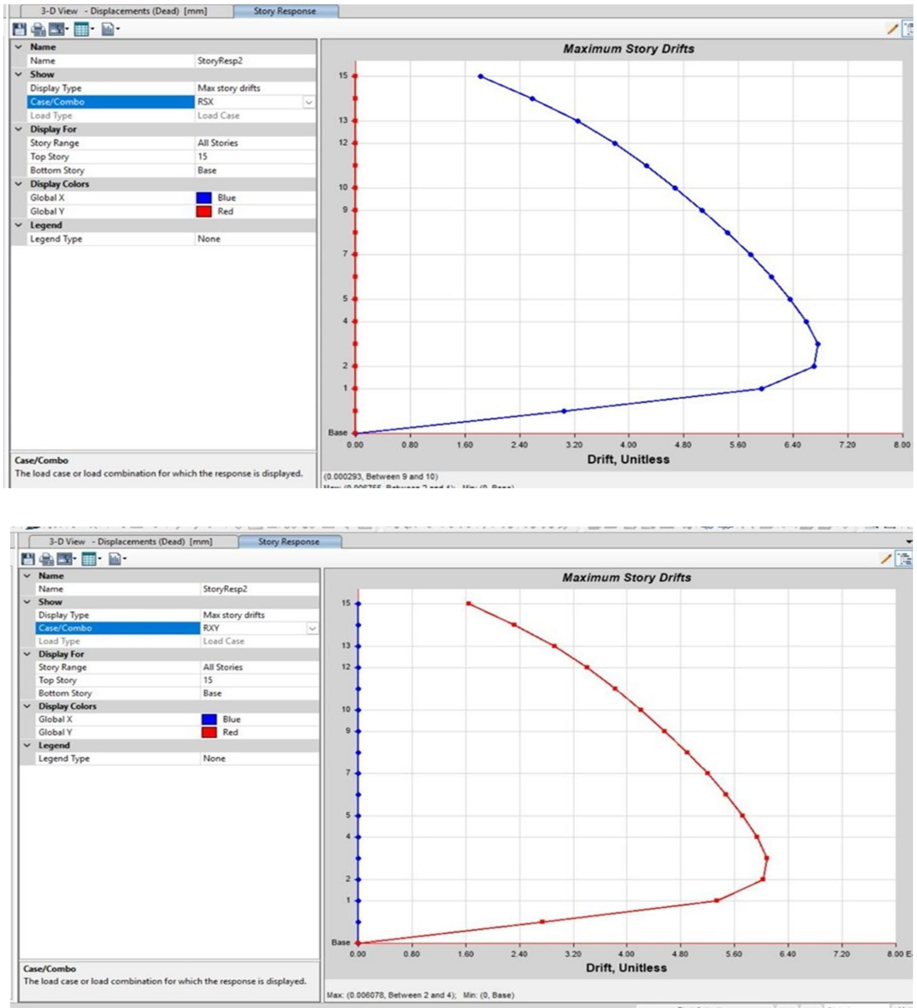

Fig.9: Maximun Story Drift For G+15 Structure

VII. CONCLUSION

The seismic performance of a G+15 reinforced concrete building was evaluated using ETABS in accordance with IS 1893 (Part 1): 2016. Based on the analytical results, the following conclusions are drawn:

1) Modal Analysis successfully determined the natural time period and modal characteristics of the building, providing an understanding of its dynamic behaviour.
2) Equivalent Static Analysis and Response Spectrum Analysis effectively evaluated the seismic response of the structure under earthquake loading.
3) The maximum base shear obtained was 10850.26 kN in the X-direction and 9765.23 kN in the Y-direction, indicating the seismic forces acting on the structure.
4) The maximum storey displacement occurred at the top storey, with values of 211.616 mm in the X-direction and 190.419 mm in the Y-direction.

5) The maximum storey drift was observed in the middle storeys and remained within the permissible limits specified by IS 1893 (Part 1): 2016, indicating satisfactory seismic performance.
6) The study demonstrates that ETABS is an efficient tool for seismic analysis and that the adopted structural configuration provides adequate stability and safety under seismic loading

REFERENCES

[1] N. Bhojkar and M. Bakade, "Seismic Evaluation of High-Rise RC Structures Using Steel Bracing System," International Journal for Research in Applied Science & Engineering Technology (IJRASET), 2015.
[2] P. Reddy and R. Kumar, "Effect of Steel Bracing on Seismic Performance of RCC Framed Structures," International Journal of Engineering Research, vol. 6, no. 1, 2018.
[3] V. Mondal, S. Dhawale, and R. Kakpure, "Behaviour Study of RCC Building with and without Bracing Using STAAD.Pro," Journal of Emerging Technologies and Innovative Research (JETIR), vol. 7, no. 9, pp. 271–276, 2020.
[4] K. Anupam and Tasleem, "Comparative Study of Shear Wall and Steel Bracing Systems for High-Rise RC Buildings," 2021.
[5] S. Dhotre, S. Manekari, and A. Sathe, "Structural Assessment of Multi-Storey Buildings Incorporating Steel Bracing Systems," International Research Journal of Engineering and Technology (IRJET), vol. 8, no. 7, 2021.
[6] S. Balaji and M. S. Kariappa, "Steel Bracing Configurations and Their Influence on RC Building Performance under Seismic Loading," International Research Journal of Modernization in Engineering Technology and Science, vol. 4, no. 7, pp. 1621–1626, 2022.
[7] Pradeep, A. Thampi, and S. Shrikant, "High-Rise Building Stability Analysis and Bracing Configuration Optimization," 2022.
[8] M. Shoeb and S. Abdulla, "Lateral Force Distribution in Multi-Storeyed Buildings Adopting Various Bracing Types," International Journal of Research, Publication and Reviews, vol. 4, 2023.
[9] K. Kanchan and P. Kumar, "Seismic Evaluation of High-Rise Buildings Using Various Bracing Techniques," Proceedings of the International Conference on Advanced Earth Science and Foundation Engineering (ICASF), AIP Conference Proceedings, 2024.
[10] IS 1893 (Part 1): 2016, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, India, 2016.
[11] IS 456: 2000, Plain and Reinforced Concrete – Code of Practice, Bureau of Indian Standards, New Delhi, India, 2000.
[12] IS 875 (Part 1): 1987, Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Dead Loads, Bureau of Indian Standards, New Delhi, India, 1987.
[13] IS 875 (Part 2): 1987, Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Imposed Loads, Bureau of Indian Standards, New Delhi, India, 1987.