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"Comparative Seismic Analysis of A G+14 Building Using Static, Response Spectrum, Bhuj, And Burma Time History Analysis in Surat. (Zone III)"

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Abstract - Seismic forces play a crucial role in the design and performance of multi-storey buildings in earthquake-prone regions. This study presents a comparative analysis of a G+14 reinforced concrete building located in Surat (Seismic Zone III as per IS 1893:2016). The structural model is developed in ETABS and analyzed using Equivalent Static Method, Response Spectrum Method, and Time History Analysis based on Bhuj earthquake (26-01-2001---7.7 magnitude) and Burma earthquake (06-08-1988---7.5 magnitude) records. Key response parameters such as base shear, storey displacement, storey drift, and overturning moment are evaluated and compared across all methods. The study highlights variations in structural response and provides insights into the suitability of different seismic analysis techniques for buildings in seismic zones III.

Key Words: Seismic Analysis, G+14 Reinforced Concrete Building, Equivalent Static Method, Response Spectrum Method, Time History Analysis, Bhuj Earthquake Record, Burma Earthquake Record, ETABS, Seismic Zone III, Storey Drift, Displacement, Overturning moment, Base Shear.

1.OBJECTIVE

The primary objective of this study is to evaluate the seismic performance of a multi-storey reinforced concrete building and to ensure structural safety by minimizing the risk of damage or collapse under earthquake loading conditions. The study focuses on understanding the behaviour of a G+14 building subjected to different seismic analysis methods and identifying the most effective approach for accurate prediction of structural response.

In order to achieve this, a three-dimensional analytical model of the building is developed using in accordance with the provisions of and . The study involves performing seismic analysis using the Equivalent Static Method, Response Spectrum Analysis, and Time History Analysis based on Bhuj and Burma earthquake records.

The research further aims to evaluate important seismic response parameters such as overturning moment, storey displacement, and storey drift in order to understand the structural behaviour under different loading conditions. A comparative assessment of results obtained from various analysis methods is carried out to identify variations in predicted responses and to determine the reliability of simplified and advanced seismic analysis techniques.

Additionally, the study seeks to examine the influence of different earthquake inputs on the performance of the structure and to provide insights into the suitability of various analysis procedures for multi-storey buildings located in moderate seismic zones. The overall objective is to contribute towards the development of safer and more efficient earthquake-resistant design practices.

2. Methodology

Table -1: Data used for modeling in ETABS.

Parameter	Value/Description	Reference Code
Dead Load	As per IS-875:1987 Part-1	IS-875:1987 Part-1
Live Load	As per IS-875:1987 Part-2	IS-875:1987 Part-2
Seismic Zone	III	As per IS-1893:2016 Part-1
Zone Factor (Z)	0.16	
Response Reduction Factor	5	
Importance Factor (I)	1.2	
Soil Type	Medium-2	

Chart

3. RESULTS

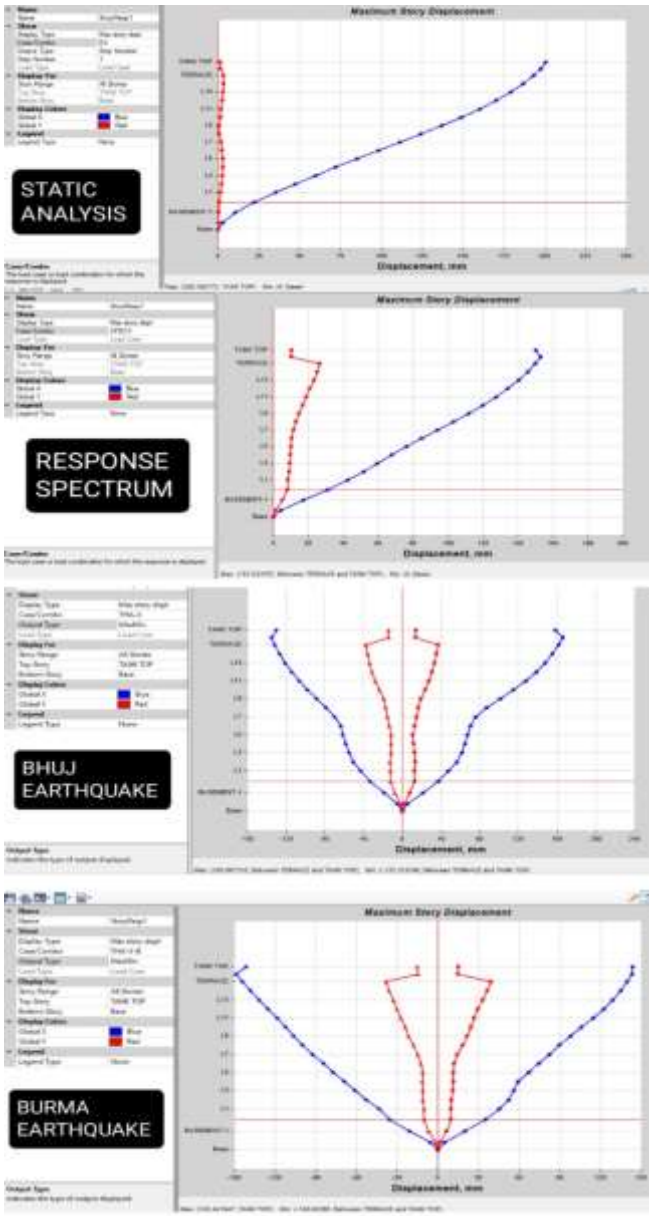

Fig -1: Displacement in X direction

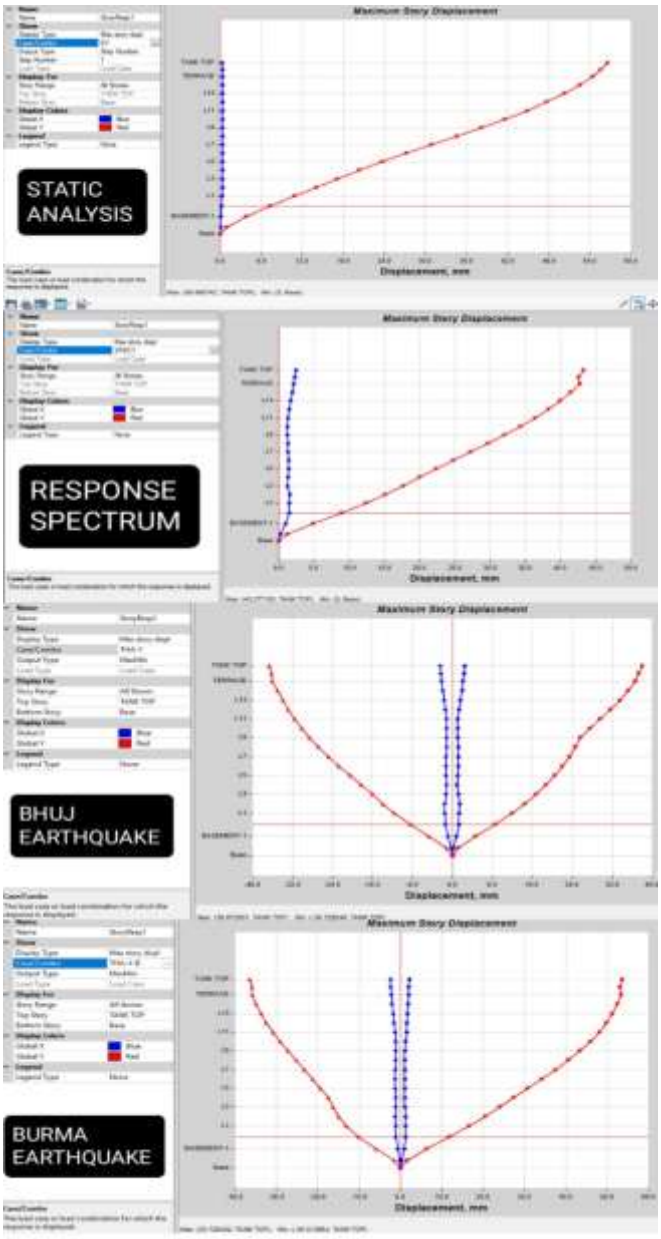

Fig -2: Displacement in Y direction

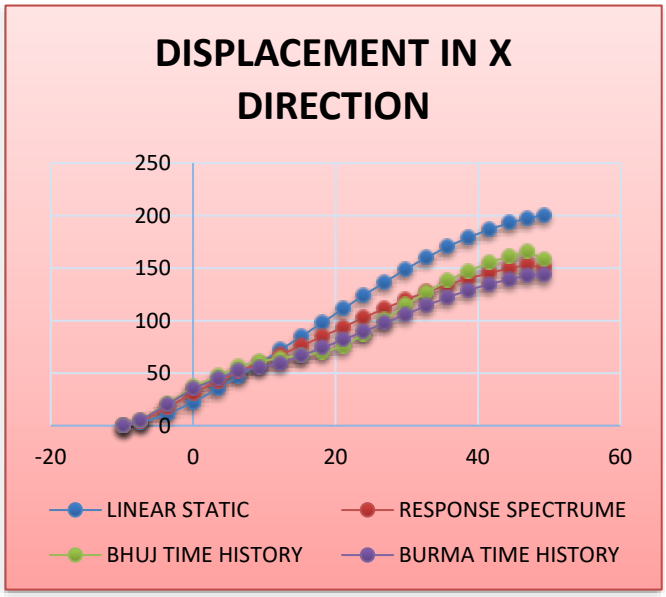

Chart -1: Displacement in X direction

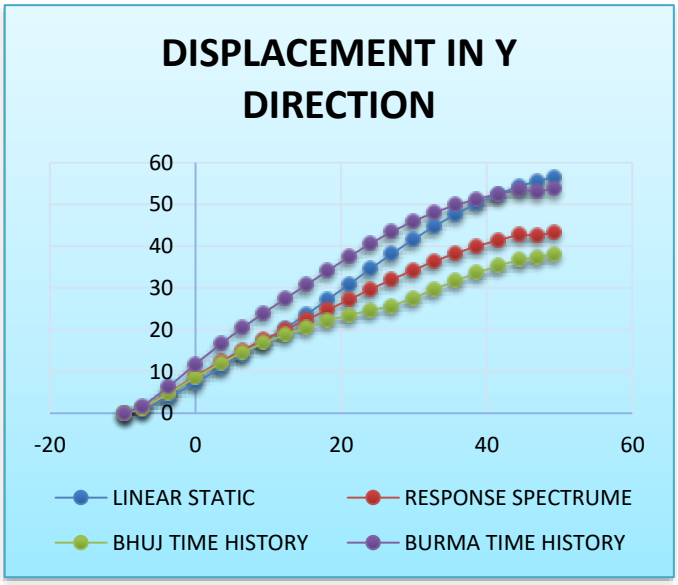

Chart -2: Displacement in Y direction

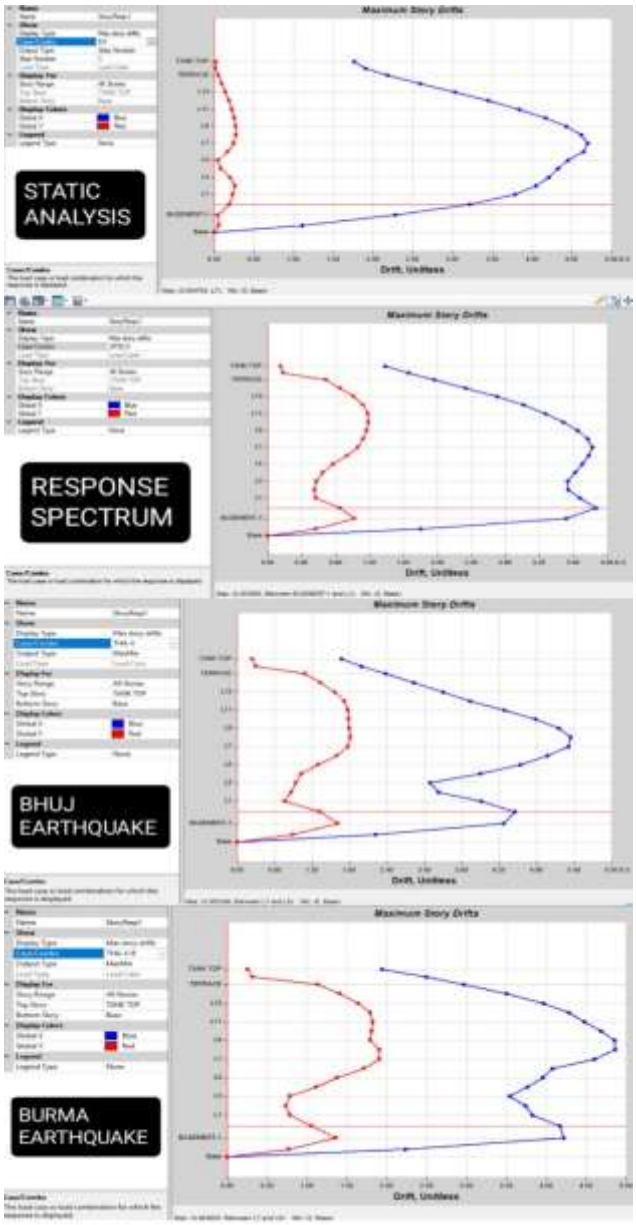

Fig -3: Story Drift in X direction

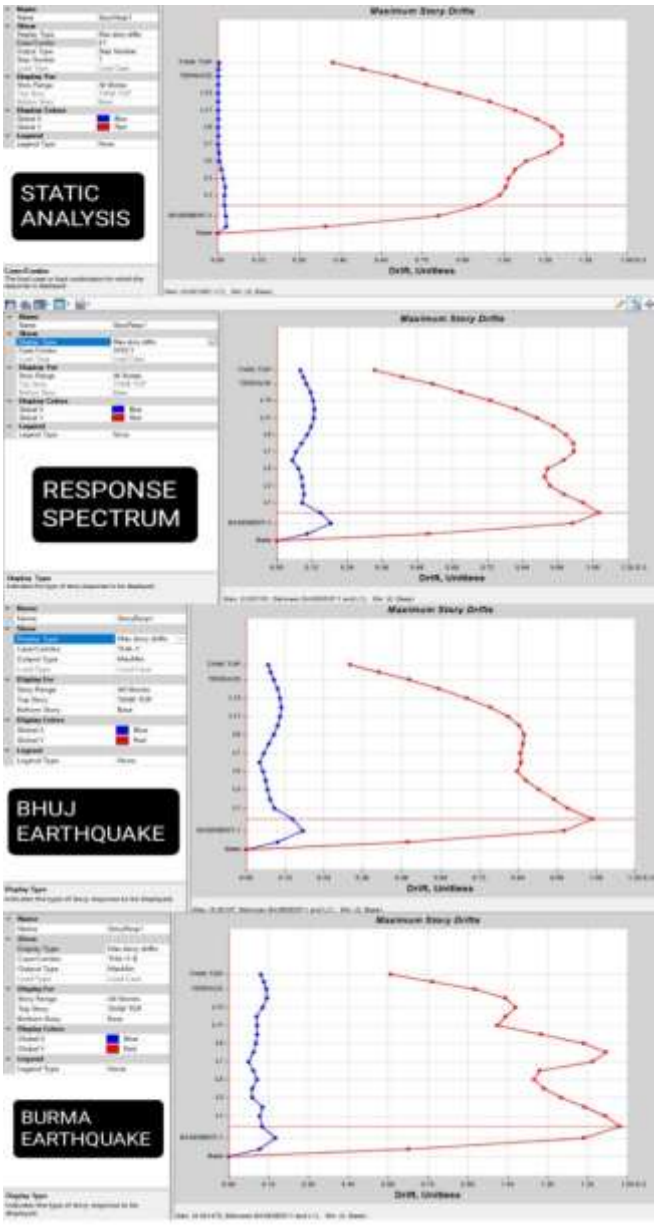

Fig -4: Story Drift in Y direction

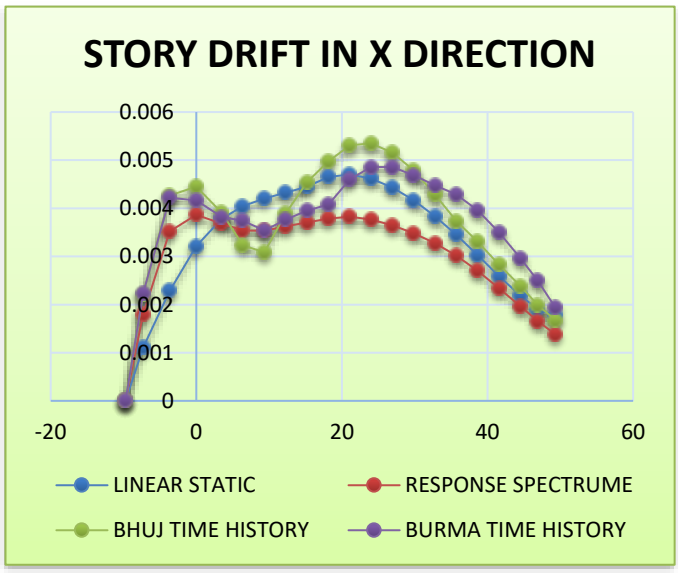

Chart -3: Story Drift in X direction

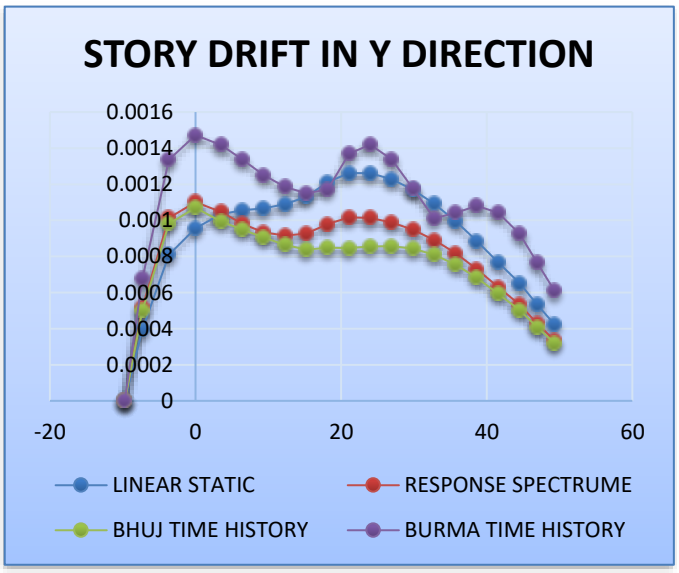

Chart -4: Story Drift in Y direction

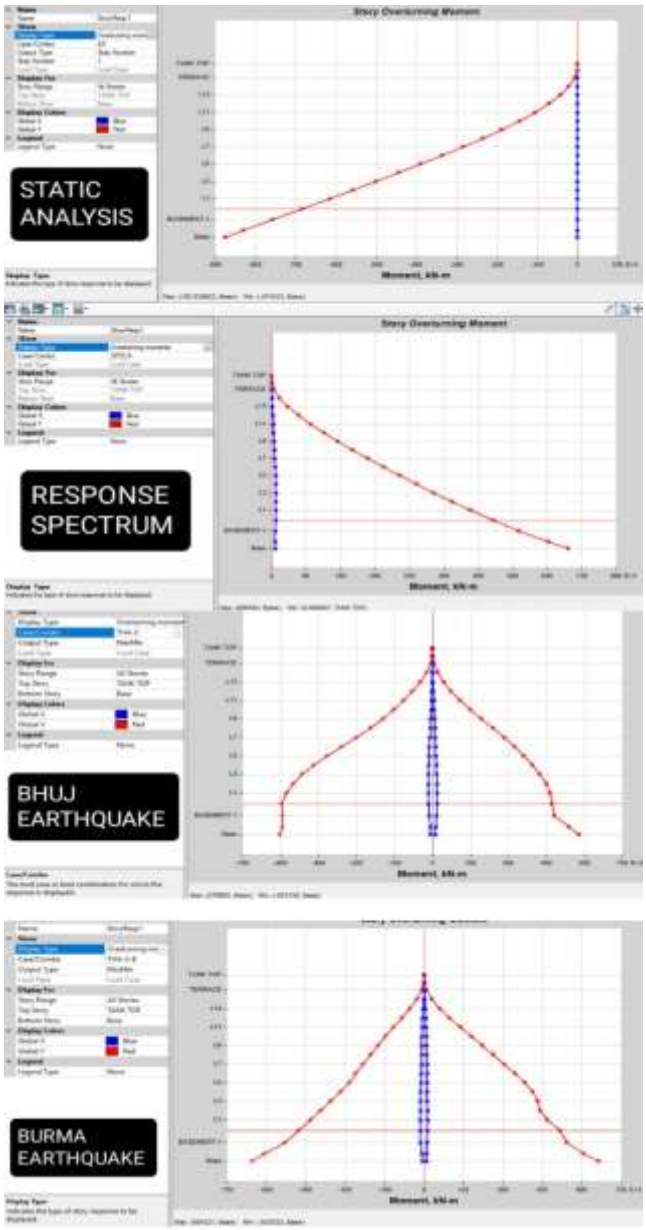

Fig -5: Overturning Moment in X direction

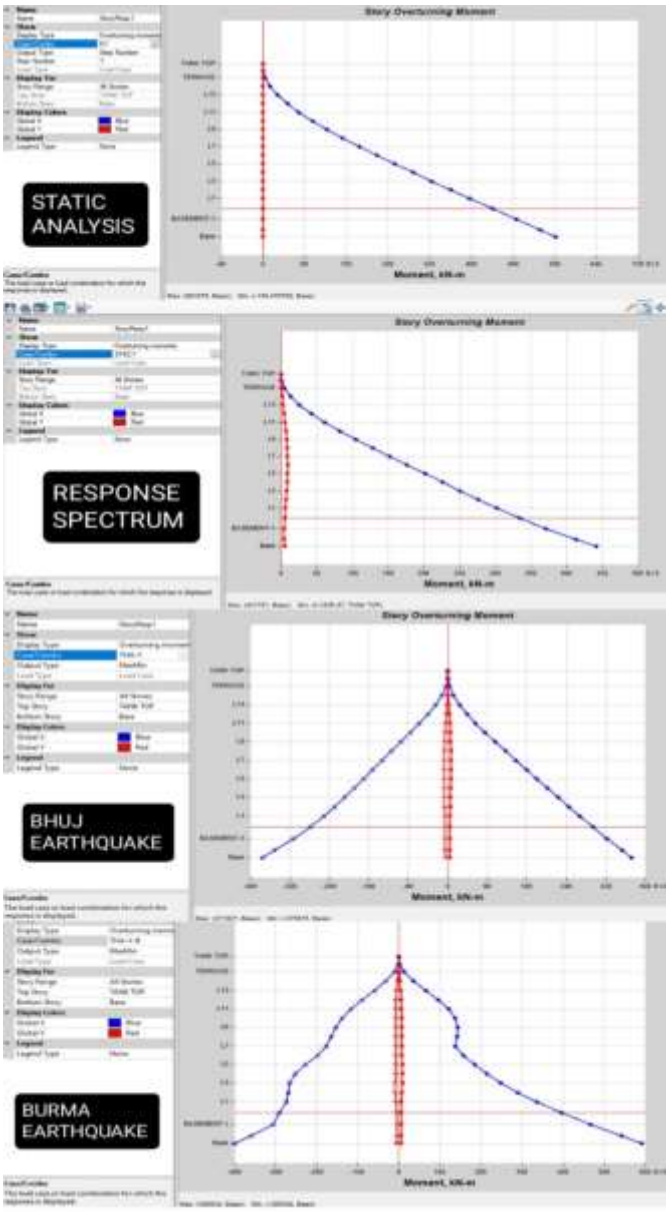

Fig -6: Overturning Moment in Y direction

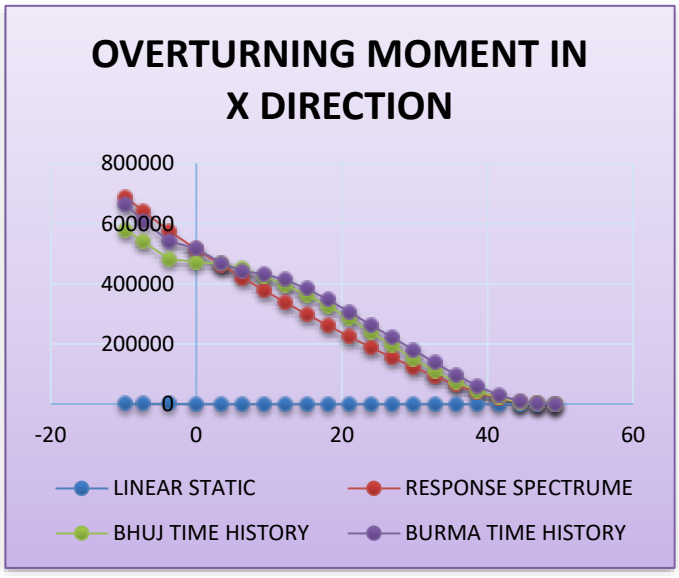

Chart -5: Overturning Moment in X direction

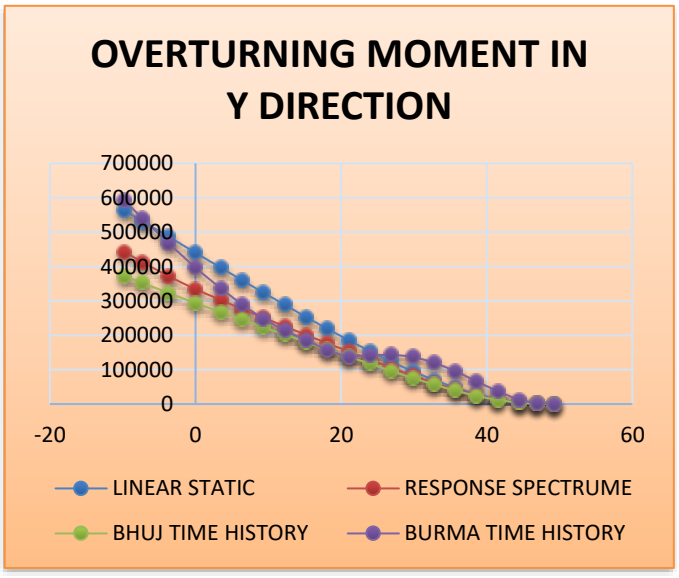

Chart -6: Overturning Moment in Y direction

Table -2: Results of analysis.

Linear Static	Response Spectrume	Bhuj Earthquake	Burma Earthquake
Fig. -1 Displcement in X direction			
200.396 mm	153.033 mm	165.867 mm	143.442 mm
Fig. -2 Displcement in Y direction			
56.565 mm	43.277 mm	38.073 mm	53.721 mm
Fig. -3 Storey Drift in X direction			
0.004704	0.003866	0.005349	0.004858
Fig. -4 Storey Drift in Y direction			
0.001262	0.001101	0.00107	0.001472
Fig. -5 Overturning Moment in X direction			
192.0386 KN.m	688404 KN.m	578803 KN.m	664521 KN.m
Fig. -6 Overturning Moment in Y direction			
561675 KN.m	441781 KN.m	371827 KN.m	590934 KN.m

3. CONCLUSIONS

The results indicate that Time History Analysis using Bhuj and Burma earthquake records provides a more realistic structural response compared to Linear Static and Response Spectrum methods, as it considers actual ground motion variation with time.

For the Bhuj earthquake record, displacement in the X-direction is about 17% lower than static analysis but 8% higher than response spectrum, while in the Y-direction it is about 33% lower than static and 12% lower than response spectrum. Storey drift in the X-direction is slightly higher (about 14% more than static and 38% more than response spectrum), whereas in the Y-direction it is about 15% lower than static and nearly equal to response spectrum. Overturning moment in the X-direction is significantly higher than static but about 16% lower than response spectrum, while in the Y-direction it is about 34% lower than static and 16% lower than response spectrum.

For the Burma earthquake record, displacement in the X-direction is reduced by about 28% compared to static and 6% compared to response spectrum, while in the Y-direction it is nearly equal to static but about 24% higher than response spectrum. Storey drift in the X-direction increases slightly (about 3% more than static and 26% more than response spectrum), and in the Y-direction it increases by about 17% compared to static and 34% compared to response spectrum. Overturning moment in the X-direction is much higher than static and nearly equal to response spectrum, while in the Y-direction it is about 5% higher than static and 34% higher than response spectrum.

Overall, Time History Analysis captures the actual seismic behaviour more effectively and shows variations in structural response that are not reflected in static or response spectrum methods. Therefore, it is recommended for detailed and safer seismic design of multi-storey buildings.

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