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Structural Response and Stability Analysis for Highrise Building in ETABS

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Abstract - This research presents ETABS-based structural analysis of a G+21 non-uniform high-rise RC building. The study includes modal analysis, response spectrum, P-Delta effects, wind gust calculations, eccentricity, torsional checks, storey drift, overturning checks, time history and column verification in compliance with IS codes. The document includes generated figures and tables created from the numerical results available in the project file. All results satisfy codal criteria.

***Key Words*:** ETABS, high-rise, seismic analysis, modal participation, Time history

1.INTRODUCTION

Time history analysis is used to evaluate the response of structures under time-varying loads such as earthquakes. In ETABS, it applies ground motion records to determine displacement, acceleration, and forces at each time step. The software also provides plot functions, such as time vs. displacement and time vs. acceleration graphs, to clearly visualize the structural response over time.

2. METHODOLOGY

The structural model is developed and analyzed using ETABS. Time history analysis is performed by applying suitable ground motion records to evaluate the dynamic response of the building.

The methodology includes the following steps:

1. **Modeling of Structure**: The building geometry, material properties, section details, and load conditions are defined in ETABS.
2. **Definition of Time History Function**: Earthquake ground motion data (acceleration vs. time) is input and assigned to the model.
3. **Load Case Setup**: Time history load cases are defined with appropriate damping and analysis parameters.
4. **Analysis Execution**: The model is analyzed to obtain the response at each time step.
5. **Result Extraction**: Key response parameters are evaluated, including:
   - **Overturning Moment** at the base to assess global stability
   - **Storey Displacement** to measure lateral movement at each floor
   - **Storey Drift** to evaluate inter-storey deformation
6. **Graphical Evaluation**: ETABS plot functions are used to generate time history graphs for displacement, drift, and overturning moment to understand variation with time.

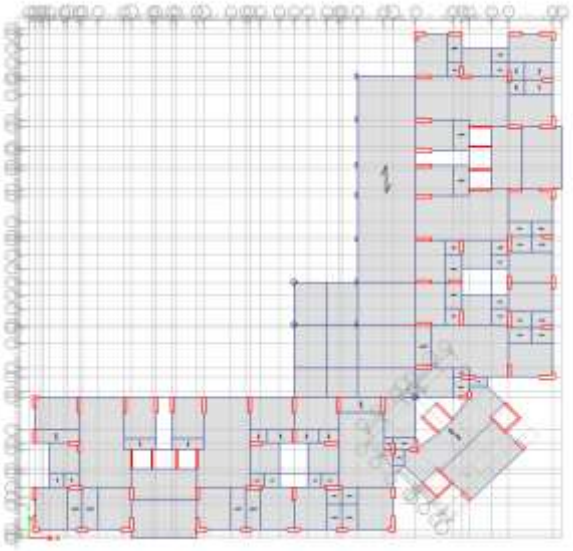

Fig -1: Figure of typical floor

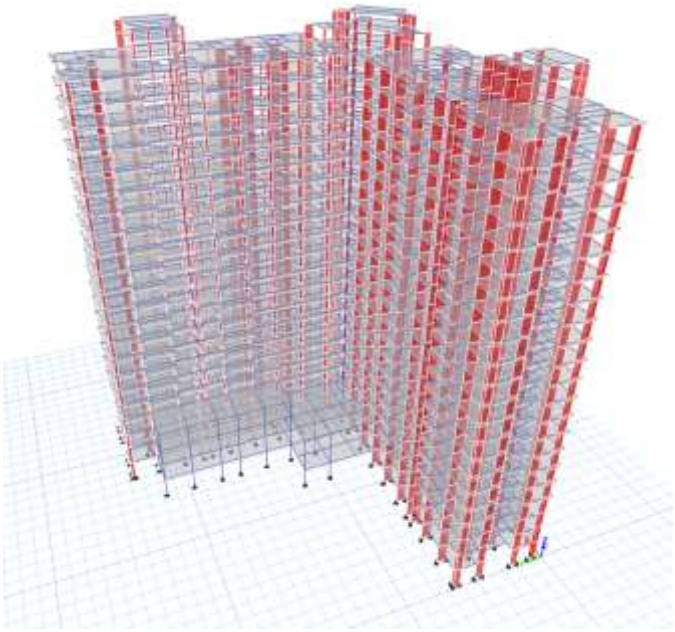

Fig -2: Figure of ETAB 3-D modal

3. TIME HISTORY

Time history refers to how **loads and structural responses vary with time**, especially during events like earthquakes.

3.1 Bhuj (INDIA):

The **Bhuj earthquake (2001, magnitude Mw 7.7)** time history represents the variation of ground acceleration with time during the event, characterized by strong shaking lasting about 80–90 seconds with peak ground acceleration up to ~0.3–0.4 g near the epicenter, and is widely used for dynamic structural analysis.

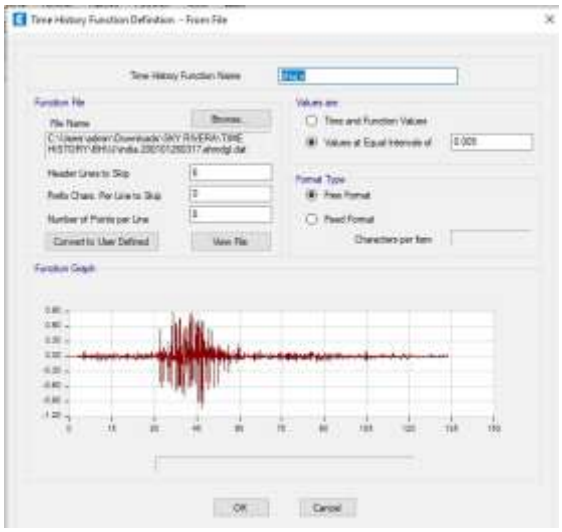

Fig -3: Figure of Magnitude of Bhuj X

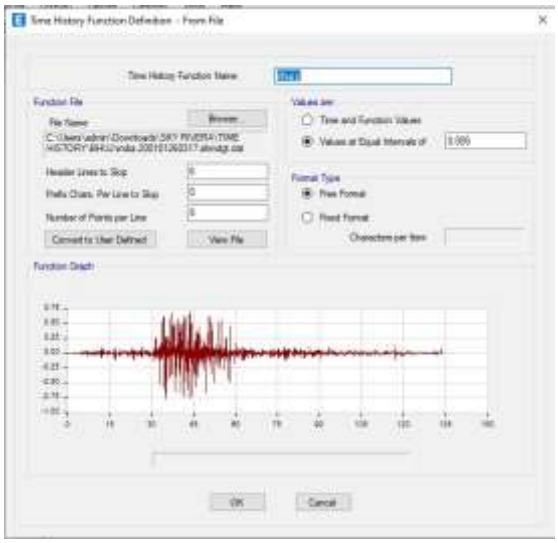

Fig -4: Figure of Magnitude of Bhuj Y

3.1.1. Overturning Moment:

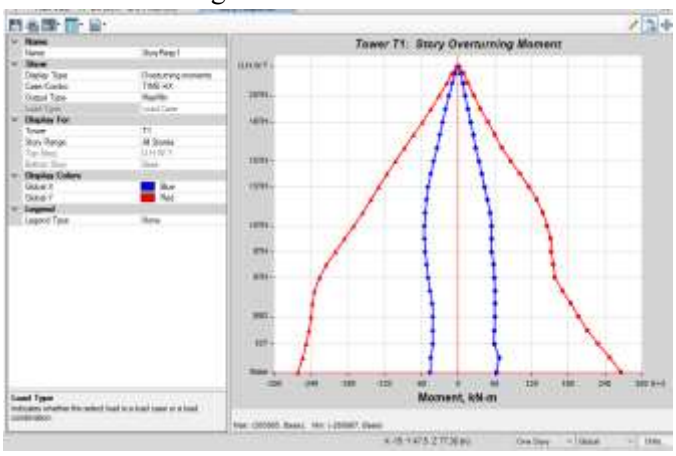

Fig -5: Figure of Overturning Moment THX

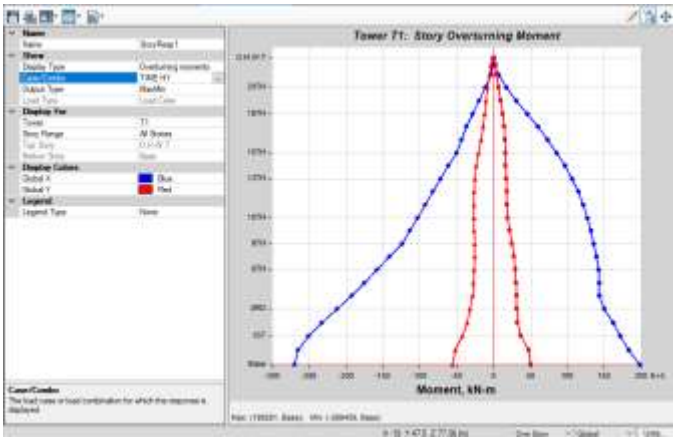

Fig -6: Figure of Overturning Moment THY

3.1.2. Storey Drift:

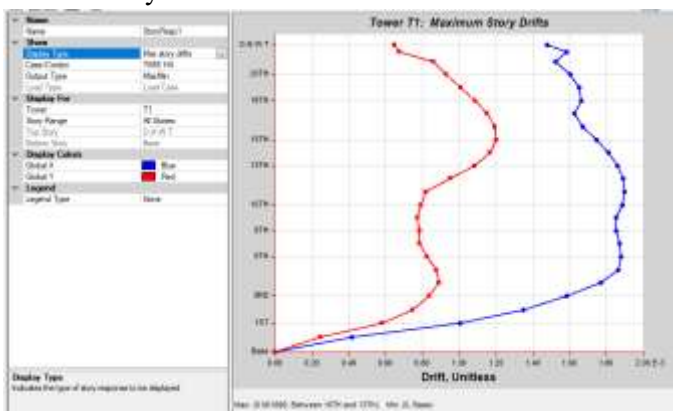

Fig -7: Figure of Storey Drift THX

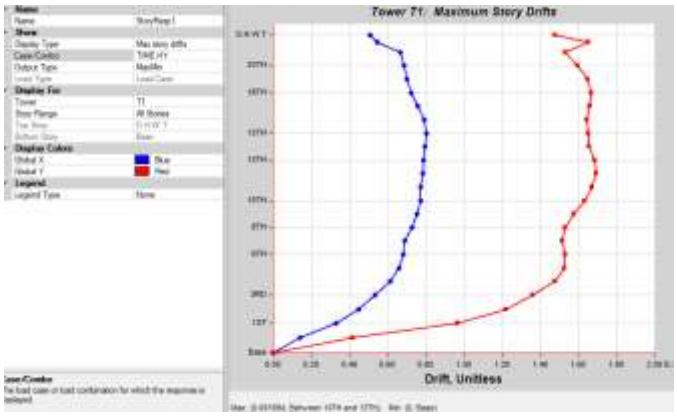

Fig -8: Figure of Storey Drift THY

3.1.3. Storey Displacement:

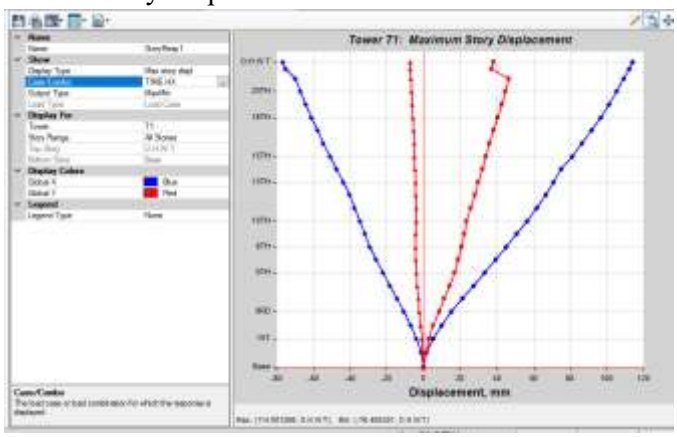

Fig -9: Figure of Storey Displacement THX

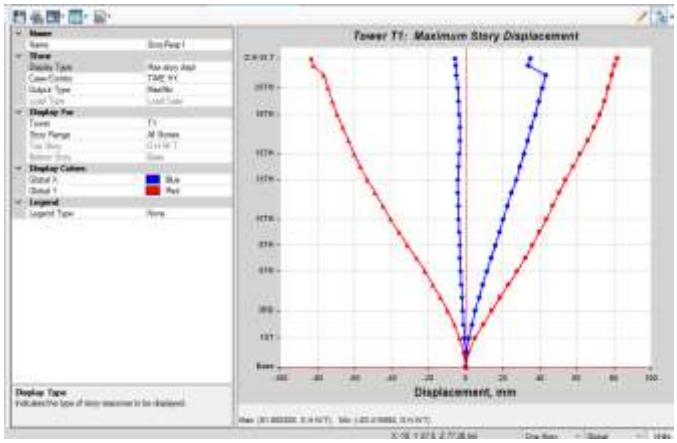

Fig -10: Figure of Storey Displacement THY

Table-1: Plot Function Of Bhuj

	Max X	Min X	Max Y	Min Y
Overturning moment	265865	-260987	198261	-269456
Storey drift	0.0018	0	0	0.001694
Storey displacement	114.081	-76.49	81.00	-83.415

3.2 El-Centro (CHINA):

"The El Centro earthquake (1940), with a magnitude of about 6.9, provides one of the earliest and most widely used ground motion time history records, showing peak ground acceleration of approximately 0.34 g and a strong shaking duration of around 10–15 seconds."

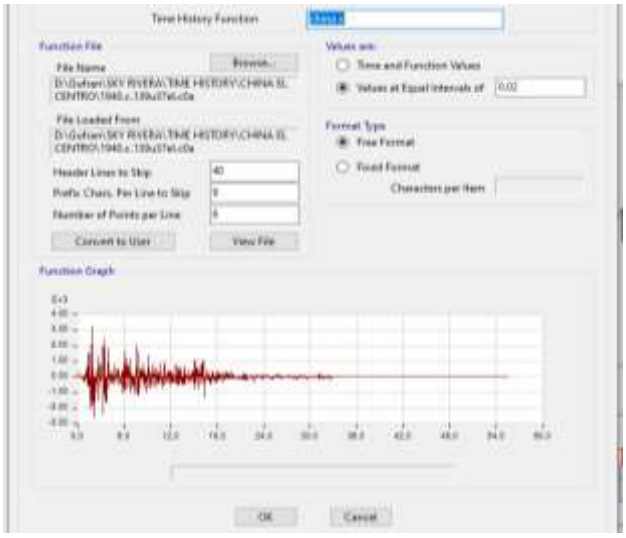

Fig -11: Figure of Magnitude of El-Centro X

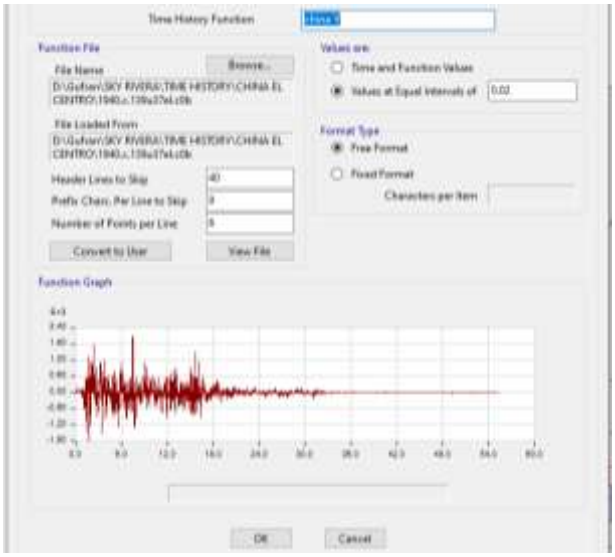

Fig -12: Figure of Magnitude of El-Centro Y

3.2.1. Overturning Moment:

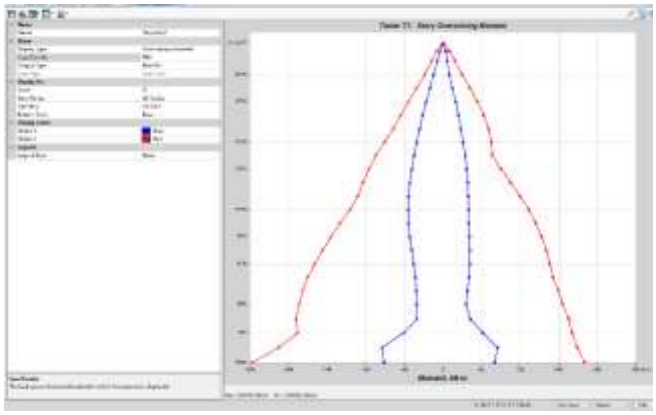

Fig -13: Figure of Overturning Moment THX

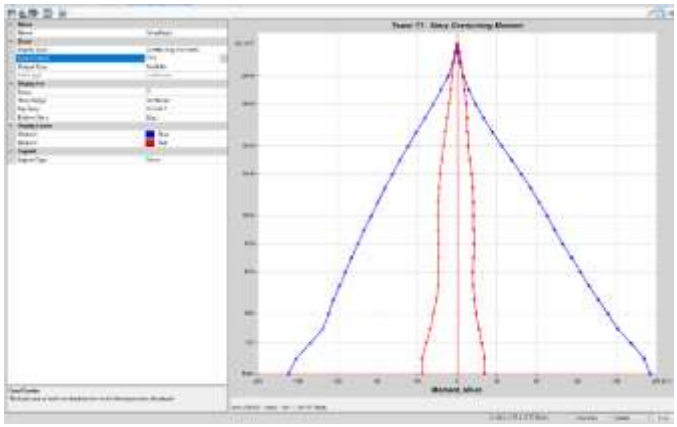

Fig -14: Figure of Overturning Moment THY

3.2.2. Storey Drift:

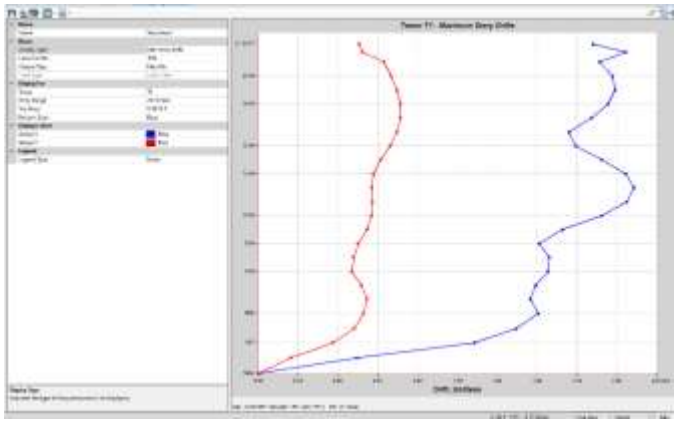

Fig -15: Figure of Storey Drift THX

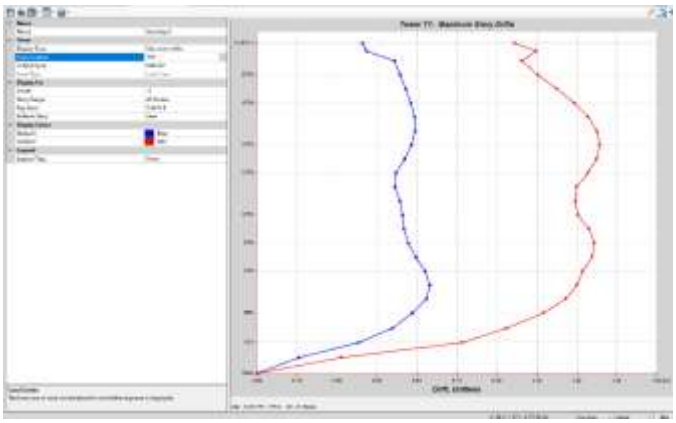

Fig -16: Figure of Storey Drift THY

3.2.3. Storey Displacement:

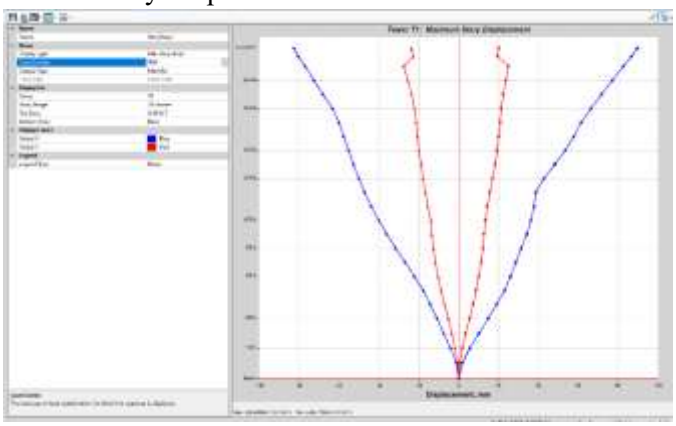

Fig -17: Figure of Storey Displacement THX

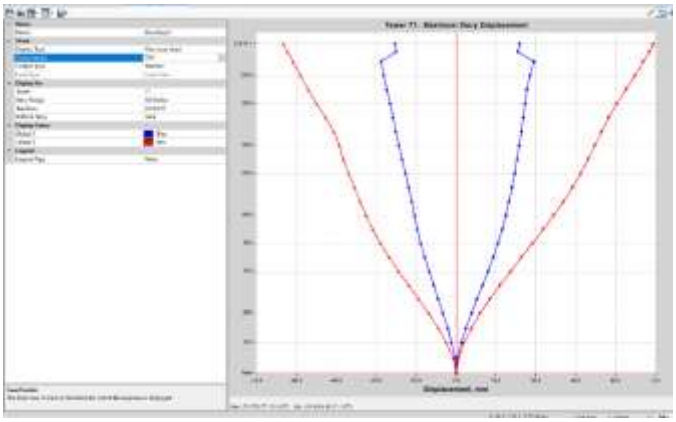

Fig -18: Figure of Storey Displacement THY

Table-2: Plot Function of El-Centro

	Max X	Min X	Max Y	Min Y
Overturning moment	220160	-296583	193631	-169127
Storey drift	0.0018	0	0	0.0012
Storey displacement	89.49	-82.71	74.23	-64.94

4. CONCLUSIONS

Time history analysis using earthquakes like the El Centro, Bhuj, Nongstion, and Burma border records helps us understand how buildings behave during real shaking. From the graphs, the overturning moment increases sharply during strong shaking and is maximum at the base. The storey drift is higher in middle storeys and must be controlled for safety. The storey displacement increases from bottom to top, with maximum displacement at the top floor. Among these, stronger earthquakes like Bhuj generally produce higher responses compared to El Centro. Overall, time history analysis shows that building response changes with time and is very important for safe earthquake-resistant design.

ACKNOWLEDGEMENT

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