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Comparative Study of Time History Analysis of Multistorey Steel & RCC Buildings

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Abstract- The study will investigate the effectiveness of different lateral force-resisting systems, such as shear walls, bracing systems, and damping systems, to improve the seismic performance of the buildings. The findings will provide recommendations for selecting appropriate structural elements and retrofitting strategies to enhance the seismic performance of multistorey steel and RCC buildings. The study's probable implications include improved seismic performance, cost-effective design, safer buildings, compliance with building codes, and contribution to research. Overall, the proposed work will contribute to the development of a comprehensive understanding of the behavior of multistorey steel and RCC buildings under seismic loading conditions and provide valuable insights for the design and retrofitting of buildings to improve their seismic performance.

Keywords- Multi-Storey Building, Non-Linear Seismic Analysis, Time History Method and ETABS.

I. INTRODUCTION

It is an important part of our community, providing real estate, shelter, work and play. It is designed and manufactured to withstand a variety of loads, including gravity, wind, earthquakes and other forces of nature.

To ensure the safety and integrity of buildings, designers use analytical tools to evaluate how the building will behave in different situations. Two popular materials used to construct high-rise buildings are steel and reinforced concrete (RCC). However, the behavior of these structures under dynamic loading conditions such as earthquakes is complex and should be analyzed in detail. Time history analysis (THA) is a powerful tool for simulating and predicting the response of structures to seismic events. In this study, we will compare the THA results of various steel buildings and RCC buildings to evaluate their structural performance under seismic loading.

1. Behavior Spectrum Analysis:

Behavior Spectrum Analysis is a widely used method to evaluate the seismic behavior of various buildings. The process takes into account the building's response to a range of ground motion intensities at different times. It includes the following steps:

- Soil Selection: Select appropriate ground data representing different seismic scenarios based on the location and design of the project.
- Generating a Response Spectrum: Converting ground motion into a response spectrum that describes the maximum response over time (for example, acceleration, velocity, or displacement).
- Modal Superposition: Combine the response spectra for each vibration mode using the modal superposition technique to determine the overall response of the building.
- **Evaluation of Design Patterns:** The results of the behavior spectrum analysis are compared with the design standards and design standards specified in the building code to ensure the safety and security standards of the house.

II. LITERATURE REVIEW

Studies by Xu et al. "Seismic Behavior Analysis of Long Steel Frame Structures". (2019) performed a THA analysis of a 50-storey steel framed building under different seismic loads. This study evaluated the effectiveness of different methods, including braces, shear walls and damping devices, in reducing the effects of seismic loads. The results show that braces and shear walls reduce the movement of the building, while the damping material reduces acceleration and response.

In another study, Yoon et al. (2018) performed a THA analysis of a 50-storey reinforced concrete building with different systems, including shear walls, connecting walls and buttress systems. Studies have shown that continuous walls and beams reduce the motion and acceleration response of the building, while the shear wall reduces the acceleration response.

Giri et al. (2017) presents a THA analysis of a 10-storey shear wall reinforcement building under varying seismic loads.This study evaluates the effectiveness of shear walls in reducing lateral movement and dynamic response of buildings. The results show that shear walls reduce the lateral displacement and acceleration response of the building.

Memon et al. (2019) provides a comparative review of the seismic behavior of steel and concrete. This study evaluated the effectiveness of different systems in two types of buildings, including braces, sections and shear walls.The results show that steel buildings outperform concrete buildings under seismic loading conditions.

Kurniawan et al. (2020) provides a comparative THA analysis of reinforced concrete structures with and without shear wall under different seismic loading conditions. This study evaluates the effectiveness of shear walls in reducing lateral movement and dynamic response of buildings. The results show that the presence of shear walls reduces the lateral displacement and acceleration response of the building.

III. METHODOLOGY

The following models are considered for the RCC building:

- Model I: RCC Building without any lateral load resisting elements
- Model II: RCC Building with X Brace at Core area.
- Model III: RCC Building with Shear Wall at Core area.
- Model IV: RCC Building with Shear Wall at outside.
- Model V: RCC Building with X braces at outside.
- Model VI: RCC Building with Shear Wall at corner.
- Model VII: RCC Building with X brace at corner.

The following model parameters are considered for the RCC building

Table 1. Analysis data for example RCC building.

Plane dimensions	12x12 m
Total height of building	91 m
Height of each storey	3m
Height of parapet	1m
Depth of foundation	1.5m
Size of beams	300x450mm
Size of brace	300x300mm
size of columns	500x500mm
Thickness of slab	125 mm
Thickness of external walls	230 mm
Thickness of internal walls	115mm
Thickness of shear wall	230mm
Seismic zone	IV
Soil condition	Hard
Response reduction factor	5
Importance factor	1
Floor finishes	1.5 kN/m^2
Live load at all floors	3 kN/m^2
Grade of Concrete	M25
Grade of Steel	Fe500
Density of Concrete	25 kN/m^3
Density of brick masonry	20 kN/m^3

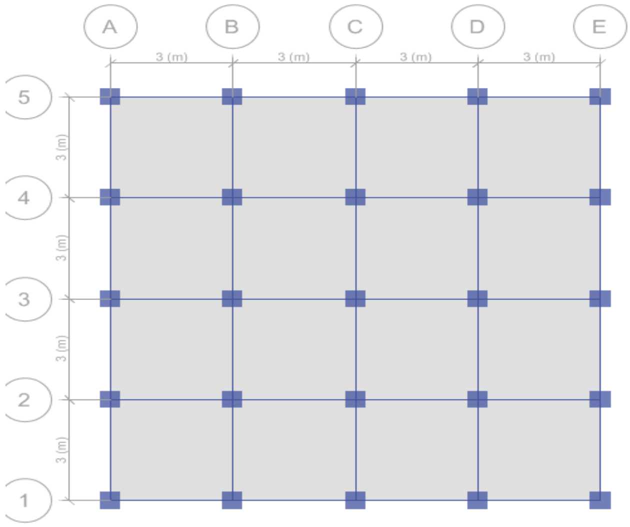

Fig 2. Plan of building.

The above figure shows the plan of the RCC building as per ETABS software

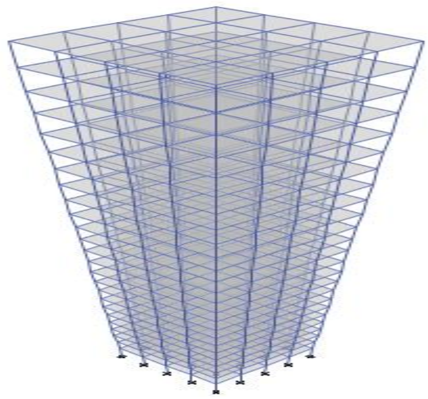

Fig 3. 3D Model of building generated in ETABS.

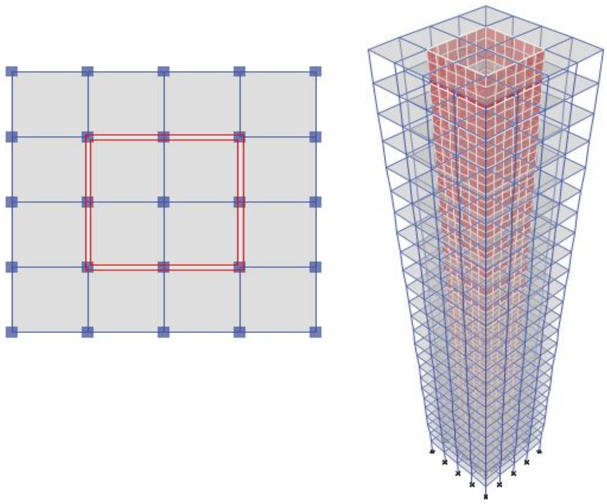

Fig 4. Model III- RCC Building with Shear Wall at Core area.

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The above figure shows Model III- RCC Building with Shear Wall at Core area.as per ETABS software.

IV. RESULTS

The results are obtained for the all models in case of RCC building and steel buildings. The comparison is carried out in the terms of lateral displacement, storey drift, and time period and storey stiffness.

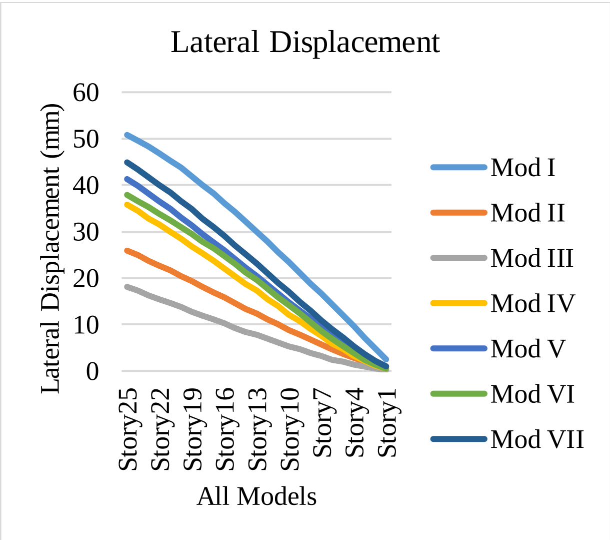

Fig 4. Lateral Displacement for RCC building.

The above figure shows the Lateral Displacement for RCC building, the maximum displacement is observed for the model-I while the minimum displacement is observed in the case of model-III.

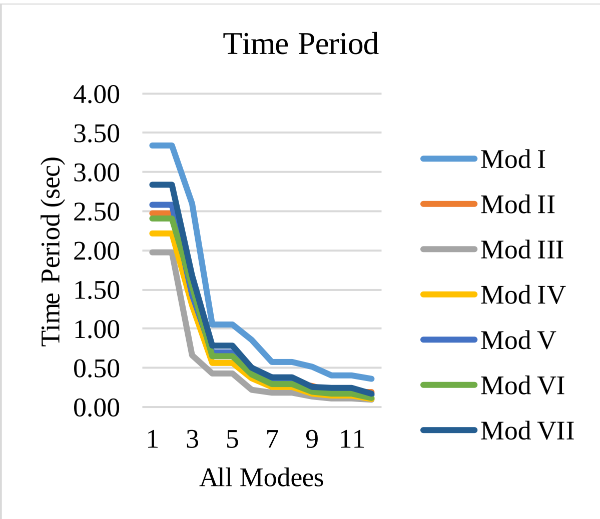

Fig 5. Time Period for RCC building.

The above figure shows the Time Period for RCC building, the maximum Time Period is observed for the mode-1 while the minimum Time Period is observed in the case of model-12.

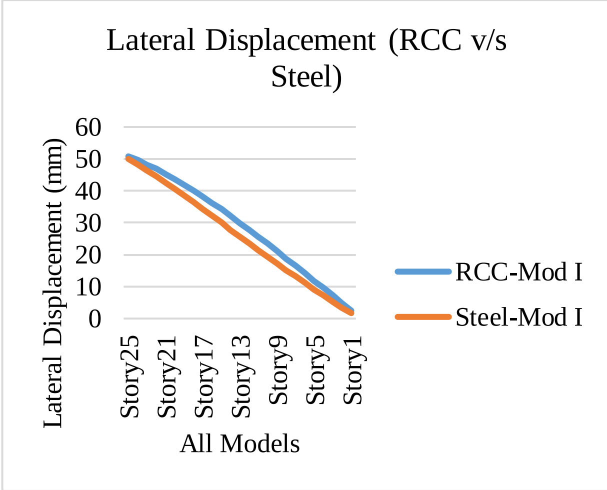

Fig 6. Comparison of lateral displacement for the RCC building and steel building.

The above figure shows the Comparison of lateral displacement for the RCC building and steel building, the maximum lateral displacement is observed for the model-I (RCC building) while the minimum lateral displacement is observed in the case of model-I (Steel building).

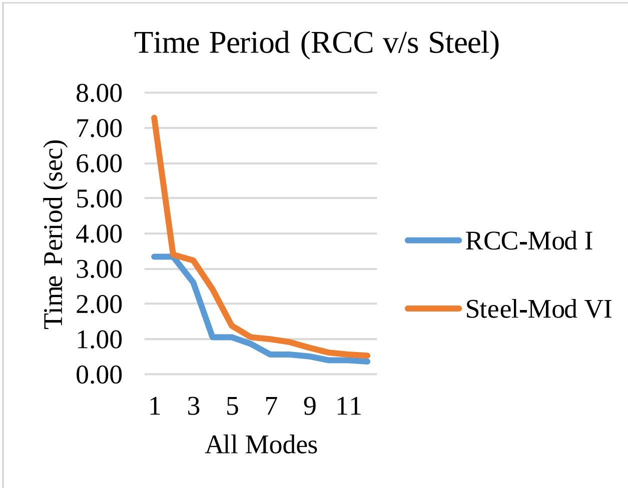

Fig 7. Comparison of Time Period for the RCC building and steel building.

The above figure shows the Comparison of Time Period for the RCC building and steel building, the maximum Time Period is observed for the model-VI (Steel building) while the minimum Time Period is observed in the case of model-I (RCC building).

V. CONCLUSIONS

The following conclusions are obtained
When comparing only RCC buildings, the maximum displacement is observed for the Model I: RCC Building without any lateral load resisting elements while the minimum displacement is observed in the case of Model III: RCC Building with Shear Wall at Core area.

When comparing only RCC buildings, the maximum Storey Shear is observed for the Model IV: RCC Building with Shear Wall at outside while the minimum Storey Shear is observed in the case of Model I: RCC Building without any lateral load resisting elements.

When comparing only steel buildings, the maximum Lateral Displacement is observed for the Model VI: steel Building with steel plate Shear Wall at corner while the minimum Lateral Displacement is observed in the case of Model III: Steel Building with steel plate Shear Wall at Core area.

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