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STUDY ON STRUCTURAL RESPONSE OF A 35-STOREY BUILDING UNDER DIFFERENT LOAD COMBINATIONS WITH AND WITHOUT SEISMIC EFFECTS USING STAAD PRO

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Abstract: In this research we have analyzed structure with the different floor numbers for blast & seismic loading This research presents a detailed comparative study on the structural response of a 35-storey (G+34) reinforced concrete residential building analyzed with and without seismic load combinations using STAAD Pro software. The building is modeled as a fixed jointed multi-storey frame and analyzed as per relevant Indian Standards, including IS 456:2000, IS 875 (Parts 1–3), and IS 1893 (Part 1):2002 for Zone V seismic conditions. Structural parameters such as displacements, bending moments, shear forces, axial forces are evaluated under different load combinations. The results indicate that the inclusion of seismic loads significantly increases lateral displacement, axial forces in columns, and bending moments in beams, particularly in lower storeys and corner structural members. Seismic load combinations govern the design of critical elements, leading to higher reinforcement requirements compared to non-seismic cases.
Keywords: Staad Pro, Axial Force, Displacement, Shear Force.

I. INTRODUCTION

High-rise buildings are becoming increasingly common in urban areas, providing efficient use of limited space and accommodating growing populations. However, their structural design and performance become critical factors to ensure the safety of occupants, particularly under seismic events. Earthquakes can exert significant forces on buildings, causing structural damage and compromising their stability.

Seismic design provisions and load combinations are essential in ensuring the structural integrity of high-rise buildings. These provisions consider the effects of lateral forces generated by seismic activity and aim to minimize structural damage and protect human life during an earthquake. It is crucial to evaluate the performance of buildings under different loading conditions, including seismic load combinations, to ensure they meet safety standards and codes.

STAAD Pro is a widely used software program for structural analysis and design in the engineering industry. It provides engineers with the necessary tools to model, analyze, and optimize structures. By utilizing STAAD Pro, engineers can simulate various loading conditions, including seismic loads, and assess the response and stability of the building.

This comparative study aims to evaluate the structural behavior of a 35-storey building using STAAD Pro under two scenarios: with and without seismic load combinations. By comparing the results obtained from both cases, the study seeks to determine the significance of seismic design provisions and the impact they have on the structural performance of the building. The findings of this research will contribute to the understanding of the importance of incorporating seismic load combinations in the design process of high-rise buildings and aid in improving their safety and resilience.

(shock waves) and try to reduce the amount of damages to the people and the structure itself.

II.OBJECTIVE OF STUDY

- The primary objectives of this comparative study of a 35-storey building with and without seismic load combination, using STAAD Pro, are as follows:
- To analyze and model a 35-storey building using STAAD Pro software, considering its geometrical specifications, material properties, and structural components.
- To simulate and analyze the structural behavior of the building under non-seismic load combinations, such as dead loads and live loads, using STAAD Pro.
- To simulate and analyze the structural behavior of the building under seismic load combinations, incorporating lateral forces generated by seismic activity, using STAAD Pro.
- To compare and evaluate the structural response of the building under non-seismic load combinations and

seismic load combinations, focusing on parameters such as displacements, member forces, and stresses.

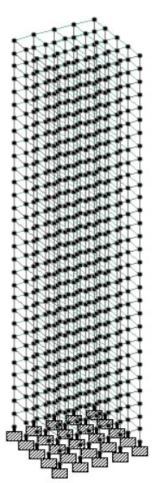
- To identify and analyze the critical areas within the building that are most affected by seismic load combinations, assessing their vulnerability and potential structural weaknesses.
- To assess the compliance of the building's structural response with established seismic design provisions and safety codes.
- To provide recommendations and insights into the importance of incorporating seismic load combinations in the design process of 35-storey buildings, based on the findings of the study.

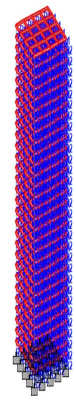
III. METHODOLOGY & MODELLING APPROACH

3.1 Building Description and Specifications :

- Utility of building: Residential building
- Type of structure -multi-storey fixed jointed plane frame.
- Number of stories 35, (G+34)
- Floor height 3.5m
- No of bays and bay length 4 nos,5 m each.
- Materials Concrete (M 35) and Reinforcement (Fe500).
- Size of column 0.8m×0.8m.
- Size of beam 0.45m×0.45m
- Depth of slab 125mm thick
- Specific weight of RCC 25 KN/m^3
- Specific weight of in fill 19.2 KN/m^3
- Type of soil medium soil.
- Response spectra as per IS 1893.
- Seismic zone V (IS1893 (part1):2002)

3.2 Modelling





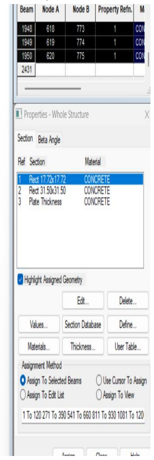


FIG.3.1 (Modelling of structure)
FIG.3.2 (Properties of element)

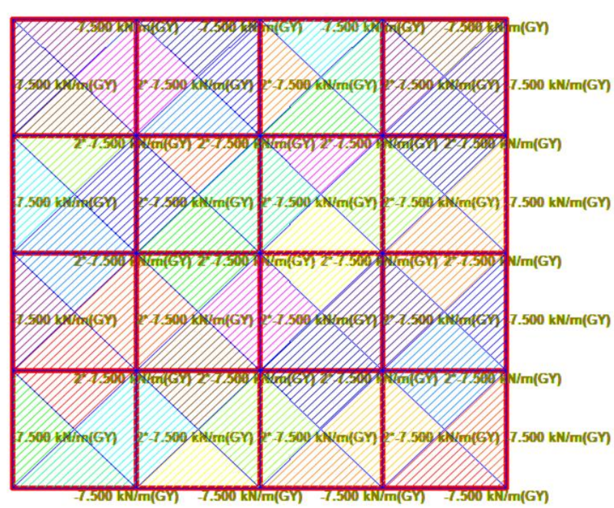
3.3 LOAD COMBINATION

For seismic load analysis of a building the code refers following load combination.

- 1.5 (DL+ IL)
- 1.2 (DL+IL±EL)
- 1.5 (DL±EL)
- 0.9 DL±1.5EL

- For wind load analysis of a building the code refers following load combination.
  - DL+LL
  - DL+WL
    DL+0.8LL+0.8WL

Both WL and EL are applied in X and Z direction. These loads are also applied further in negative X and Z direction. So for Seismic analysis there are 18 load combinations and for Wind load analysis there are 11 load combinations



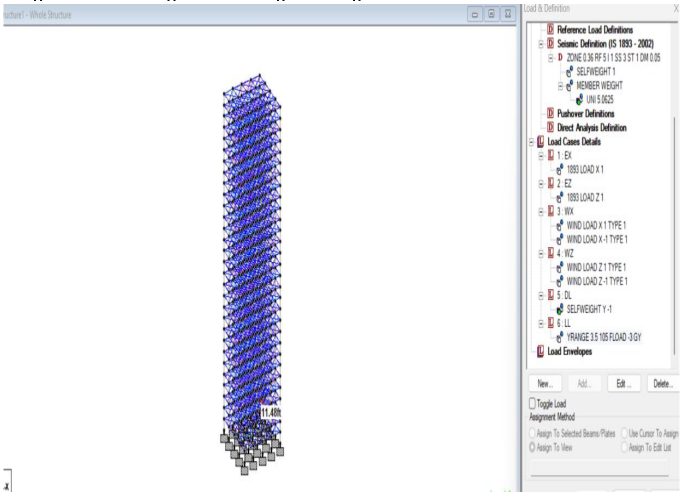
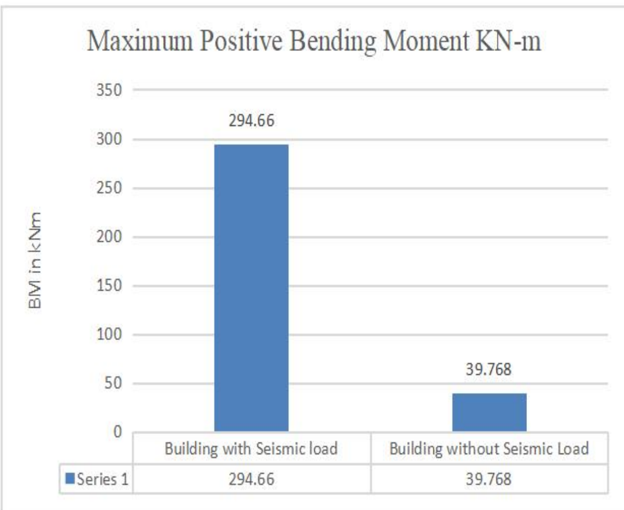


FIG.3.3 (Live load assigning on structure)

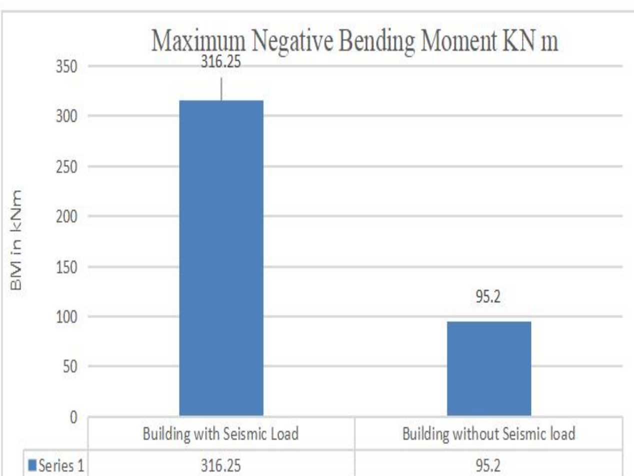
FIG.3.4 (Load combination on structure)

IV.RESULT AND DISCUSSION

4.1 Bending Moment:

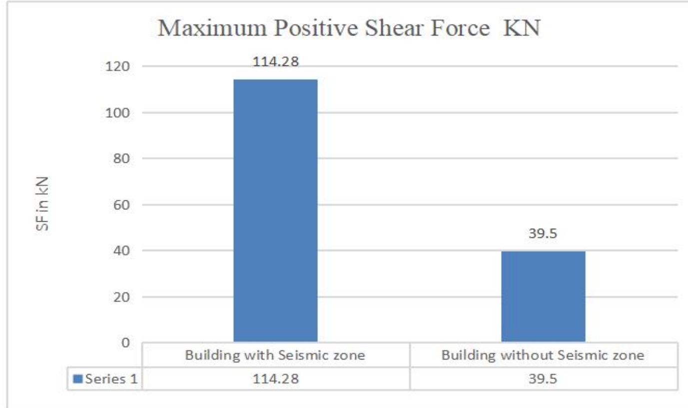


Graph 4.1 Maximum Positive Bending Moment

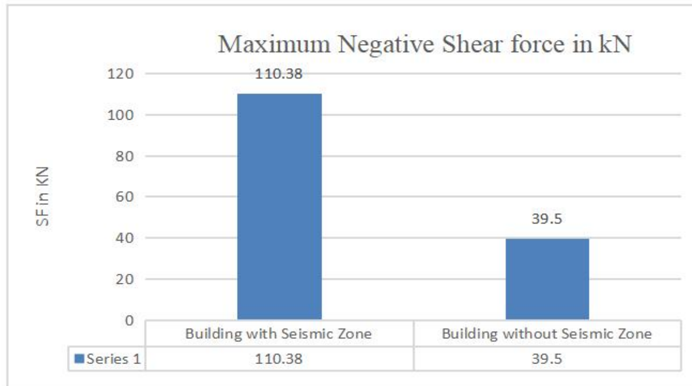


Graph 4.2 Maximum negative bending moment

4.2 Shear Force

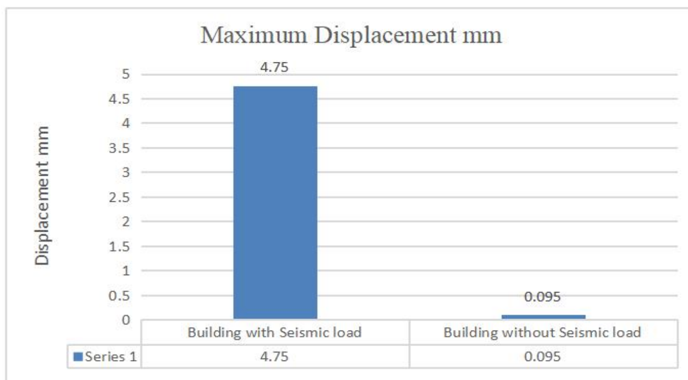


Graph 4.3 Maximum positive shear force



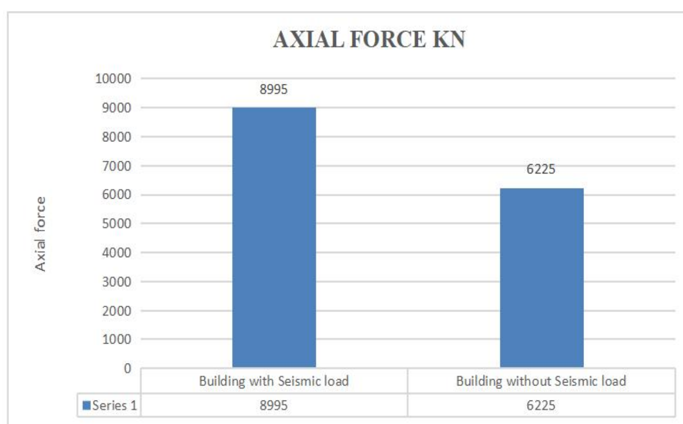
Graph 4.4 Maximum negative shear force

4.3 Displacement



Graph 4.5 Maximum displacement

4.4 Axial Force



Graph 4.6 Axial force in column

V. CONCLUSION

Based on the results obtained from the structural analysis and discussion of a 35-storey reinforced concrete building with and without seismic load combinations, the following conclusions are drawn:

1. The inclusion of seismic load combinations significantly influences the overall structural behavior of the building, particularly in terms of lateral displacement, bending moments, shear forces, and axial forces.
2. Maximum bending moments and shear forces in beams are observed to increase under seismic loading conditions, especially in lower storeys and edge beams, indicating that seismic forces govern beam design in high-rise structures.
3. Columns experience a substantial increase in axial forces when seismic loads are considered, highlighting the critical role of columns as primary vertical and lateral load-resisting elements.
4. Lateral displacement of the structure increases considerably under seismic load combinations compared to non-seismic cases, emphasizing the necessity of seismic analysis to control drift and ensure serviceability and stability.

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