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Analysis and Design of Multistorey Residential Building with Response Spectrum Analysis Using SAP2000

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Abstract: The principle objective of this project is to analysis and design a multi-storeyed building [G + 10 (3-dimensional frame)] using SAP2000. The design involves load calculations manually and analyzing the whole structure by SAP2000. The design methods used in SAP2000 analysis are conforming to Indian Standard Code of Practice and features a state-of-the-art user inter face, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification. The project is designed in accordance with Indian codes, considering various loads such as Reinforced concrete (IS 456-2000), dead load (IS875-1987 part1), live load (IS875-1987 part2), wind load (IS875-1987 part3), seismic load (IS1893-2016 part1) and load combinations are considered as per the (IS875-1987 part-5) codebooks. The analysis considers seismic zone III and ensures safety by considering dead load, liveload, seismic and wind forces, and balancing economy and safety. Structural design is crucial for Civil Engineers, and proper analysis can prevent structure failure and loss of life. Engineers analyze structures considering constraints like serviceability and deformability, following IS codes. Our project focuses on analyzing and designing superstructures like slabs, beams, and columns, considering dead load, live load, seismic and wind forces Response Spectrum Analysis and Shear Wall. The analysis parameters such as shear force, bending moment, and displacement.

KEYWORDS: Response Spectrum Analysis, Shear Wall, SAP2000, Seismic and Wind loads.

II INTRODUCTION

The multistorey buildings is used to designing for building allows the use of land and reduce the space. The Response Spectrum Analysis used to evaluate the dynamic effect of ground motions and using the SAP2000 Software. To analysis and design a multi-storeyed building [G + 10 (3-dimensional frame)] using SAP2000.

Design considerations include ensuring adequate strength, stiffness, and stability to resist gravity and lateral loads.

As the population grows, more integrated tools are used for multistory buildings, absorbing surface phenomena. Dynamic analysis methods like time history and response spectrum method are used for seismic analysis. Structural design is crucial for earthquake resistance, considering height and lateral forces like seismic and wind, Shear Wall.

II USING CODES AND STANDARDS

- IS 456-2000 code of Practice for Plain and Reinforced Concrete - For design of any structural member (slab, beam, column, footing, staircase).
- IS 875 code of Practice for design of loads - This code is generally used to design the loads (dead load, live load, wind load) acting on the structure.
- IS 875 part 1 refers detailed design about deadload.
- IS 875 part 2 refers detailed design about live load.
- IS 875 part 3 refers detailed design about wind load.
- IS 1893-2002 refers detailed design about seismic load.
- IS 875 part 5 refers detailed design about load combinations
- IS 1893- 2016 refers to Response Spectrum Analysis.

III SEISMIC ZONES

The Geological Survey of India (G. S. I.) published a seismic zoning map of India in 1935, identifying four distinct seismic zones. The map, color-coded in red, shows the seismic activity of different regions of India, ranging from Zone II to Zone V. The seismic zone is crucial for calculating probabilistic ground motions and determining the destruction of structures. The map prominently displays the diverse seismic zones of the nation.

- Zone - II: Seismic Intensity =0.10
- Zone- III: Seismic Intensity =0.16.
- Zone - IV: Seismic Intensity=0.24.
- Zone - V: Seismic Intensity=0.36.

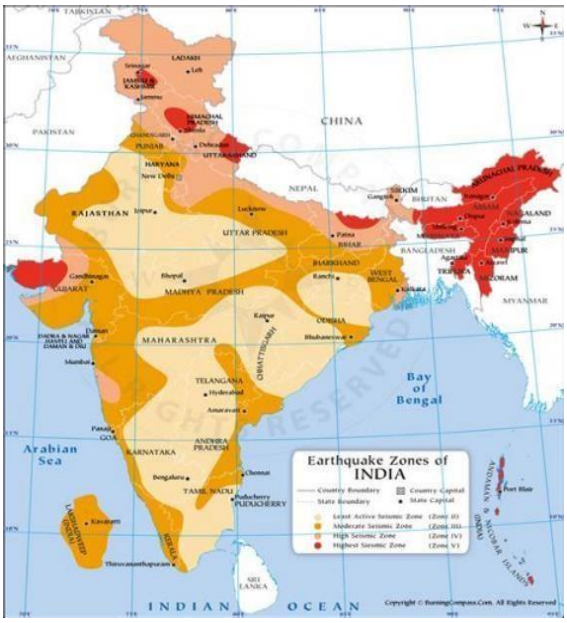

Figure-1: Seismic zone representation on Indian Map

IV PROBLEMIDENTIFICATION

1. Tall buildings is widely influenced by seismic and wind loads, requiring careful consideration for safety, strength,and stiffness.
2. The structures failures due to seismic waves and wind forces of the multistorey building

V OBJECTIVES OF WORK

Analysis and Design the multi-story residential building by using SAP2000 which includes:

- To find the behaviour of the building structure subjected to sudden loads due to earthquakes forces.
- To study about the loads and response spectrum analysis on the building.
- To check and design of the response spectrum analysis of the multi storey building.

VI SCOPE OF STUDY

To Study of the multistorey buildings to resist the Earthquakes. And the building to protect the seismics and wind forces to the earthquake resistance.

VII PROPERTIES OF THE MATERIALS

Grade of concrete for slab, beam, column:M30
Column Sizes = 300X500mm
Beam Size = 230X450mm
Slab thickness = 150mm
Shear Wall = 230mm
Number of Stories = 10
Dead load = 4.2kN/m2
Live load = 3kN/m2

VIII IDESIGN PROCEDURE

Step-1: Create a plan in AUTOCAD. select blank page and import plan from AUTOCAD to SAP2000.

Step-2: Select the full center line plan then go to edit, click on edit lines and select divide frames and then click on break then it will be applied.

Step-3: Select joints, go to edit click on extrude then click on linear and give distance, direction, number and then clickon ok.

Step-4: Then select the first floor and copy and paste them to the above floors by specifying the distance in specific direction.

Step-5: Add slabs drawing a rectangular area and selecting each part of the plan parts. Then go the display option on the top, click on general then go to view type and click on extrude then the slab will be applied.

Step-6: Select the first floor and go to edit then click on replicate and give number in direction and click on ok.

Step-7: Now we must go to assign select joints, click on restraints, selectfixed and it will be applied.

Step-8: Do the load calculations. After that select the external walls and give the loads by selecting assign and then click on frame loads then go to distributed and apply the loads.

Step-9: Now select the internal walls and apply the loads in the same procedure.

Step-10: Then for applying circular columns wherever necessary, go to define then select section property and click frame section then add new property by typing circular and give the values (HYSD) and click on ok to get it applied.

Step-11: Then we have given slab loads, go to assign select area load and then select uniform to frame in the same procedure like when we gave to internal and external walls.

Step-12: Now select the whole view from the top view and show only selected frames and select all the beams.

Step-13: Then go to define and select load patterns by giving the wind loads and seismic loads by entering the specific values needed by verifying the code books needed.

Step-14: Select the full structure then go to assign select joints click on constraints and then select body and then select diaphragm and it gets applied.

Step-15: Then in the concrete frame

design then select view or revise preferences then click on design code and select the code book we need that is IS 456 and click on ok.

Step-16: Now select the first load combination and then click on modify and then we should modify all other load combinations in the same way.

Step-17: After all the loads are applied, we have to go to analysis then select run analysis.

Step-18: Now go to design and select concrete frame design and then start the design check or check for the structure.

Step-19: Now once again do the run analysis and design check also.

Step 20: DESIGN OF STRUCTURE

Following the completion of the analysis, we designed the structure in concrete in accordance with IS 456:2000.

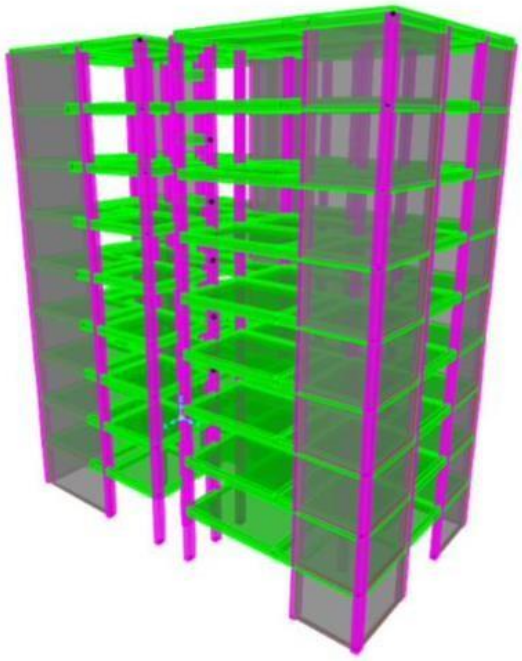

Figure-2 3D View of Structure

IX LOAD COMBINATIONS

The structures must be constructed to sustain a variety of loads as determined by design codes. The following load combinations has been taken:

1. DL0.9+WLX1.5
2. DL0.9-WLX1.5
3. DL0.9+WLY1.5
4. DL0.9-WLY1.5
5. DL0.9-WLY1.5
6. DL+LL+EQX
7. DL+LL-EQX
8. DL+LL+EQY
9. DL+LL-EQY
10. DL+EQX1.5
11. DL+EQX1.5
12. DL1.5-EQX1.5
13. DL1.5-EQX1.5
14. DL0.9+EQX1.5
15. DL0.9+EQX1.5
16. DL0.9-EQX1.5
17. DL0.9-EQX1.5
18. DL0.9+EQY1.5
19. DL0.9+EQY1.5
20. DL0.9-EQY1.5
21. DL0.9-EQY1.5
22. DL0.9+RSAX1.5
23. DL0.9+RSAX1.5
24. DL0.9+RSAY1.5
25. DL0.9+RSAY1.5

X RESULTS OF ANALYSIS

Diagrams showing shear and bending moments are crucial analytical tools used in structural analysis to support structural design. They determine the exact position of shear force and bending moment along structural parts like beams.

These schematics offer vital insights into the internal forces acting on the structure, enabling engineers to create robust and secure building elements.

- **Bending Moment Diagram**

Bending moment diagrams are useful for assessing how a structure responds to applied stresses and for identifying possible problems such excessive deflection or bending.

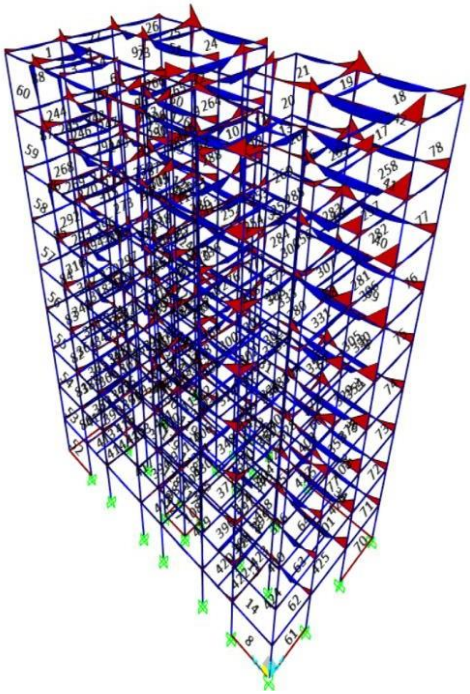

Figure-3 Bending Moment of Structure

- **Shear Force Diagram**

Shear force diagrams help to explain how loads are carried through a building by offering crucial insights into the distribution of forces inside a structure.

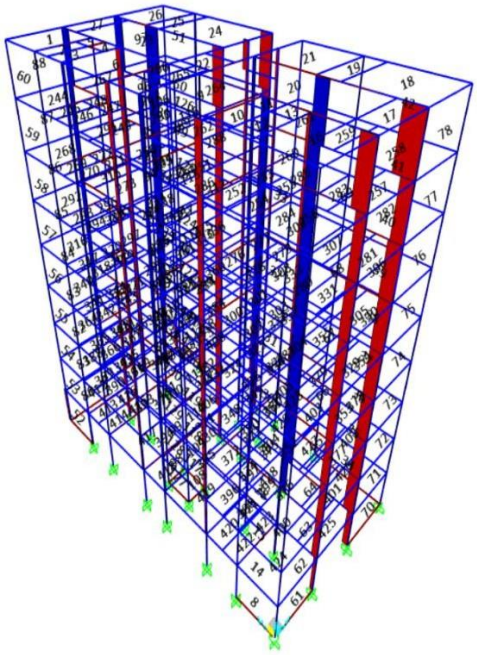

Figure-4 Shear Force of Structure

- **AXIAL FORCE OF STRUCTURE**

Analysis of structure assisting the loads are transferred through a building axial force of structure.

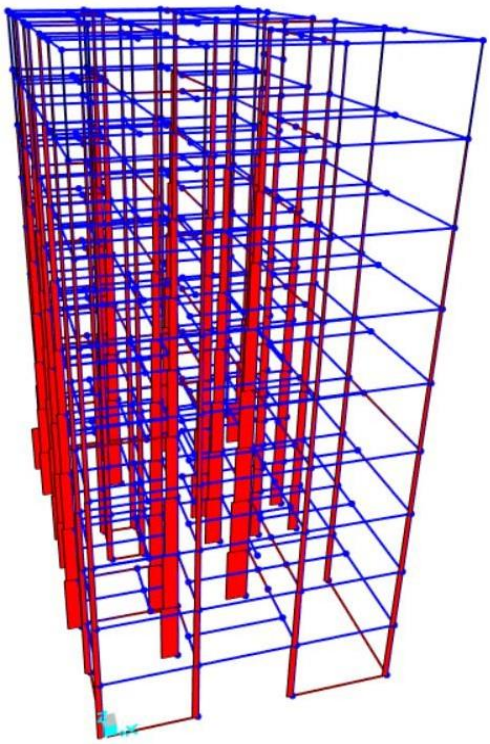

Figure: 5 Axial force

XI CONCLUSION

Assigning the shear walls and Response spectrum analysis to the multistorey residential building it is safer for the seismic loads and wind loads. Analysis and designing process using SAP2000 software to evaluate the seismic forces and wind forces. The building was energy efficiency and collapse prevention using to Response spectrum analysis to seismic and wind resistant design features. RCC framed building is done by using SAP2000 software for analysis and design.

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