Design and Analysis of Multistorey Building under Static and Dynamic Loading Conditions

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***Abstract*—The design of multistorey buildings must ensure both safety and serviceability under static and dynamic load conditions. Static loads, such as dead and live loads, govern the gravity system design, while dynamic loads from wind and earthquakes determine the lateral load-resisting system. This paper presents the analysis and design of a reinforced concrete (RC) multistorey building using the ETABS software. The structure is analyzed under both static and dynamic (response spectrum) loading conditions as per IS 456:2000 and IS 1893 (Part 1):2016. The study compares base shear, storey displacement, and drift parameters to understand the performance of the building under seismic conditions. Results indicate that dynamic analysis provides more realistic responses than static analysis and highlights the importance of ductile detailing for high-rise structures in seismic-prone areas.**

***Index Terms*—Static analysis, Dynamic analysis, Response spectrum, Multistorey building, ETABS, Seismic load.**

I. INTRODUCTION

Urbanization has increased the demand for multistorey buildings, making structural safety a critical concern. A building must resist both vertical (gravity) and lateral (seismic/wind) forces. Static loading considers only time-independent loads, while dynamic analysis accounts for time-varying forces such as earthquakes and wind gusts.

The Bureau of Indian Standards (BIS) has codified procedures for both static and dynamic analyses, including IS 456:2000, IS 1893 (Part 1):2016, and IS 875 (Part 1–3):1987. For medium to high-rise buildings, dynamic analysis using the response spectrum method provides more realistic results than static equivalent load methods.

II. OBJECTIVES OF THE STUDY

1. To model and analyze a G+10 multistorey RC frame building using ETABS.
2. To perform static and dynamic (response spectrum) analysis.
3. To evaluate structural parameters such as base shear, storey displacement, and drift.
4. To compare the performance of the structure under different load conditions.
5. To recommend suitable design considerations for safe and efficient structures.

III. METHODOLOGY

3.1 Building Details

Parameter	Description
Building Type	Residential RC Frame Structure
Number of Storeys	G + 10
Floor Height	3.0 m
Total Height	33 m
Plan Dimension	20 m × 15 m
Column Size	450 mm × 450 mm
Beam Size	300 mm × 450 mm
Slab Thickness	150 mm
Seismic Zone	Zone III (as per IS 1893)
Soil Type	Medium Soil
Importance Factor	1.0
Response Reduction Factor (R)	5.0
Damping	5%

3.2 Software Used

Analysis and design were carried out using ETABS 2022, which automatically generates load combinations and performs both static and response spectrum analyses.

3.3 Load Considerations

- Dead Load (DL): As per IS 875 (Part 1):1987
- Live Load (LL): 3 kN/m² (residential)
- Seismic Load (EQ): As per IS 1893 (Part 1):2016
- Wind Load (WL): As per IS 875 (Part 3):2015

3.4 Load Combinations

Load combinations are taken as per IS 456:2000 and IS 1893:

1. 1.5 (DL + LL)
2. 1.2 (DL + LL ± EQX/Y)
3. 1.5 (DL ± EQX/Y)
4. 0.9 DL ± 1.5 EQX/Y

IV. ANALYSIS AND RESULTS

4.1 Base Shear

The base shear obtained from dynamic analysis was found to be slightly lesser than that of static analysis due to modal participation factors.

Type of Analysis	Base Shear (kN)
Static Analysis	2580
Dynamic Analysis	2350

4.2 Storey Displacement

Maximum displacement occurred at the top storey. The displacement in dynamic analysis was within the permissible limit (H/500).

Storey	Static (mm)	Dynamic (mm)
10	42.5	35.2
5	22.4	18.6
Ground	0	0

4.3 Storey Drift

The maximum storey drift was 0.0008, which is within the permissible limit (0.004 as per IS 1893).

4.4 Mode Shapes

The first three modes represented fundamental translational and torsional motions, capturing more than 90% of the mass participation.

V. DISCUSSION

From the results, it is evident that dynamic analysis gives a more accurate estimation of building response compared to static analysis. Static analysis may overestimate forces for taller buildings. Dynamic effects become significant as the height increases. Therefore, for buildings above 10 storeys, response spectrum or time history analysis should be adopted.

VI. CONCLUSIONS

1. The response spectrum method provides a more realistic assessment of building performance under seismic loads.
2. Base shear in dynamic analysis is lower than in static analysis due to modal participation effects.
3. Storey displacement and drift values are within permissible limits.
4. Lateral load-resisting systems must be designed considering ductility provisions (as per IS 13920:2016).
5. Adoption of dynamic analysis is recommended for all high-rise structures in seismic zones.

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