

Case Study Over the Building Analysis for Seismic and Wind Load

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Abstract: This project presents the structural analysis of a G+7 reinforced concrete (RC) framed building located in Ahmedabad, which lies in Seismic Zone III as per IS 1893 (Part 1):2016. The building is modeled and analyzed using STAAD.Pro CONNECT Edition to evaluate its performance under seismic and wind loading. The total height of the building is 26.365 meters, including a foundation depth of 1.524 meters and floor heights as per architectural design. The structure is designed with Special Moment Resisting Frames (SMRF) to ensure ductile behavior during seismic activity. Dead loads such as floor finish, slab, and terrace loads are included based on IS 875 (Part 1):1987, with values like 5.75 kN/m² for floor slabs, 6.5 kN/m² for the terrace, and 15 kN/m² for the water tank. Live loads are considered as 2.0 kN/m² on typical floors, 1.5 kN/m² on the terrace, and 8.64 kN/m on landing beams. The structure consists of 0.45 m × 0.30 m beams, 0.30 m × 0.23 m plinth beams, and 0.60 m × 0.30 m columns. Wind load is applied based on a basic wind speed of 39 m/s as per IS 875 (Part 3):2015. Seismic analysis is carried out using the response spectrum method with a zone factor of 0.16, importance factor of 1.0, and response reduction factor of 5. The results show that the first three natural frequencies are 1.099 Hz, 1.593 Hz, and 3.004 Hz. Maximum base shear values are 201.61 kN and 195.83 kN in the X and Z directions respectively. The building shows a maximum storey drift of 10.99 mm at the fifth storey and a top displacement of 39.46 mm in the X direction, all within IS 1893 permissible limits. This confirms the structure's adequate seismic and wind performance.

Keywords: reinforced concrete, seismic zone, wind, base shear.

1. Introduction

In earthquake-prone regions like India, the seismic design of buildings is a critical consideration for ensuring structural safety and

resilience [1]. Ahmedabad, located in Seismic Zone III, has a moderate level of seismic risk, making it essential for structures to be designed with appropriate lateral force-resisting systems. Reinforced concrete (RC) framed buildings are commonly used for residential and commercial purposes due to their strength, durability, and ease of construction [2]. The present study aims to evaluate the structural behavior of a G+7 RC building under the action of seismic and wind forces using STAAD.Pro, a powerful finite element-based structural analysis software [3].

The building under consideration has a total height of 26.365 meters, with a 1.524-meter-deep foundation, a ground floor height of 2.896 meters, and typical floors of 3.353 meters each. Structural members include beams of size $0.45 \text{ m} \times 0.30 \text{ m}$, plinth beams of $0.30 \text{ m} \times 0.23 \text{ m}$, and columns of $0.60 \text{ m} \times 0.30 \text{ m}$. The design follows IS 456:2000 and IS 13920:2016, using Special Moment Resisting Frames (SMRF) to ensure ductility under seismic loads [4].

The loading conditions are defined as per IS 875, with dead loads accounting for self-weight, slab load, terrace load, and a 15 kN/m^2 water tank load on the roof. Live loads of 2.0 kN/m^2 on floor slabs, 1.5 kN/m^2 on terrace, and 8.64 kN/m on stair landing beams are considered. Wind loading is applied based on a basic wind speed of 39 m/s . Seismic loading parameters are adopted from IS 1893 (Part 1):2016, using the response spectrum method with appropriate zone, importance, and reduction factors [5].

The purpose of this study is to assess the structural response of the building in terms of base shear, storey drift, lateral displacement, and natural frequencies, ensuring compliance with Indian codal provisions

2. Methodology

The structural analysis for this project involves a G+7 reinforced concrete (RC) building modelled and analysed using STAAD.Pro. The building has a total height of 26.365 meters, which includes a foundation depth of 5 feet (1.524 m), a ground floor height of 9 feet 6 inches (2.896 m), and typical floor heights of 11 feet (3.353 m). Staircase flight height is modeled with a step spacing of 9.5 feet ($\sim 2.9 \text{ m}$), based on practical detailing.

The building employs Special Moment Resisting Frames (SMRF) as its lateral load-resisting system, ensuring adequate ductility and energy dissipation during seismic events. The structural members consist of beams sized $0.45 \text{ m} \times 0.30 \text{ m}$, plinth beams of $0.30 \text{ m} \times 0.23 \text{ m}$, and columns of $0.60 \text{ m} \times 0.30 \text{ m}$. All supports are assumed to be fixed at the base level.

The loads acting on the building are defined in accordance with IS 875. A mass model is generated by combining dead loads and 25% of live loads, as per IS 1893 (Part 1):2016 recommendations, to be used in seismic analysis. The building is assumed to be located in Ahmedabad, which lies in Seismic Zone III, with a Zone Factor (Z) of 0.16. A Response Reduction Factor (R) of 5 is used for SMRF systems, and the Importance Factor (I) is taken

as 1.0, as the building serves standard residential use. Medium soil conditions are considered, and the Response Spectrum Method is used for dynamic seismic analysis.

Modal analysis was performed to determine dynamic behavior, with the first three natural frequencies found to be 1.099 Hz, 1.593 Hz, and 3.004 Hz. Seismic results showed base

Mode	Frequency(Hz)	Time Period(s)
1	1.099	0.901
2	1.593	0.628
3	3.004	0.333

shear values of 201.61 kN (X) and 195.83 kN

Direction	Base Shear	(Z), a
X	201.61	
Z	195.83	

maximum storey drift of 10.99 mm, and top displacement of 39.46 mm (X)—all within IS code limits

For wind load analysis, the basic wind speed is taken as 39 m/s, applicable to Ahmedabad, based on IS 875 (Part 3):2015. Wind loads are automatically generated in STAAD.Pro and applied in both X and Z directions. Terrain Category 2, Risk Coefficient (k_1) = 1.0, and Topography Factor (k_3) = 1.0 are considered for calculating wind pressure distribution.

3. Results

NATURAL FREQUENCIES (HZ)

BASE SHEAR (KN)

STOREY DRIFT

Storey	Upper node (in mm)	Lower node (in mm)	Drift	Drift Ratio
Ground to 1 st	28.97	15.70	13.26	0.0039
1 st to 2 nd	41.07	28.97	12.09	0.0036
2 nd to 3 rd	51.67	41.07	10.60	0.0031
3 rd to 4 th	60.74	51.67	9.067	0.0027
4 th to 5 th	68.18	60.74	7.447	0.0022
5 th to 6 th	73.68	68.18	5.498	0.0016
6 th to 7 th	76.84	73.68	3.161	0.0009

4. Conclusion

The seismic and wind load analysis of a G+7 reinforced concrete (RC) framed structure located in Ahmedabad (Seismic Zone III) was successfully performed using STAAD.Pro CONNECT Edition. The building was modeled with Special Moment Resisting Frames (SMRF) and designed in compliance with IS 456:2000, IS 875 (Parts 1 to 3), IS 1893 (Part 1):2016, and IS 13920:2016. Detailed structural modeling included realistic elevation levels, beam and column dimensions, and practical live and dead loading conditions.

The analysis results indicate that the structure performs satisfactorily under both seismic and wind actions. The first three natural frequencies obtained—1.099 Hz, 1.593 Hz, and 3.004 Hz—are well within typical dynamic response ranges for RC buildings. The base shear values of 201.61 kN in the X-direction and 195.83 kN in the Z-direction fall within safe design limits. The maximum storey drift observed was 10.99 mm at the fifth storey, which complies with the IS 1893 limit of 0.004 times the storey height. The top storey displacements of 39.46 mm (X-direction) and 35.24 mm (Z-direction) also reflect acceptable lateral flexibility for an 8-storey structure.

Wind loads based on a basic wind speed of 39 m/s were applied in both horizontal directions, and their effects were found to be less critical compared to the seismic loads in this case. The use of SMRFs, adequate member sizing, and proper mass modeling ensured that the building remains stable, ductile, and serviceable under all design conditions.

In conclusion, the G+7 RC building demonstrates sufficient strength, stiffness, and ductility to resist expected lateral and vertical loads, making it structurally safe and compliant with Indian standards. The study confirms that STAAD.Pro is a reliable tool for comprehensive analysis and design of multi-storey RC buildings under complex loading scenarios.

References

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