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Comparative seismic performance evaluation of RC dual system buildings under NBC 105:2025 and IS 1893 (Part I):2025 across varying heights

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Abstract

This paper provides a comparative seismic performance evaluation of reinforced concrete (RC) dual-system buildings (4, 8, and 16 stories) modeled under the newly updated NBC 105:2025 and IS 1893 (Part I):2025. The structures were analyzed using the response spectrum method, considering Soil Type D for NBC 105:2025 and the newly introduced Zone VI parameters with Site Class D for IS 1893 (Part I):2025 to represent extreme regional seismic demands. Results indicate a significant shift in conservatism; contrary to historical trends, the updated Indian standard now yields higher seismic demands across all heights. This increased conservatism is primarily rooted in intensified seismic load estimation rather than detailing alone. Specifically, the introduction of Zone VI with a high seismic zone factor ($Z = 0.75$) and a more aggressive spectral acceleration plateau for Site Class D ($S_a/g = 2.5$) creates a significantly more rigorous hazard envelope than the current Nepalese mapping. Furthermore, while NBC 105:2025 utilizes refined, decoupled ductility (μ) and overstrength (Ω) factors, the total magnitude of the hazard parameters in the Indian code governs the design force requirements. Quantitatively, the IS 1893 (Part I):2025 base shear is 1.92 and 2.11 times greater for 4 and 8-storey buildings, respectively. Lateral displacements mirror this trend, recorded at 32 mm (IS 1893 (Part I):2025) versus 14 mm (NBC 105:2025) for the 4-storey model. While results for the 16-storey building show a trend toward convergence (233 mm vs 223 mm), the Indian standard remains the governing case. The study emphasizes the increased stiffness and strength requirements necessitated by the more conservative force demands of the 2025 Indian code update.

1. Introduction

The Himalayan region, which encompasses the boundary between Nepal and India, is characterized by extreme seismic vulnerability due to the ongoing subduction of the Indian plate beneath the Eurasian plate. This geological context necessitates a continuous evolution of structural design standards to protect the burgeoning urban populations in both nations. In Nepal, the seismic code underwent a major transformation following the 2015 Gorkha earthquake, moving from the deterministic NBC 105:1994 to the probabilistic NBC 105:2020 [1]. Recently, the release of NBC 105:2025 has further updated these hazard parameters, refining spectral acceleration maps and site-specific coefficients based on a decade of post-earthquake research [1]. Simultaneously, the Bureau of Indian Standards has modernized its criteria with the release of IS 1893 (Part 1):2025 [2]. A significant feature of this update is the introduction of Zone VI to represent regions of extreme hazard and Site Class D to account for deep soft soil amplification, marking a significant shift in Indian seismic design philosophy [2].

Building codes in both countries have historically followed divergent design philosophies despite the shared tectonic risk. Older iterations of the Nepal National Building Code adopted a Probabilistic Seismic Hazard Analysis (PSHA) approach earlier than many regional counterparts [3]. This resulted in stricter seismic demands, as PSHA accounts for uncertainties in earthquake magnitude and frequency more comprehensively

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than deterministic methods [4]. Previous comparative studies between the 2020 Nepalese code and the 2016 Indian code consistently noted that the Nepalese standard was significantly more conservative, often yielding base shears over 50% higher than the Indian equivalent [5]. These increased demands led to higher structural costs and more rigorous drift control requirements for RC buildings in Nepal [6].

For mid-to-high-rise construction, Reinforced Concrete (RC) dual systems consisting of moment-resisting frames coupled with shear walls are commonly employed due to their superior lateral stiffness and energy dissipation capacity. However, the accuracy of predicting the response of such complex systems is heavily dependent on the analysis method used. As established by [7], while the Equivalent Static Method (ESM) may be suitable for low-rise, regular structures, the Response Spectrum Method (RSM) is essential for taller buildings to accurately capture higher-mode effects and dynamic behavior. Beyond the analysis method, differences in the treatment of ductility and overstrength continue to cause divergent results; while NBC 105:2025 utilizes decoupled ductility(μ) and overstrength (Ω) factors, IS 1893:2025 continues to rely on a single response reduction factor (R) [8]. Furthermore, variations in soil classification systems can lead to significantly different amplification results for the same site conditions [9].

Despite the importance of these standards, there is a critical knowledge gap regarding the specific quantitative impact of the new Zone VI and Site Class D parameters introduced in IS 1893:2025. Emerging research suggests that these updates may bridge, or even reverse, the historical gap in conservatism between the two codes [10]. This paper addresses this gap by conducting a comparative seismic performance evaluation of 4, 8, and 16-storey RC dual-system buildings. By modeling these structures under NBC 105:2025 (Kathmandu, Soil Type D) and IS 1893:2025 (Zone VI, Site Class D), this study analyzes fundamental performance indices including base shear, roof displacement, inter-storey drift, and fundamental natural periods. The findings provide essential data for engineers and policymakers navigating the evolving landscape of earthquake-resistant design in the seismically volatile Himalayan region.

2. Methodology

The research study is carried out on three buildings comprising 4, 8, and 16 stories with 1 single basement floor. Its structures are constructed in a dual manner to resist lateral loads, where the buildings consist of shear walls, and moment-resisting frames. To give a share of real design practices the structural element is scaled with the building height. The buildings were modelled, then they were evaluated through response spectrum method.

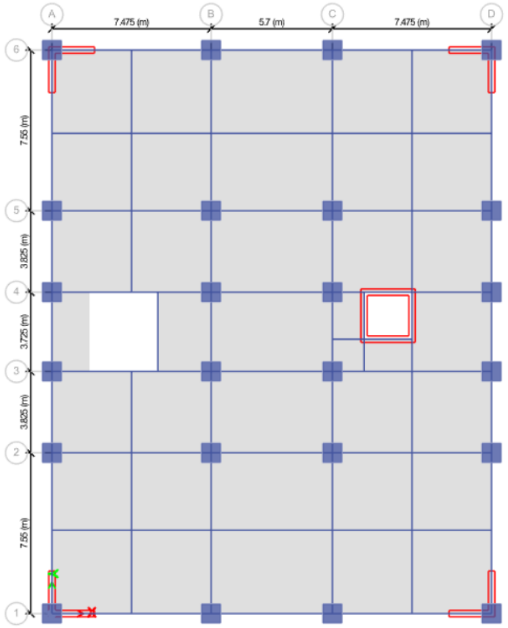

Figure 1: Typical plan view of 4,8 and 16 storey building models

While a 4-storey RCC building is often designed as a pure moment-resisting frame, this study utilizes a dual system (frames and shear walls) for all models (4, 8, and 16 storeys). This was done to maintain a consistent structural system across all variables. By keeping the system type constant, the research can accurately isolate and compare how the two seismic codes evaluate the interaction between different structural elements as the building height scales.

2.1. Research workflow

The research followed a systematic workflow as shown in Figure 5 and is summarized as follows:

- Selection of representative building heights (4, 8, and 16 stories). The 3D models are shown in Figures 2, 3, and 4, and the typical plan view is presented in Figure 1.
- Preparation of geometric and material parameters for each building.
- Development of three-dimensional structural models in ETABS v22.1.0.
- Assignment of material properties and section dimensions.

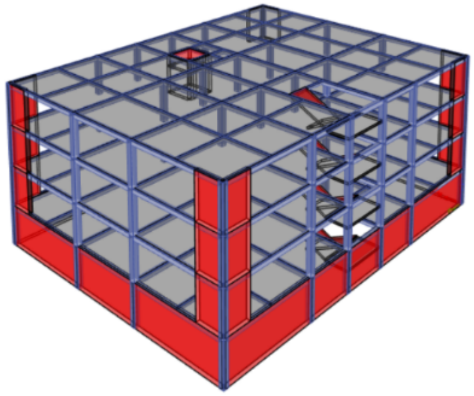

Figure 2: 3D view of 4-storey building model

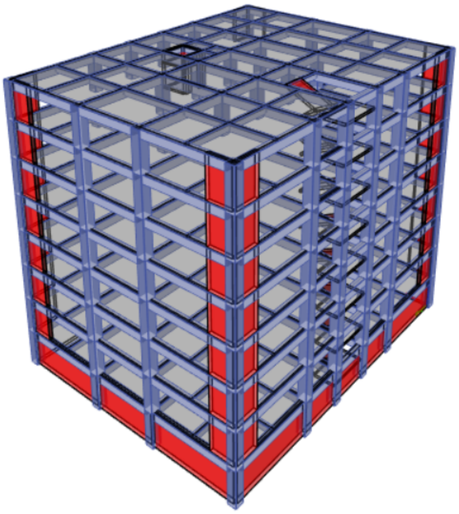

Figure 3: 3D view of 8-storey building model

- Application of boundary conditions (fixed base) and diaphragm constraints at each floor
- 5 by 5 meshing was done to the shell elements.
- Definition of loads and mass source (dead load and appropriate portion of live load).
- Implementation of response spectrum functions: User-defined IS 1893:2025 spectrum and NBC 105:2025 spectrum.
- Response Spectrum Analysis using the Square Root of the Sum of Squares (SRSS) method to obtain seismic responses.

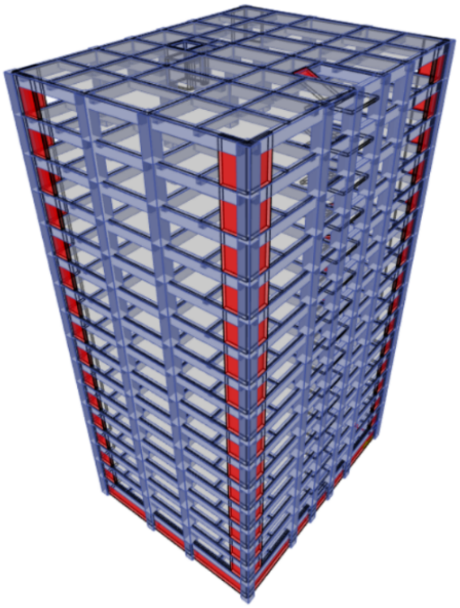

Figure 4: 3D view of 16-storey building model

2.2. Software and modelling setup

All modelling and analysis were conducted in ETABS Version 22.1.0, which supports frame and shell elements, modal analysis, and response spectrum analysis. Response spectrum for NBC 105:2025 Soil Type D and IS 1893:2025 Site Class D were manually imported using the user defined spectrum feature. ETABS also facilitated the assignment of diaphragm constraints, boundary conditions, and seismic loads.

2.2.1. Material properties

Standard concrete and reinforcement properties were assigned to ensure consistency. The Modulus of Elasticity (E_c) for concrete was calculated as $5000(f_{ck})^{1/2}$ per IS 456:2000. The structural member dimensions and assigned concrete grades for each building height are presented in Table 1. Additionally, the specific physical and mechanical properties of the concrete and reinforcement steel used across all models are summarized in Table 2.

2.2.2. Structural elements

Beams and columns were modelled as frame elements, slabs as shell elements, and shear walls as vertical lateral load-resisting elements.

2.3. Boundary conditions and constraints

A fixed base was assigned at the foundation to restrain all degrees of freedom. Rigid diaphragm constraints were applied at each floor to simulate in-plane stiffness and realistic lateral load distribution.

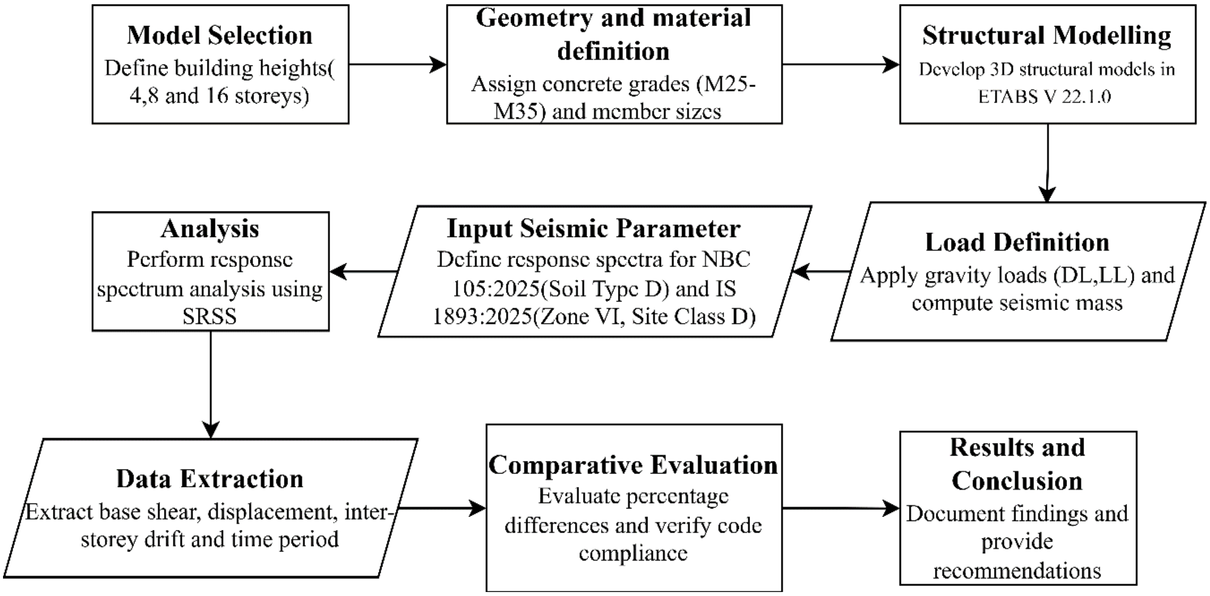

Figure 5: Research workflow

Table 1: Structural member dimensions and concrete grades

Building Height	Concrete Grade	Slab Thick.	Waist Slab Thick.	Secondary Beam	Main Beam	Column
4-Storey	M25	125 mm	150 mm	150 × 225 mm	230 × 300 mm	350 × 350 mm
8-Storey	M30	150 mm	200 mm	300 × 450 mm	450 × 600 mm	700 × 700 mm
16-Storey	M35	175 mm	225 mm	450 × 550 mm	500 × 800 mm	900 × 900 mm

Table 2: Mechanical properties of materials

Property	Value
Poisson's Ratio	0.2
Density of Concrete	25 kN/m^3
Reinforcement Grade	Fe500
Modulus of Steel (E_s)	2×10^5 MPa

2.4. Damping assumption

A uniform damping ratio of 5 percent was adopted for all modes in both IS 1893:2025 and NBC 105:2025 analyses, consistent with code recommendations.

2.5. Loads and mass source

Dead, live, and superimposed loads were applied according to standard code practice. The seismic mass was defined using dead load plus a percentage of live load for accurate dynamic modelling.

2.6. Load combinations

Load combinations were developed according to both codes. The complete list is provided in Table 3.

2.7. Seismic design parameters

The seismic analysis for all models was performed according to the Nepal National Building Code (NBC 105:2025) and IS 1893(Part 1): 2025. Table 4 presents the key seismic parameters for the buildings, assuming a location in Kathmandu.

The primary difference in seismicity between the two codes lies in their hazard calculation. NBC 105:2025 is based on a Probabilistic Seismic Hazard Analysis (PSHA) specifically mapped for the Nepal region. In contrast, IS 1893:2025 introduces Zone VI as an extreme deterministic category for areas near major active faults. The Indian code's spectral peak ($S_a/g = 2.5$) is higher than the Nepalese peak ($C_h = 2.25$), leading to the increased conservatism observed in this study.

Table 3: Seismic load combinations used for analysis under NBC 105:2025 and IS 1893 (Part 1):2025

NBC 105:2025	**IS 1893 (Part 1):2025**
1.2 DL + 1.5 LL	DL + LL + RSX
1.2 DL + 0.5 LL + S	DL + λ LL ± E
0.9 DL ± E	1.2 DL + 1.5 LL
1.2 DL + 0.5 LL + 1.2 S	DL + LL ± RSX
	DL + LL ± RSY
	0.9 DL ± RSX
	0.9 DL ± RSY

Where:
$S = 1.5\, S_{ep}$ for earth pressure
$\lambda = 0.6$ for storage facilities
$= 0.3$ for other usage

2.8. Design response spectra and analysis procedure

Figures 6 and 7 present the design response spectrum curves for NBC 105:2025 (Soil Type D) and IS 1893:2025 (Site Class D), respectively. The response spectrum governs how seismic demand varies with the natural period, effectively reflecting the dynamic sensitivity of different building heights. Both spectra rise sharply at very low periods, plateau for mid-to-short period structures, and decline as the period increases for taller structures.

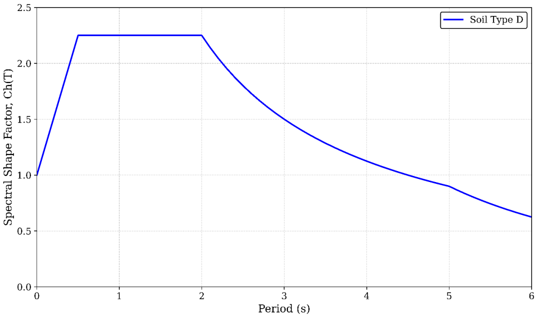

Figure 6: Response spectrum curve as per NBC 105:2025 for soil type D

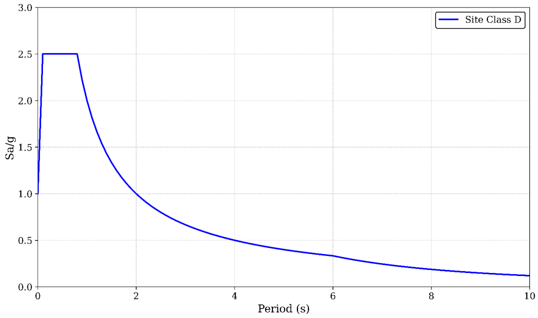

Figure 7: Response spectrum curve as per IS 1893 (Part 1):2025 for site class D

A fundamental shift is observed in the 2025 spectral shapes compared to previous standards. The IS 1893:2025 spectrum (Site Class D) exhibits a higher acceleration peak of $S_a/g = 2.5$, whereas the NBC 105:2025 spectrum (Soil Type D) plateaus at a Spectral Shape Factor (C_h) of 2.25. While the NBC plateau is notably more extended maintaining its peak value up to a period of 2.0 seconds the higher initial acceleration peak in the Indian code for Zone VI results in significantly greater base shear and lateral demands for low and mid-rise buildings. This is clearly reflected in the computed results, where the base shear for IS 1893:2025 is approximately 1.92 times higher for the 4-storey building and 2.11 times higher for the 8-storey building compared to NBC 105:2025. Furthermore, the observed transition in spectral shapes at $T = 5.0s$ (NBC 105:2025) and $T = 6.0s$ (IS 1893:2025) signifies the introduction of the long-period transition period (T_L). This update accounts for the constant-displacement region of the response spectrum, which is critical for the stability of high-rise structures in deep alluvial basins. This mathematical shift from a $1/T$ to a $1/T^2$ decay prevents the underestimation of forces in flexible structures while simultaneously capping excessive displacement demands. These differences in spectral shapes and transitions explain why the updated Indian standard now enforces a more conservative seismic demand envelope for the short-to-mid period range, while both codes converge toward a regional consensus for long-period structures.

The selection of Soil Type D for NBC 105:2025 and Site Class D for IS 1893:2025 is appropriate and justifiable, as both represent soft soil conditions (deep alluvial deposits) commonly found in the urban centers of Nepal and India. These soil types possess relatively low shear wave velocities, resulting in higher seismic amplification which is critical for evaluating the maximum possible seismic demand on buildings. Using equivalent soft soil categories ensures a consistent and rational comparison of the two codes seismic provisions and their impact on building performance, reflecting realistic foundation conditions in seismically active regions.

The Response Spectrum Method (RSM) was applied to each 3D model. For the analysis, a uniform damping ratio of 5% was considered for all modes. Modal responses were combined using the Square Root of the Sum of Squares (SRSS) method, with a sufficient num-

Table 4: Key seismic parameters for the Buildings

Seismic Parameters	**NBC 105:2025**	**IS 1893 (Part 1):2025**
Seismic zone factor (Z)	0.35	Zone VI, $Z = 0.75$
Soil type	D	Site Class D
Importance factor (I)	1.25	1.25
Response reduction factor	–	5
Ductility factor (μ)	3.5	–
Overstrength factor for ultimate limit state (Ω_u)	1.4	–
Overstrength factor for serviceability limit state (Ω_s)	1.2	–

ber of modes included in the modal analysis to achieve at least 90% mass participation in both orthogonal directions.

3. Results and discussion

This section evaluates the seismic response of the 4,8 and 16-storey dual-system buildings. The primary focus is to compare the impact of newly updated seismic hazard parameters in IS 1893:2025 and NBC 105:2025.

The percentage differences between the NBC and IS code results for various structural parameters of the buildings in the X-direction were calculated using the following formula:

$$\text{Percentage Difference } (\%) = \frac{\text{IS} - \text{NBC}}{\text{NBC}} \times 100 \quad (1)$$

where IS is the value obtained according to the IS code provisions and NBC is the value obtained according to the NBC code provisions. The parameters considered in this comparison are Base Shear, Maximum storey Displacement, Maximum Inter-storey Drift, and Time Period.

3.1. Seismic base shear

The seismic base shear is a fundamental indicator of the lateral force demand on the structure. As illustrated in Table 5, IS 1893:2025 yields significantly higher base shear values compared to NBC 105:2025.

The increasing gap in base shear demand between the two codes with building height is clearly illustrated in Figure 8. This sharp increase in IS 1893:2025 is a direct consequence of the extreme hazard parameters associated with Zone VI and the amplification effects of Site Class D. The 2025 Indian standard enforces a much higher acceleration plateau (Sa/g=2.5) for short and mid-rise buildings, which explains the nearly double force requirement for the 4 and 8-storey models.

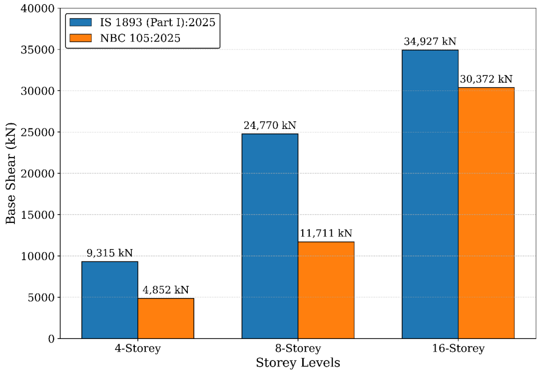

Figure 8: Base shear variation with storey levels NBC 105:2025 vs IS 1893 (Part 1):2025

3.2. Maximum storey displacement

Under IS 1893:2025, the lateral displacements are much higher for low- to mid-rise buildings, a trend that mirrors the base shear results. However, the ratio of IS displacement to NBC displacement tends to decrease with the height of the model, converging significantly in the 16-storey model as shown in Table 6.

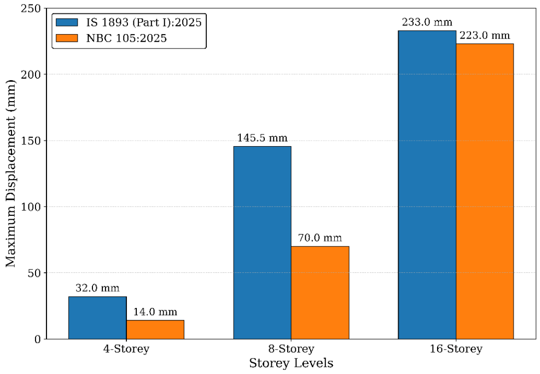

Figure 9: Max displacement variation with storey levels NBC 105:2025 vs IS 1893 (Part1):2025 (X-direction)

As illustrated in Figure 9, the maximum storey displace-

Table 5: Comparison of seismic base shear

Building Height	IS 1893:2025 (kN)	NBC 105:2025 (kN)	% Difference
4-Storey	9315	4852	+92
8-Storey	24770	11711	+111.5
16-Storey	34927	30372	+15

Table 6: Comparison of maximum storey displacement (X-direction)

Building Height	IS 1893:2025 (mm)	NBC 105:2025 (mm)	% Difference
4-Storey	32.0	14.0	+128.6
8-Storey	145.5	70.0	+107.9
16-Storey	233.0	223.0	+4.5

ment increases with height for both codes; however, IS 1893:2025 produces substantially larger values than NBC 105:2025 in the lower-rise models. This shows that for low- to mid-rise constructions, significantly more robust lateral-force-resisting systems will be necessary when designing to IS 1893:2025 to ensure that displacements are controlled. Conversely, as the natural period increases beyond 1.0s in high-rise structures (16 storeys), the spectral displacement demands of both codes reach a regional consensus, requiring similar stiffness controls for serviceability.

3.3. Maximum inter-storey drift

Figure 10 clearly shows that inter-storey drift demands are substantially influenced by the updated seismic parameters, with IS 1893:2025 consistently producing higher drift values than NBC 105:2025 in the X-direction. The inter-storey drift, which is critical for assessing potential damage to both structural and non-structural components, is consistently higher for buildings designed as per IS 1893:2025 (Zone VI) compared to those under NBC 105:2025. This difference is most pronounced in mid-rise structures, though it remains higher across all heights as shown in Table 7.

The increasing drift values under IS 1893:2025 are a direct consequence of the significantly higher base shear and spectral accelerations prescribed by the updated Indian code for Zone VI and Site Class D. This is particularly evident in the 8-storey building, where the drift of 0.80% is double the standard permissible limit of 0.4%, indicating that mid-rise buildings are highly sensitive to the intensified seismic hazard mapping introduced in the 2025 Indian revision. For the 16-storey structure, while the forces are larger, the drift values begin to converge, suggesting that the long-period spectral demands of both codes are reaching a unified regional consensus.

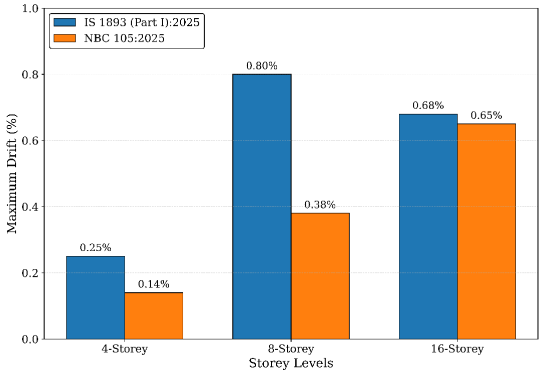

Figure 10: Max inter-storey drift variation with storey levels NBC 105:2025 vs IS 1893 (Part1):2025 (X-direction)

3.4. Fundamental time period

The fundamental time period of a building, which reflects its dynamic response and overall flexibility, is consistently higher when calculated according to NBC 105:2025 compared to IS 1893:2025. This increase remains nearly constant across different building heights as shown in Table 8.

Figure 11 illustrates the variation of the fundamental time period with building height. The longer natural periods observed under NBC 105:2025 suggest that the Nepalese code perceives a more flexible dynamic response for RC dual systems. In contrast, the empirical formulas prescribed in IS 1893:2025 result in significantly shorter periods, indicating a stiffer structural estimation. It is important to note that NBC 105:2025 (Clause 7.1.2) incorporates an amplification factor of 1.25 applied to the empirical time period to define the upper bound for the fundamental period used in base shear calculation. This provision ensures that the flexibility captured in three-dimensional modeling does not lead to

Table 7: Comparison of maximum inter-storey drift (X-direction)

Building Height	IS 1893:2025 (%)	NBC 105:2025 (%)	% Difference
4-Storey	0.25	0.14	+78.6
8-Storey	0.80	0.38	+110.5
16-Storey	0.68	0.65	+4.6

Table 8: Comparison of fundamental time period

Building Height	IS 1893:2025 (s)	NBC 105:2025 (s)	% Difference
4-Storey	0.32	0.45	-28.9
8-Storey	0.54	0.76	-28.9
16-Storey	0.91	1.28	-28.9

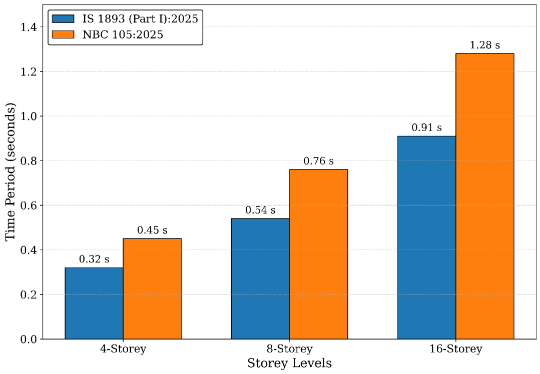

Figure 11: Fundamental time period variation with storey levels NBC 105:2025 vs IS 1893 (Part1):2025

an over-optimistic reduction in seismic forces by shifting the response too far into the lower-acceleration region of the spectrum. This trend emphasizes the impact of code-specific empirical equations and scaling factors on the dynamic characterization of structures.

The results clearly show that while NBC 105:2025 results in longer natural periods, it is IS 1893:2025 (Zone VI) that produces significantly higher base shear, displacements, and inter-storey drifts. This marks a significant shift from previous code iterations. The shorter fundamental periods in the Indian code effectively push the structural response toward the higher-acceleration plateau of the design spectrum ($S_a/g = 2.5$), especially when coupled with the extreme hazard parameters of Zone VI and Site Class D. Additionally, despite the 1.25 amplification safeguard in NBC, the higher spectral accelerations in the 2025 Indian update lead to much greater seismic demands for short and mid-period structures. This highlights the conservative nature of the updated IS 1893:2025 in terms of force and deformation requirements, despite the structures being modeled with stiffer dynamic characteristics.

These trends indicate that buildings designed under the new Indian standard, particularly mid-rise structures, will require significantly stronger and stiffer lateral load-resisting systems to control the excessive drifts and displacements resulting from the intensified seismic zoning. Overall, the choice of code significantly influences the perceived dynamic behavior, structural robustness, and economic viability of buildings, with the 2025 Indian revision now serving as the more demanding standard for seismically active regions like the Himalayas.

3.5. Summary of code-induced differences

The overall percentage differences between the two codes for all parameters are summarized in Figure 12.

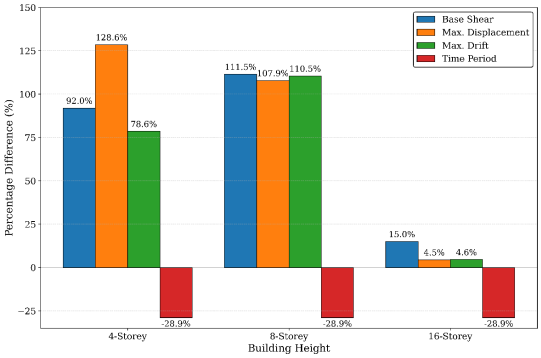

Figure 12: Percentage differences between NBC and IS for different structural parameters

As illustrated in Figure 12, there is a clear convergence of seismic results for the 16-storey buildings. This indicates that both codes predict nearly the same earthquake demand for tall structures. This convergence occurs because as building height increases, the fundamental natural period becomes longer, and the seismic forces calculated from the response spectra decrease in both codes.

Although IS 1893:2025 initially produces much higher seismic forces for low-rise buildings (4 and 8 storeys), these forces reduce more rapidly as the buildings get taller compared to those in NBC 105:2025. By the 16-storey mark, the seismic demands from both codes become almost identical, with only a 15% difference in base shear and less than 5% difference in displacement and drift. This trend reflects a growing regional consensus on seismic hazard levels for high-rise structures in the Himalayan region, even though the codes differ significantly in their approach to shorter buildings.

3.6. The Impact of Code updates on design philosophy

The results highlight the conservative nature of the updated IS 1893:2025 compared to NBC 105:2025, marking a complete reversal from the trends observed in previous code versions (2016 vs 2020) [5], [6]. The selection of Site Class D and Zone VI results in higher seismic amplification and stricter design provisions. While the higher base shear and drift demands of IS 1893:2025 offer improved safety margins for extreme events, they also increase structural robustness and material consumption. This highlights the importance of code selection for structural engineers in the Himalayan region, as the implications on both structural economy and performance are heavily dependent on the building height and the specific zoning adopted in the 2025 revisions.

4. Novelty and limitations

4.1. Novelty

The novelty of this research lies in its timely evaluation of the most recent seismic regulatory updates in the South Asian region. The specific contributions are summarized as follows:

1. This study is among the first to conduct a comparative seismic analysis between NBC 105:2025 and IS 1893:2025. While previous research focused on older standards, this paper provides a critical update by incorporating the newly introduced Zone VI parameters and Site Class D from the Indian code.
2. While many studies evaluate simple frame structures, this paper concentrates on RC dual systems (shear wall + moment-resisting frame). These systems are the standard for mid-to-high-rise urban construction due to their redundancy, yet they remain under-researched in the context of comparative code-based performance.
3. A significant novel finding of this work is the identification of a trend reversal; whereas historical data consistently placed the Nepalese code as the more conservative standard, this study quantifies how the 2025 Indian update has effectively overtaken the Nepalese code in terms of seismic demand for high-intensity zones.
4. The research offers a holistic analysis by correlating building height (4, 8, and 16 storeys) with multiple seismic indices, including base shear, displacement, drift, and time period, providing a clear map of how code-induced differences evolve as structures become taller and more flexible.

4.2. Limitations

Despite the rigorous application of the Response Spectrum Method, this study acknowledges several limitations that provide avenues for future research:

1. For a fair comparison, we incorporated shear walls and a basement in all three of our models, which made the buildings relatively rigid and produced modest drift values.
2. Instead of going through a thorough, in-depth design process, the sizes of the beams and columns were selected to be representative for each building height.
3. The analysis utilizes linear elastic modeling assumptions. While appropriate for code-mandated comparative studies, it does not account for the post-yield behavior and energy dissipation mechanisms that occur during non-linear structural response.
4. The study employs idealized boundary conditions and fixed-base supports. The effects of Soil-Structure Interaction (SSI), which can significantly modify the natural period and damping of structures in soft soil (Site Class D), were not considered.
5. The buildings analyzed are characterized by regular plans and elevations. The findings may vary for structures with vertical or horizontal irregularities, which are common in dense urban topographies.
6. The research is confined to specific hazard scenarios Kathmandu for NBC and Zone VI for IS. While these represent extreme cases, the findings may not be directly applicable to lower seismic zones or different soil profiles.

5. Conclusion

In this comparative study, it is revealed that the differences in the seismic requirements prescribed by IS 1893:2025 and NBC 105:2025 for low, mid, and high-rise RC dual system buildings are significant. A primary finding of this research is a complete reversal of historical conservatism trends; the updated Indian standard now imposes substantially higher demands than the Nepalese standard. The important conclusions are as follows:

1. IS 1893:2025 (utilizing Zone VI and Site Class D) is significantly more conservative than NBC 105:2025, particularly for low and mid-rise structures. The base shear ratio (IS/NBC) is approximately 1.92 for 4-storey buildings and peaks at 2.11 for 8-storey buildings. However, as the building height increases to 16 storeys, the forces begin to converge, with the ratio reducing to 1.15, suggesting a regional consensus for long-period structures.
2. The substantially greater base shear in IS 1893:2025 results in significantly larger storey displacements and inter-storey drifts. In the mid-rise (8-storey) model, the drift under the Indian code (0.80%) is double the permissible limit of 0.4%, whereas the NBC 105:2025 drift (0.38%) remains within safety bounds. This indicates that mid-rise buildings are most vulnerable to the intensified hazard mapping in the 2025 Indian update and will require drastically stiffer lateral-load-resisting systems.
3. The convergence of seismic results for the 16-storey buildings indicates that both codes predict nearly the same earthquake demand for tall structures. This occurs because, as building height increases, the fundamental period becomes longer and the seismic forces calculated from the response spectra decrease in both codes. Although IS 1893(Part I):2025 initially produces much higher seismic forces for low-rise buildings, these forces reduce more rapidly with increasing height than those in NBC 105:2025. As a result, by 16 storeys, the seismic demands from both codes become almost identical. This convergence reflects a common understanding of regional seismic hazard for tall buildings in the Himalayan region, despite differences in force levels for shorter buildings.
4. The consequences of choosing a seismic design code are far-reaching in terms of structural design, construction cost, and safety. Buildings designed based on IS 1893:2025 (Zone VI) will be significantly more robust and resistant to extreme seismic events; however, they will be substantially costlier to construct compared to those designed under NBC 105:2025, as larger structural components and thicker sections are necessary to satisfy the rigorous demand.

From a practical standpoint, the higher seismic demands prescribed by IS 1893:2025 for Zone VI offer improved safety margins by reducing the likelihood of collapse during extreme earthquakes. However, these stricter requirements also increase construction costs, material consumption, and the need for more robust detailing practices. This influences design decision-making, as engineers in the Himalayan region must now balance heightened safety expectations with the economic constraints introduced by the 2025 code revisions. Such results are vital for practicing structural engineers and policymakers in both Nepal and India. They provide a precise quantitative analysis of the two updated codes and reiterate that the implications of design are not uniform across all building heights but are, in fact, heavily dependent on the magnitude of the structure and the specific hazard parameters adopted in the 2025 standards.

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References

[1] Department of Urban Development and Building Construction (DUDBC). Seismic design of buildings in Nepal – NBC 105:2025[R]. Kathmandu, Nepal: Government of Nepal, 2025.

[2] Bureau of Indian Standards. IS 1893 (part 1):2025 – criteria for earthquake resistant design of structures[S]. New Delhi, India: Bureau of Indian Standards, 2025.

[3] Paudyal S, Pradhan A. Comparison of deterministic and probabilistic approaches in seismic hazard assessment[J]. Journal of Structural Engineering Nepal, 2021, 31(1): 11-18.

[4] Shrestha R R, Adhikari K R. Seismic hazard analysis for Kathmandu valley[J]. Nepal Journal of Civil Engineering, 2022, 8 (2): 65-72.

[5] Aryal D, Bhatta B. Comparative study of base shear and structural cost using NBC 105:2020 and IS 1893:2016[C]// Proceedings of the 2nd National Conference on Earthquake Engineering Nepal. 2021: 33-39.

[6] Karki R, Bista N. Base shear comparison in mid-rise RC buildings using NBC 105:2020 and IS 1893:2016[J]. International Journal of Structural Engineering, 2021, 6(1): 41-49.

[7] Shrestha R, Shrivastav M, Pal R. Evaluating the accuracy of equivalent static vs. response spectrum method for seismic analysis of buildings of varying heights[J/OL]. International Journal of Engineering and Technology, 2025, 3(1): 81-90. DOI: 10.3126/injet.v3i1.86983.

[8] Maharjan T, Dahal D. Drift control and code-based evaluation under seismic loads[J]. Nepal Journal of Earthquake Engineering, 2021, 3(2): 61-68.

[9] Basnet U, Poudel A. Soil classification and seismic response under NBC and IS[J]. Geotechnical Engineering Journal of Nepal, 2021, 12: 25-31.

[10] Sharma V, et al. Analyzing the impact of 2025 code updates on mid-to-high rise RC structures[J]. Asian Journal of Civil Engineering, 2025, 15(1): 112-120.