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Comparative Study of a Commercial RCC Building as per IS 1893:2016, NBC 105:2020, and NBC 105:2025

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Abstract. Reinforced concrete structures are analyzed using seismic design codes under seismic loading to ensure the safety and optimal performance of the structures. The primary objective of this study is to investigate and compare the effects of Indian and Nepalese seismic design codes on the seismic behavior of RCC structures. In this study, a G+4 commercial Reinforced Cement Concrete building situated in soil type D is modeled and analyzed using the response spectrum method of analysis. ETABS (version 22) is used to analyze the seismic characteristics of reinforced concrete buildings under NBC 2020, NBC 2025 (ULS & SLS), and IS 1893:2016, as per codal guidelines, and their results are interpreted. In this study, drift, displacement, and base shear are used as comparison parameters, and their corresponding findings are compared. In NBC 2025 (ULS), the drift and displacement are observed to decrease by approximately 7% compared to the 2020 version, while SLS experiences a notable reduction of nearly 30%. Among all the cases, the values obtained from IS 1893:2016 are the lowest, reflecting the reduction in drift and displacement by more than 50%. The base shear was found to be similar for NBC 2020 and NBC 2025 ULS (Reduced by around 4% from NBC 2025 SLS); But the results from IS 1893:2016 were quite lower (dropped by nearly 30%). These observations indicate that NBC 105:2025 shows greater control over deformation compared to NBC 105:2020, while IS 1893:2016 results in significantly lower seismic demand. However, despite showing lower seismic demand, IS 1893:2016 results in higher longitudinal reinforcement in both beam and columns than NBC codes. This is primarily due to factors such as unmodified stiffness factor, higher load combination factors, and higher importance factor, showing lower seismic demand does not necessarily indicate to lower material consumption.

Keywords: Base shear, Storey Drift and Displacement, Extended Three-dimensional Analysis of Building Systems (ETABS), Indian Standard (IS), Nepal National Building Code (NBC), Response spectrum, Serviceability Limit State (SLS), Ultimate Limit State (ULS).

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1. INTRODUCTION

Nepal lies in a seismically active region and has a long history of devastating earthquakes [1]. As Nepal lies in an earthquake-prone region between the Indo-Australian Plate and the Eurasian Plate, it has experienced many major and minor earthquakes. Such major and minor earthquakes result in loss of life and structural failure [2]. On 25th April and 12th May 2015, Nepal was hit by earthquakes, which are the most devastating disasters. The 7.9 magnitude earthquake was the strongest to hit Nepal since the 1934 Nepal-Bihar border earthquake. The earthquake measuring 7.9 on the Richter scale, which was followed by numerous aftershocks of magnitude 3.0-6.9 on the Richter scale, caused extensive destruction in Kathmandu Valley and injured thousands of people[3]. To address seismic vulnerability, Nepal has developed its own building codes, including the updated version of NBC 105:2020, i.e., NBC 105:2025, which provides guidelines for earthquake-resistant design of buildings. Similarly, IS 1893:2016 is widely used in the region and serves as a comprehensive guideline for seismic analysis and design of structures. Although these codes aim to enhance structural safety, differences exist in their approaches regarding seismic zoning, design spectra, load calculations, and detailing provisions. Therefore, a comparative study of NBC 105:2020, NBC 105:2025, and IS 1893:2016 is essential to understand their similarities, differences, and effectiveness in addressing seismic risks.

The primary objective of this study is to compare the base shear, story drift, lateral displacement, and reinforcement demand of an identical structural model evaluated across NBC 105:2020, NBC 105:2025, and IS 1893:2016. However, several methodological limitations boundary this scope. Structural evaluations are restricted to a single soil condition (Type D as per NBC standards, corresponding to Type C per IS 1893:2016), which may not reflect local geotechnical variations. Furthermore, structures with plan or vertical irregularities were excluded, despite their potential to exhibit distinct dynamic responses under seismic loading. Torsional irregularities were not explicitly evaluated in this phase, and a detailed economic analysis comparing material quantities or construction costs across code provisions was not included.

2. LITERATURE REVIEW

The influence of national seismic codes on the structural behavior of the building under earthquake loading has been the subject of extensive research across the globe, with various comparative studies evaluating the responses of a structure designed using different seismic codes. This study compares seismic parameters under NBC 105:2020 and IS 1893 (part 1):2016 using finite element modeling in ETABS and SAP2000 by equivalent static and response spectrum method of analysis. Results show NBC 105:2020 requires nearly double the base shear compared to IS 1893:2016. NBC 105:2020 shows a significant increase in lateral displacement compared to IS 1893:2016, i.e., Static analysis shows 50.6-66.6% higher lateral displacement, while dynamic response spectrum revealed 106-108% higher values. Drift patterns mirrored displacement trends, showing a similar percentage increase. This study suggests that municipalities and engineers in Nepal should follow the NBC code. While NBC 105:2025 has stricter seismic provisions requiring more robust structural systems, amplified design forces, and higher reinforcement demands compared to IS 1893 (part 1):2016 escalate construction costs, its conservative approach ensures enhanced seismic resilience, critical for high-seismic-risk regions like Nepal [4].

This study focuses on the comparison of seismic performance of a five-story residential building located in Seismic Zone V, characterized by Type III soil conditions according to IS 1893:2016, and in Kathmandu, characterized by Type C soil conditions according to NBC 105:2020. Response Spectrum Method is employed using ETABS software to evaluate key parameters, including base shear, storey displacement, and storey drift. The results reveal that buildings designed according to NBC 105:2020 experience higher base shear and greater storey displacements and drifts compared to those designed with IS 1893:2016. These findings emphasize the importance of adopting context-specific seismic design standards that consider local geological and seismic conditions. The study provides valuable insights for engineers, policymakers, and stakeholders, highlighting the need for

careful code selection to ensure both safety and economic efficiency in building construction in Nepal [5].
This study performs a comparison between different RC buildings as per the Nepal National Building code (NBC) and Indian Standard (IS), both revised and former versions of the design codes. In this paper, a three-storey low-rise RC building is analyzed using linear, non-linear static, and linear dynamic methods. The results obtained show that the base shear from NBC 105:2020 is higher by 104%, 116%, 157% than from NBC 105:2020 SLS, IS 1893:2002, and NBC 105:1994. Drift and displacement are also greater in NBC 105:2020 than in other codal provisions. NBC 105:2020 may overestimate the value of the performance limit state due to the adaptation of updated seismic parameters [6].
This research studies a comparative study between NBC 105:2020 and IS 1893:2016(Part 1) in different soil types in torsionally irregular structures. The values of base shear obtained from the IS code were reduced by 40.57%, 18.52%, and 43.32%, and drift was reduced by 38.95%, 14.63%, and 40.60% in X direction, while reduced by 40.92%, 16.64%, and 42.01% in Y direction in hard, medium, and soft soil, respectively. The adaptation of the latest seismic indices in NBC 105:2020 results in larger lateral forces in torsionally irregular structures [7].
This study aims to investigate the differences between the seismic results obtained from three different codes: American Society of Civil Engineers (ASCE 7-22), IS 1893:2016, and NBC 105:2020. Five different RC buildings are taken for the analysis and comparison of several provisions. ETABS is used for the analysis of various seismic parameters, such as base shear, storey displacement, storey drift, and percentage of reinforcement and fundamental time period. Among all codes, NBC 105:2020 showed a higher value of base shear, storey drift, displacement, and time period. The results show a higher percentage of reinforcement for ASCE 7-22, while NBC 105:2020 shows the lowest value. This study highlights the strict compliance with the codal provisions during the construction phase, which is important for structural safety and integrity. The findings of this research provide engineers with the necessary information while making the choices of seismic codes [8].
A review of the existing literature shows that several studies have compared NBC 105:2020 with IS 1893:2016. However, only a limited number of studies have considered the recently updated NBC 105:2025, which introduces important changes such as separate checks for the Ultimate Limit State (ULS) and Serviceability Limit State (SLS). This marks a clear improvement over NBC 105:2020. Moreover, the updated seismic parameters and revised spectral shape in NBC 105:2025 indicate a significant shift in Nepal's seismic design approach, which has not yet been thoroughly explored in previous research. To date, no study has carried out a comprehensive comparison of NBC 105:2020, NBC 105:2025 (including both ULS and SLS), and IS 1893:2016 using the same building model under identical conditions. Medium-rise commercial RCC buildings are very common in Nepal, yet their behavior under the updated code provisions has not been studied in detail. Therefore, this study aims to fill this gap by performing a comparative analysis of these codes for a G+4 commercial RCC building, providing a clearer understanding of the practical implications of adopting NBC 105:2025 in engineering design.

3. METHODOLOGY

For the study, a five-storey commercial building was chosen for analysis. Structural elements were designed as per IS 456:2000 [9]. Dead loads (DL) and live loads (LL) are calculated and assigned as per IS 875 (part 1) [10] and IS 875 (part 2) [11], respectively. The building was analyzed and designed using the same dimensions and materials but with different codes: NBC 105:2020 [12], NBC 105:2025 [13], and IS 1893:2016 [14]. The research primarily focuses on different parameters such as storey displacement, storey drift, and base shear under the three different codes.
The preliminary design was performed to determine the size of various structural members. The model was prepared, analyzed, and designed in ETABS (version 22) [15], CSI finite element software for NBC 105:2020, NBC 105:2025, and IS 1893:2016. The structural analysis was carried out using the Response Spectrum Method in accordance with NBC 105:2025. While NBC 105:2020 follows

a single-level Ultimate Limit State (ULS) design approach, NBC 105:2025 improves upon this by introducing a dual limit state framework. This includes the Ultimate Limit State (ULS) for ensuring structural safety against collapse and the Serviceability Limit State (SLS) for maintaining acceptable performance under moderate seismic events. In NBC provisions, force reduction is governed by the ductility factor ($R_\mu = 4$) and the overstrength factor ($\Omega_u = 1.5$), whereas IS 1893:2016 uses a single Response Reduction Factor ($R = 5$). Additionally, the spectral shape defined in NBC 105:2025 is specifically calibrated for Nepal's seismic conditions, resulting in higher spectral accelerations for Soil Type D compared to those specified in IS 1893:2016 for Soil Type C over the fundamental period range of the building.
Since the total height of the building is 19.05m, dynamic analysis is mandatory for the building with a total height exceeding 15m. Furthermore, the fundamental time period of the structure exceeds 0.5 seconds, which makes it necessary to choose the Response Spectrum Method. This method accounts for the multi-modal behaviour of the structure, providing a more realistic representation of seismic forces compared to the Equivalent Static Method.
All models have identical material and sectional properties with M25 grade concrete and Fe500 grade rebar (HYSD). Although the soil classifications differ between the two codes, Soil Type D in NBC 105:2025 and Soil Type C in IS 1893:2016, both represent soft soil conditions and are considered equivalent for this comparative study. Beam and column elements were modeled using frame elements, whereas the floor slab, landing slab, and going slab were modeled as thin shell elements with a rigid diaphragm. All the joints in the frame were assumed to be rigid, and the frames were interconnected using a rigid diaphragm in the horizontal plane. A damping ratio of 5% is assumed for all models in accordance with standard practice for RC structures.
The building consists of a lift core consisting of reinforced concrete shear walls, which extends throughout the full height of the building. Due to its significant stiffness and mass concentration, eccentricity arises, leading to torsional irregularity under seismic loading. To counteract this eccentricity, a counter shear wall is introduced.

The methodology adopted in this study is presented in the given flowchart.

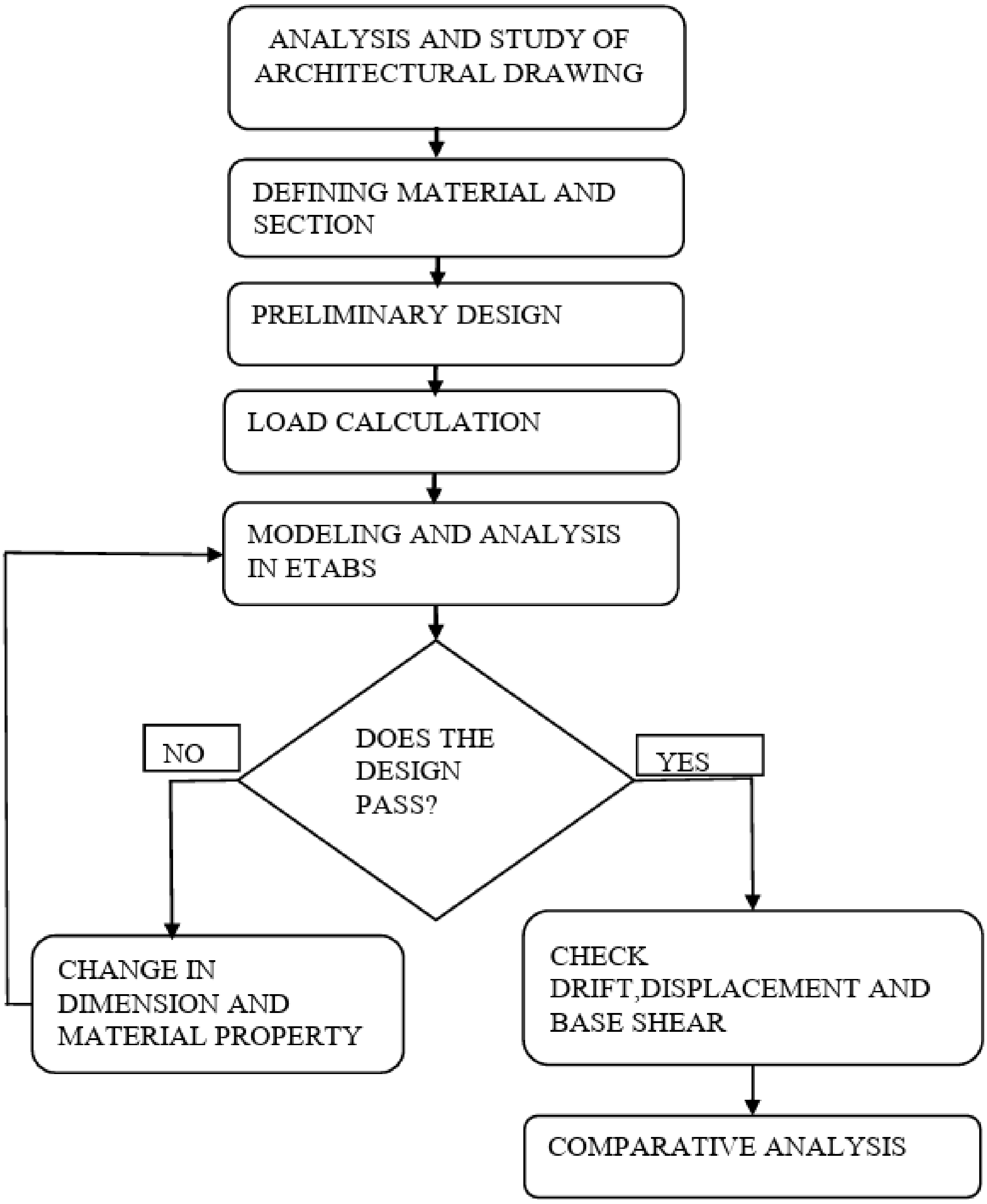

FIGURE 1. Flowchart of the methodology adopted in the study.

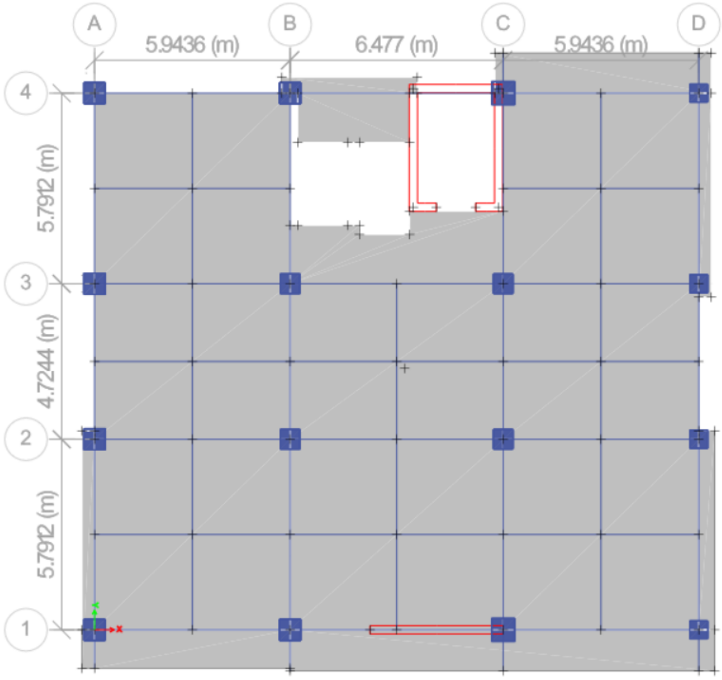

FIGURE 2. Typical floor plan of the G+4 commercial RCC building.

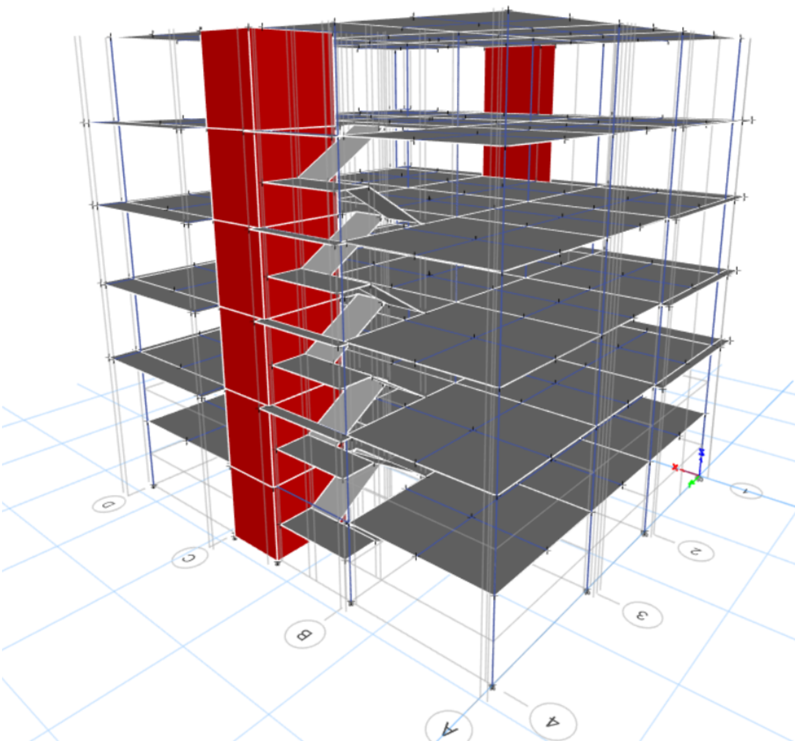

FIGURE 3. Three-dimensional ETABS model of the G+4 commercial RCC building.

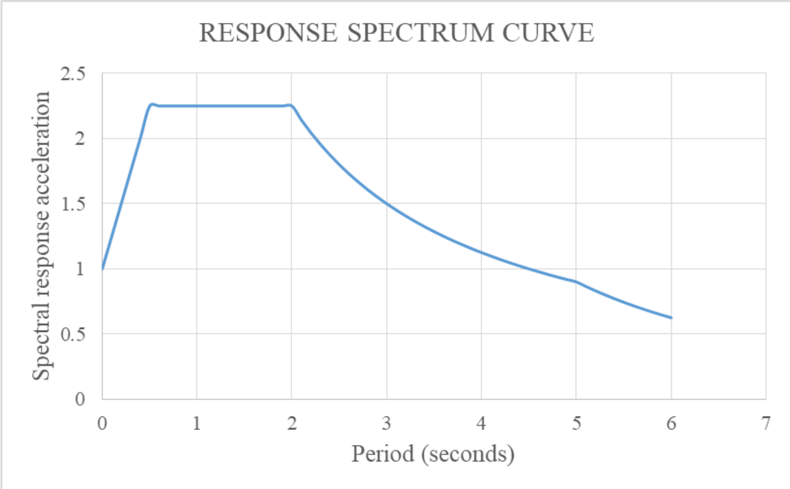

FIGURE 4. Spectral shape factor for the model response spectrum method of soil type D.

TABLE 1. General Description of the Building Parameters

Parameters	NBC 105:2020	NBC 105:2025	IS 1893:2016
Building Model	B1	B2	B3
Grade of concrete	M25	M25	M25
Grade of steel	Fe500	Fe500	Fe500
Frame type	Moment resisting concrete frame	Moment resisting concrete frame	Special moment resisting frame
Soil Type	D (soft soil)	D (soft soil)	C (soft soil)
Seismic zone factor	0.35	0.35	0.36
Importance factor	1	1	1.2
Ductility factor (R_μ)	4	4	-
Overstrength factor (Ω_u)	1.5	1.5	-
Response reduction factor (R)	-	-	5
No. of bays (X and Y)	3 × 3	3 × 3	3 × 3
Total height	19.05 m	19.05 m	19.05 m
Ground storey height	3.048 m	3.048 m	3.048 m
Other storey height	3.2004 m	3.2004 m	3.2004 m
Total length (X-axis)	18.3642 m	18.3642 m	18.3642 m
Total length (Y-axis)	16.3068 m	16.3068 m	16.3068 m
Shear wall thickness	250 mm	250 mm	250 mm
Staircase type	Doglegged	Doglegged	Doglegged
Live load (Roof accessible)	1.5 kN/m^2	1.5 kN/m^2	1.5 kN/m^2
Live load (Rooms/Balcony)	4.0 kN/m^2	4.0 kN/m^2	4.0 kN/m^2
Exterior wall load with opening	9.38 kN/m	9.38 kN/m	9.38 kN/m
Interior wall load	7.11 kN/m	7.11 kN/m	7.11 kN/m
Floor finish	1.53 kN/m^2	1.53 kN/m^2	1.53 kN/m^2

TABLE 2. Percentage of Imposed Load in Seismic Weight (IS 1893:2016)

Imposed Floor Load (kN/m^2)	Percentage of Load
Up to and including 3.0	25
Above 3.0	50

TABLE 3. Live Load Category and Factor (NBC 105)

Live Load Category	Factor
Storage	0.6
Other purpose	0.3
Roof	Nil

Table 4. Size of Structural Members

Building model	Column size (mm)	Primary beam size (mm)	Secondary beam size (mm)	Slab thickness (mm)
B1	550 × 550 600 × 600 650 × 650 700 × 700	400 × 600	250 × 300	125
B2	550 × 550 600 × 600 650 × 650 700 × 700	400 × 600	250 × 300	125
B3	550 × 550 600 × 600 650 × 650 700 × 700	400 × 600	250 × 300	125

3.1. **Load Combinations.** Load combinations are important for various potential scenarios that a structure may face, such as live loads, dead loads, and seismic forces, namely, equivalent static force (EQ_x and EQ_y) and response spectrum dynamic forces (RS_x and RS_y). These combinations are used to check the safety, stability, and serviceability of the structure. The used combinations for NBC 105:2020, NBC 105:2025, and IS 1893:2016 are shown in the table below.The applied combinations for NBC 105:2020, NBC 105:2025, and IS 1893:2016 are listed in Tables 5 , 6 and 7.

Table 5. NBC 105:2020 Load Combinations

1.2 DL + 1.5 LL
DL + 0.3 LL ± EQxULS
DL + 0.3 LL ± EQxSLS
DL + 0.3 LL ± EQyULS
DL + 0.3 LL ± EQySLS
DL + 0.3 LL ± RSx
DL + 0.3 LL ± RSy

Table 6. NBC 105:2025 Load Combinations

1.2 DL + 1.5 LL
DL + 0.3 LL ± EQXULS
DL + 0.3 LL ± EQxSLS
DL + 0.3 LL ± EQyULS
DL + 0.3 LL ± EQySLS
DL + 0.3 LL ± RSx
DL + 0.3 LL ± RSy
0.9DL ± EQxULS
0.9DL ± EQYULS
0.9DL ± EQxSLS
0.9DL ± EQySLS
0.9DL + RSX
0.9DL + RSY
1.333 DL + 0.3 LL ± EQxULS
1.333 DL + 0.3 LL ± EQxSLS
1.333 DL + 0.3 LL ± EQyULS
1.333 DL + 0.3 LL ± EQySLS

TABLE 7. IS 1893:2016 Load Combinations

0.9DL ± 1.5EQx
0.9DL ± 1.5EQy
0.9DL ± 1.5RSx
0.9DL ± 1.5RSy
1.2(DL + LL ± EQx)
1.2(DL + LL ± EQy)
1.2(DL + LL ± RSx)
1.2(DL + LL ± RSy)
1.5(DL ± EQx)
1.5(DL ± EQy)
1.5(DL ± RSx)
1.5(DL ± RSy)

4. RESULTS AND DISCUSSION

Firstly, the buildings were analyzed using the response spectrum method. After analyzing different seismic parameters, such as top displacement, fundamental time period, and storey drift, the results were obtained and are discussed below.

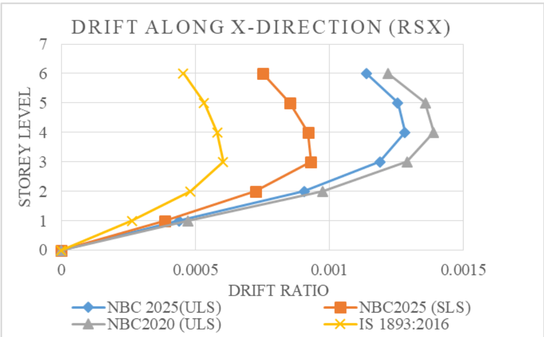

FIGURE 5. Inter-storey drift ratio across storey levels in the X-direction (RSX) for NBC 2025 ULS, NBC 2025 SLS, NBC 2020 ULS, and IS 1893:2016.

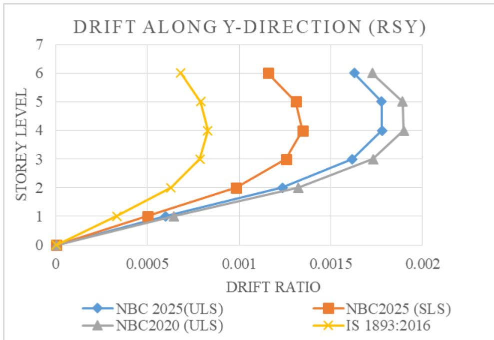

FIGURE 6. Inter-storey drift ratio across storey levels in the Y-direction (RSY) for NBC 2025 ULS, NBC 2025 SLS, NBC 2020 ULS, and IS 1893:2016.

4.1. **Inter-storey Drift.** The graphs in the Figure 5 and 6 display the variation of inter-storey drift ratio across storey levels in both X and Y directions. It is observed that for all codes, drift increases with storey level, reaches a maximum near mid height, and gradually reduces towards the upper floor. Among all codes considered, NBC 2020 (ULS) experiences the highest drift, followed by NBC 2025 (ULS). However, NBC 2025 (SLS) shows a remarkable reduction mainly in upper floors, depicting lower seismic forces related to serviceability limits. Meanwhile, IS 1893:2016 shows a significant reduction across all storey levels.

The higher drift values in NBC provisions mainly come from the use of higher spectral accelerations tailored to Nepal's seismic conditions, along with lower force reduction compared to IS 1893:2016. On the other hand, IS 1893:2016 adopts a Response Reduction Factor ($R = 5$) and an Importance Factor ($I = 1.2$), together with lower spectral accelerations developed for the wider Indian sub-continent. As a result, it leads to a lower seismic demand and, consequently, smaller drift values throughout all storey levels.

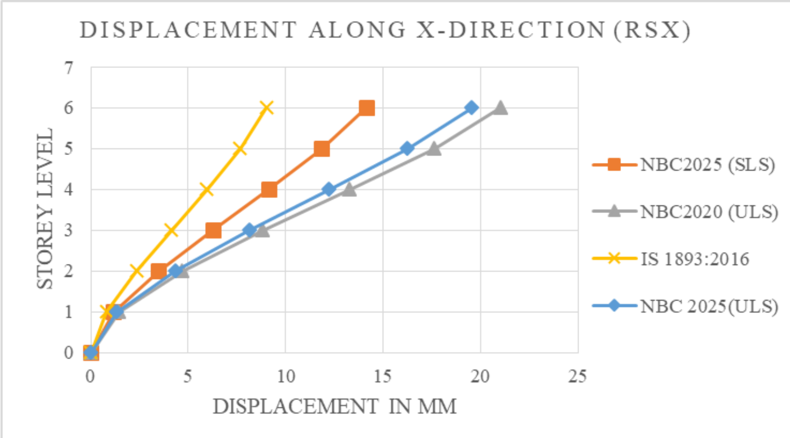

FIGURE 7. Lateral storey displacement in the X-direction (RSX) for NBC 2025 ULS, NBC 2025 SLS, NBC 2020 ULS, and IS 1893:2016.

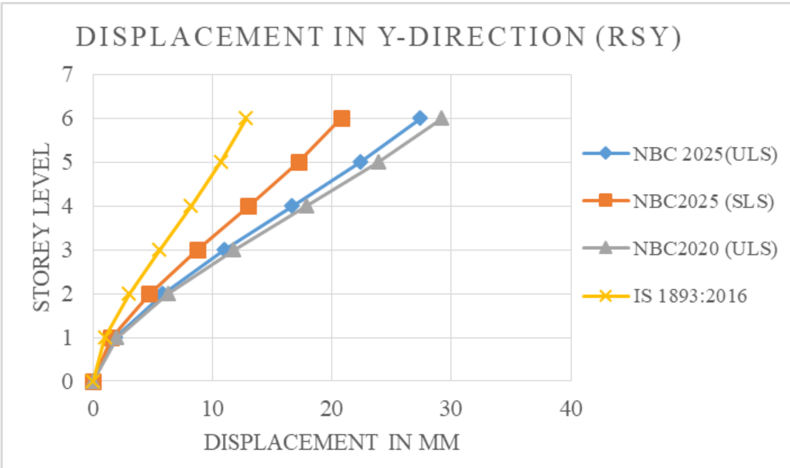

FIGURE 8. Lateral storey displacement in the Y-direction (RSY) for NBC 2025 ULS, NBC 2025 SLS, NBC 2020 ULS, and IS 1893:2016.

4.2. **Displacement.** The graphs in Figure 7 and Figure 8 show the variation of lateral displacement in mm along the x-axis (RS_x) and (RS_y) across various storey levels in the y-axis. From the given chart, it can be observed that displacement increases with storey level for all cases. This shows that the upper storeys experience larger displacements compared to the lower floors. A comparative analysis shows that, among all cases, NBC 2020 (ULS) shows the highest values of displacement for all storey levels. In contrast, NBC 2025 (ULS) gives slightly lower displacement values due to marginally reduced seismic demand compared to NBC 2020, followed by NBC 2025 (SLS), indicating moderate displacement under serviceability conditions. Furthermore, IS 1893:2016 represents the lowest displacement value.

Similar to the drift results, the lower displacement values obtained from IS 1893:2016 are a consequence of its lower seismic demand, as discussed earlier. These reduced values should not be interpreted as improved structural performance, but rather as an indication of a less conservative design approach for Nepal's seismic conditions.

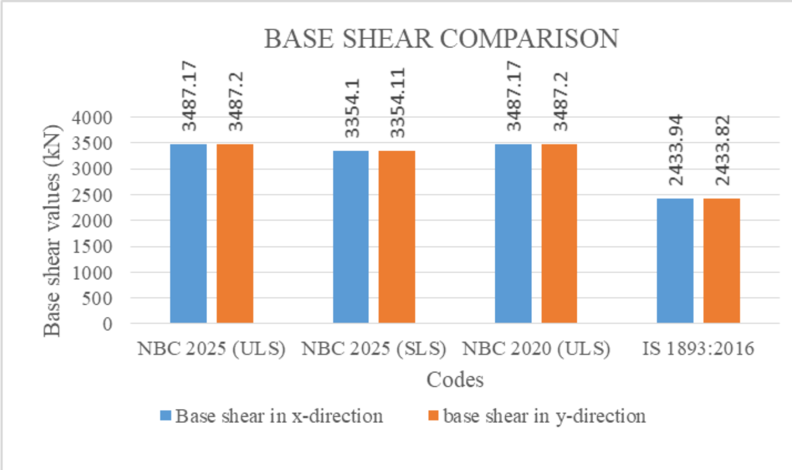

FIGURE 9. Base shear comparison along X and Y directions.

4.3. **Base Shear.** Base shear is defined as the total design lateral force generated by an earthquake at the base of a structure. From the bar graph (Figure 9) plotted for the G+4 building under different codes, such as NBC 2025 (ULS), NBC 2025 (SLS), NBC 2020 (ULS), and IS 1893:2016. It is observed that the base shear values for NBC 2025 (ULS) and NBC 2020 (ULS) are the same, with a value of 3487.20 kN. The base shear for NBC 2025 (SLS) reduced slightly to 3354.11 kN, showing lower seismic demand arising from serviceability criteria. In contrast, the base shear value from IS 1893:2016 is significantly reduced to 2433.82 kN.
The lower drift and displacement values observed in IS 1893:2016 are mainly due to the lower base shear. These results show that IS 1893:2016 adopts a comparatively lower seismic demand, making it less conservative than Nepal's building codes for buildings situated in Nepal's high seismic risk zone.

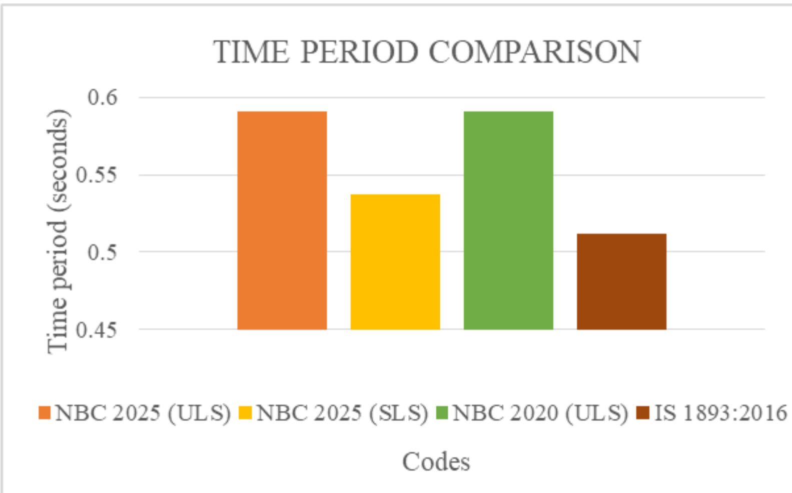

FIGURE 10. Fundamental time period comparison across seismic codes.

4.4. **Time Period.** The given bar chart shows the fundamental time period for a structure across different seismic codes, namely NBC 2025 (ULS), NBC 2025 (SLS), NBC 2020 (ULS), and IS 1893:2016. Results show that NBC 2025 (ULS) and NBC 2020 (ULS) give the same value for the time period. In contrast, the NBC 2025 (SLS) value is noticeably reduced, reflecting the code's requirement for increased stiffness when evaluating serviceability requirements. Furthermore, the value for IS 1893:2016 reduced significantly, demonstrating that the Indian standard assumes a much stiffer structural response.

4.5. **Longitudinal Reinforcement Demand.**

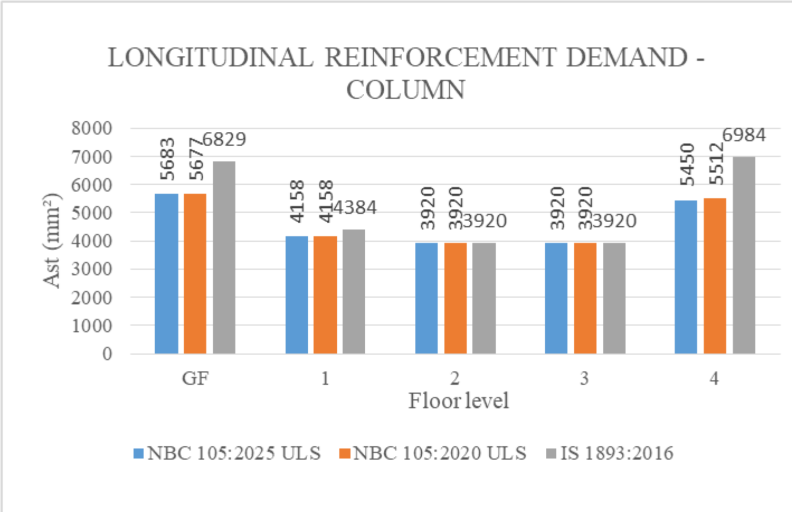

FIGURE 11. Longitudinal reinforcement demand for columns across floor levels.

4.5.1. *Column Reinforcement.* Even though IS 1893:2016 shows lower seismic demand in terms of base shear, drift, and displacement, it results in higher longitudinal reinforcement requirements in both beams and columns compared to NBC 105:2025 and NBC 105:2020. One of the main reasons for this is the use of a stiffness modification factor of 1.0 in the IS model, which assumes full gross section stiffness for both beams and columns. In contrast, NBC 105:2025 and NBC 105:2020 consider reduced stiffness values to account for cracking, leading to a more realistic representation of member behavior. In addition, the relatively higher load combination factors and the use of an importance factor ($I = 1.2$) in IS 1893:2016 further increase the design forces. Together, these factors contribute to the higher reinforcement demand observed in IS-based design.

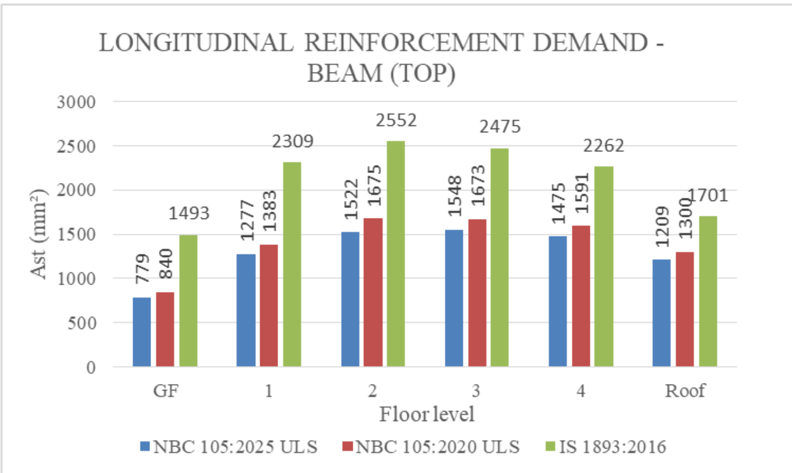

FIGURE 12. Top longitudinal reinforcement demand for beams across floor levels.

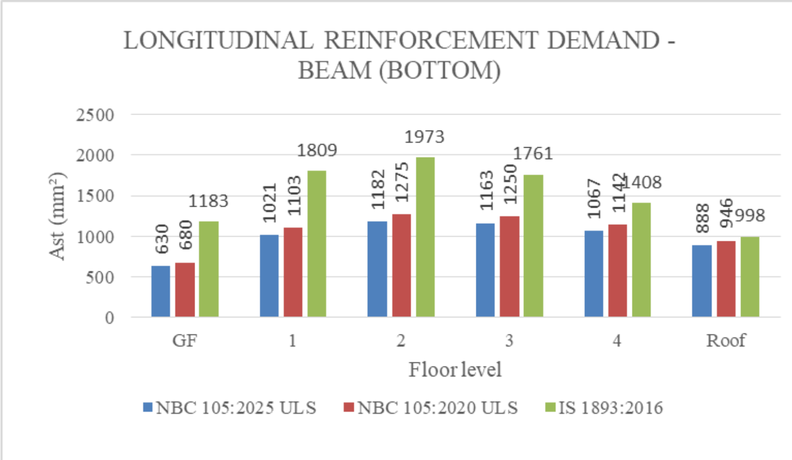

FIGURE 13. Bottom longitudinal reinforcement demand for beams across floor levels.

4.5.2. *Beam Reinforcement.* Figure 12 shows the variation of top longitudinal reinforcement in beams across different floor levels. It can be seen that IS 1893:2016 consistently results in the highest top reinforcement throughout the building height. The difference is particularly noticeable at the 2nd and 3rd floors, which can be linked to higher hogging moment demand. This is mainly due to the use of an unmodified stiffness factor (1.0) and relatively higher load combinations, such as 1.5(DL $\pm$ EQ) in the IS code, compared to NBC provisions.
In comparison, NBC 105:2025 produces slightly lower top reinforcement than NBC 105:2020 at all floor levels, reflecting its relatively lower seismic demand under the updated code provisions.
Figure 13 presents the bottom longitudinal reinforcement required in beams across all floor levels. Similar to the top reinforcement trend, IS 1893:2016 again results in the highest bottom reinforcement values. However, the difference is less pronounced compared to the top reinforcement, as sagging moments at mid-span are generally lower than hogging moments at the beam ends. NBC 105:2025 shows slightly lower bottom reinforcement than NBC 105:2020, which is consistent with its comparatively reduced seismic demand. Across all codes and floor levels, bottom reinforcement remains lower than top reinforcement, which aligns with the typical moment distribution under combined gravity and seismic loading.

TABLE 8. Percentage Reduction in Seismic Parameters of NBC 105:2025 (ULS/SLS) and IS 1893:2016 Relative to NBC 105:2020 (ULS)

Parameters	**%Change 2025 (ULS)**	**%Change 2025 (SLS)**	**%Change IS 1893**
Drift (X)	7.70	32.95	56.47
Drift (Y)	6.22	29.06	56.33
Displacement (X)	6.93	32.81	57.16
Displacement (Y)	6.15	28.80	56.12
Base Shear (X)	–	3.82	30.20
Base Shear (Y)	–	3.82	30.21

4.6. **Discussion.** This study highlights the comparative effects of NBC 105:2020, NBC 105:2025, and IS 1893:2016 on a G+4 commercial RCC building. NBC codes yield higher seismic demand, whereas IS 1893:2016 results in lower demand but higher reinforcement requirements due to stiffness and load combination provisions. Adopting locally tailored seismic codes remains critical for regions with high seismic vulnerability like Nepal.

5. CONCLUSION

This comparative study provides a clear understanding of the influence of different seismic design codes—NBC 105:2020, NBC 105:2025, and IS 1893:2016—on the structural response of RCC commercial buildings. The results show that buildings designed as per NBC codes consistently experience higher seismic demands compared to those designed using IS 1893:2016. Parameters such as drift, displacement, and base shear indicate that NBC follows a more conservative approach, resulting in higher seismic action on the structure. The increased drift and displacement observed under NBC provisions reflect higher code-specified seismic demand rather than greater structural flexibility, highlighting a fundamental difference in the design philosophy of NBC and IS codes.
Interestingly, despite showing lower seismic demand, IS 1893:2016 results in higher longitudinal reinforcement requirements in both beams and columns compared to the NBC codes. This is mainly due to factors such as the use of unmodified stiffness assumptions, higher load combination factors, and a larger importance factor in IS 1893:2016, which together lead to increased design forces. This clearly indicates that lower seismic response values do not always translate into reduced material usage, and therefore, structural economy cannot be evaluated based only on drift or displacement results.
These findings are particularly relevant to structural engineering practice in Nepal, where both NBC and IS codes are commonly used. They emphasize the importance of adopting locally developed seismic codes that better reflect Nepal's seismic characteristics. However, the study is limited to a regular G+4 commercial building situated on a single soil type (Type D), which may not fully represent different structural configurations and site conditions. Future research could extend this work to high-rise and irregular structures, incorporate nonlinear analysis methods such as pushover and time history analysis, and include a detailed cost-benefit comparison based on reinforcement demand and construction cost under different design codes.

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