International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-4, August 2022
https://doi.org/10.55524/ijirem.2022.9.4.11
Article ID IJIRD-1190, Pages 68-73
www.ijirem.org

Comparative Study of RC Frame Building with NBC 105:2020 and IS Code 1893:2002

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ABSTRACT- Construction is a vital part of every developing country in this era. Every country has specific building design codes which provide the standards to engineers for the design of various structural components like beam, column and slab. RC building design of every country is based on their geographical location. In today world of globalization, an engineer must be efficient to understand and handle codes of various countries. Considering this the main focus of this research work is to bring out differences and similarities between different RC design codes and to use it to develop a common platform. In this research RC design code of NEPAL, INDIA are considered. The main focus is the relative gains and shortcomings of various buildings design codes under certain criteria like loading analysis, design analysis, ease of use and economical point of view. Several parameters for different cross-section and different building material on basis of strength are considered. Comparison work has worked out on the basis of loading comparison like live load, dead load, wind load and different parameters for various elements of the building such as beam, column and slab. Load factor and load combination are also compared. This comparison investigates the design capacities for various building design codes.In present study RCC building models having G+8 stories with regular plan is considered for analysis. The analysis of model is done using equivalent static method in ETABS software.

KEYWORDS-Base shear; Storey Shear; Seismic Analysis; Storey Drift.

I. INTRODUCTION

The In present world lots of construction work is carried out for the development works within the nation. Among these construction works construction of the building is one which is necessary for every people of the country. The buildings need to be safe and stable. As we know that main factor affecting building is earthquake, the building must be safe against it. As the population is growing rapidly, the demand of building in different form residential, commercial and industrial are more demanding. The size and the dimension of building required than past has been increasing today multi storey buildings need to be constructed because of limited plot area in the city where more people are moving for better facilities and better service. The building are now becoming more vulnerable to earthquake.

Different country had made their own code for designing building according to suitability of their country weather, geology, topography. As we know that Nepal and India are neighboring countries and Northern part of India and Nepal weather, geology, topography are similar Nepal is following Indian building design code for designing building. Nepal has also developed its own country building code design. This thesis aims for comparing the building design with Indian building code with that of Nepal Building code. Previously Nepal has old building code designers use to follow that code for designing the building now government has implemented new code for design and analysis of the building In this study RCC building models having G+8 storey is taken for analysis and the regular plan is considered while analyzing the building. The analysis of model is done using ETABS software.

II. OBJECTIVES OF THE STUDY

The chief objectives of this thesis is to anlyse RCC building with 9 storey using both Nepal Building Code and Indian Building Code.We can summarize the objective as follows:

- Making G+8 model in ETABS Software.
- Adopting Equivalent Static method for analyzing the buildings.
- To Comparing the drift value, displacement value, shear storey, storey stiffness of both codes.

III. LITERATURE REVIEW

C. U. Nwoji and A. I. UGWU (2017)[1]:- investigate shear loads under requirements such as "loading analysis," "ease of use," and "technology innovation" for Eurocode 2 and BS 8110 in system layouts. That's something they're looking towards for beam Eurocode 2. The Eurocode2 values are recorded at the rear for maximum spanning moments or shear force value. For Eurocode2, not only column loads but also moment values are often smaller. The BS 8110 values for most span moments are lower than the Eurocode2 values. However, the Eurocode2 values for assist moments in the non-stop beam are higher than the BS 8110 values. It is more versatile, more secure, and more cost-effective to use Eurocode to obtain shear and moment force envelopes than any other method now available. These EC2 moments are larger than those of the BS 8110 values for the basic load (service), resulting in large horrible places, but still the EC2 moments are lesser than just the BS 8110 values for the final load. At the end of the day, they concluded that Eurocode 2 was easier to use, more cost-effective, and more technologically sophisticated than BS 8110.

Mourad M and Bakhoum et al. (2015)[2] : - Evaluate US, ACI, European, and Egyptian building layout regulations are taken into account in the design process. When flexural and compressive stress are applied, the sections are compared for their specific properties, such as their action (mass) and their resistance (power). Concrete and metallic systems serve as the basis for a side-by-side comparison. Differences in the safeguarding factor employed in calculating the resistivity of multiple parts, but also according to distinct design principles, are determined. After comparing the values prescribed in various codes, substantial in-stay load intensities were found. They investigate the Egyptian code, which specifies values that are similar to those in the European Union's building code but only for office buildings. The greatest sectional dimensions and the heaviest metal reinforcement values are often produced under Egyptian specifications. The Egyptian standards for metal flexure additives result in the most significant closing load combination and the lowest sectional capacity. " The ECP203-2007 and AISC-360-10 are unable to accurately compute the axial capacity of metal columns, which is why the EC3 method is used.

A. C. Nwofer (2015)[3]:- Look at where anxiety and shear reinforcements are needed from an economic standpoint and comparing BS8110-97 and Eurocode2 for reinforced concrete beam design. It was possible to use a programmed excel spreadsheet to create a six-span continuous beam that extended from of the top of a 3 story building. Self-weight became the dead loads while the staying loads was thought to be the cohesiveness of the beam itself. They discovered that Eurocode2 needed less hysterical reinforcement at the span and assistance as a result of this. There are three.08 percent and two.83 percent on average for each instance. Additional shear reinforcement is required for BS 8110 than Eurocode2. It is more cautious in terms of loading partial safety when the BS8110 span moment difference exceeds that specified by the Eurocode2 for the mix of lifeless and imposed loads. In this test, the BS8110 needed 1.3% more layout plan hundreds than the Eurocode2 for a mix of live and dead loads. Thus, Eurocode2 is included into your budget layout with the necessary margin of safety.

Labani nandi, Priyabrata guha (2014)[4]: - compared the structure of reinforced concrete structures from a comparably inexpensive point of view using three extraordinary well-known such structural building codes as IS, BS, and EC exist.. The metallic grade of three codes differs, even if their conceptual contents are equal. For slabs, they discovered that the location of steel is most closely aligned with ISO standards, while for beams and columns, ISO standards are most closely aligned with BS, and ISO standards are most closely aligned with EC. ISO standards are most aligned with ISO standards for foundations, whereas ISO standards are least aligned with ISO standards.

Nadhir Al- Ansari et al. (2014) [5]: - Reviewed code for brief records, load correction, geotechnical demands and materials used in concrete were examined in the use of several national building codes of Egypt, Syria, and Saudi Arabia. A comparison of ACI and EC codes was carried out via a case study of a foundation layout, which was developed and assessed using STAAD, in a different location. dependable and secure software The lack of a national building code in Iraq necessitates the use of ACI and EC guidelines in the construction of new buildings. Codes were rewritten in Hammurabi to ensure the safety of building manufacturing. The Saudi Arabian code has become the premier code for the Middle East since it incorporates all of the necessary specifications for construction. Bearing pressure was found to be lower than required by the ACI code after a case study was completed.

C. M. Chan,M. F. Huang (2010)[6]:- showed that wind excitation is more sensitive to higher and more irregularly shaped dwellings. PBD, or performance-based total design, is a cutting-edge method for laying out and developing form. When it comes to designing tall buildings that are wind-resistant, this research uses a computer-aided method to determine the best possible plan. A meticulously developed optimality criteria (OC) technique is needed to find the ideal structural solution that meets the power (existence-safety), flow (damage), and accelerated (occupant consolation) design performance requirements. This research also concludes an integrated wind-prompted dynamic simulation and an automated layout optimization approach based on performance.

Alica E. Diaz De Leon[7]: - confirmed the, building codes have been the principal source of guidance in the design and manufacture of construction methods. Valid knowledge and proper usage of construction plans and designs may be quite important while doing forensic research. Each code is analysed in this document, and a comparison example is provided based on the structure established for each code. IBC and NBCI's burden aggregate case is likewise covered by this. While the IBC permits seismic design criteria to be set at an early design stage, NBCI only calculates seismic loads using the zoned map of the area. In other words, IBC's seismic provisionals are based more on overall performance, but NBCI's seismic provisionals are based entirely on empirical data.

Rajmahendra Manikaro Sawant et al. (2015) [6]: - Examine the effectiveness of steel fibre plus shear reinforcement inside the production of high-grade fibre reinforced concrete. Using push-off specimens, one may do a direct shear test to measure concrete's shear energy. As a function of a shear load per unit location of the plane and the shear pressure, it is calculated (power). Tests were performed on different concrete weights using concrete grade M60 to measure workability, density, as well as shear strength. When compared to regular concrete with such a 1.5% fibre content, shear power rose by 29.42 percent after seven days and by 28.76 percent after 28 days. As stress increases, the structure becomes less brittle and less prone to spalling when it contains more fibres.

IV. METHODOLOGY

Here, two 9 stroey building is taken for the analysis. The building consist of 3 bay in both the direction. It has regular plan and the dimension of the building is kept constant. Here figure 1 shows 3D view of model for both models and figure 2 shows elevation of moel which is similar for both models. Figure 3 represents the wall load acting in the models and figure 4 shows the live load of both models. Figure 5 represents the floor finish load for the both models.

In this study following models are prepared for the study:

First Model 1.Building model using IS Cod IS 1893:2002
Second Model 2. Building model using NBC:105:2020

A. Loads

Dead loads

Brick masonry	:	Unit Weight 20KN/m3
Finishes (Floor Finishes	:	1.5 KN/m2

Reinforced Concrete Elements : UnitWeight 25KN/m3

Live load : 3 KN/m2 on all floors except roof.

Lateral loads : Earthquake Loads as per NBC:105:2020

B. Lateral load

Equivalent static method use for analysis of the building. Parameter considered using NBC code are as follows:

- Zone factor (Z) = 0.4
- Importance factor (I) = 1.25
- Response Reduction Factor (R) = 5(SMRF)
- Soil Type = A"

Load Combination considered in the analysis are mentioned below

1.2 Dead Load+1.5Live Load

Dead Load +0.3Live Load+EQX(Service limit State)
Dead Load +0.3Live Load -EQX(Service limit State)
Dead Load+0.3Live Load +EQY(Service limit State)
Dead Load+0.3Live Load -EQY(Service limit State)
Dead Load+0.3Live Load+EQX(Ultimate Limit State)
Dead Load+0.3Live Load-EQX(Ultimate Limit State)
Dead Load+0.3Live Load+EQY(Ultimate Limit State)
Dead Load +0.3Live Load-EQY(Ultimate Limit State)

Parameters considered using is code are as follows:

- Zone factor (Z) = 0.36
- Importance factor (I) = 1
- Response Reduction Factor (R) = 5(SMRF)
- Soil Type = Medium soil (Type II)"

Load Combination considered in the analysis are mentioned below

Combo1 = 1.5Dead Load
Combo2 = [1.5(Dead Load+Live Load)]
Combo3 = [1.2(Dead Load+Live Load+EQX)]
Combo4 = [1.2(Dead Load+Live Load-EQX)]
Combo5 = [1.2(Dead Load+Live Load+EQY)]
Combo6 = [1.2(Dead Load+Live Load-EQY)]
Combo7 = [1.5(Dead Load+EQX)]
Combo8 = [1.5(Dead Load-EQX)]
Combo9 = [1.5(Dead Load+EQY)]
Combo10 = [1.5(Dead Load-EQY)]
Combo11 = [0.9Dead Load+1.5EQX]
Combo12 = [0.9Dead Load-1.5EQX]
Combo13 = [0.9Dead Load+1.5EQY]
Combo14 = [0.9Dead Load-1.5EQY]

C. Material Properties

- Grade of concrete: M25 for beam and Slab
  M 25for Column
- Grade of steel : Fe 500
- Modulus of Elasticity of concrete (Ec) : 5000√fck N/mm2
- Modulus of Elasticity of Steel (Es) : 2x105 N/mm2

D. Element Dimensions

Following are the element diemension considered in the building for analysi:
Slab =125 mm
Wall thickness exterior =230 mm
Interior wall thickness=115mm
Size of column=700mmX700mm
Size of beam=350mmX650 mm

E. Model Generated in ETABS

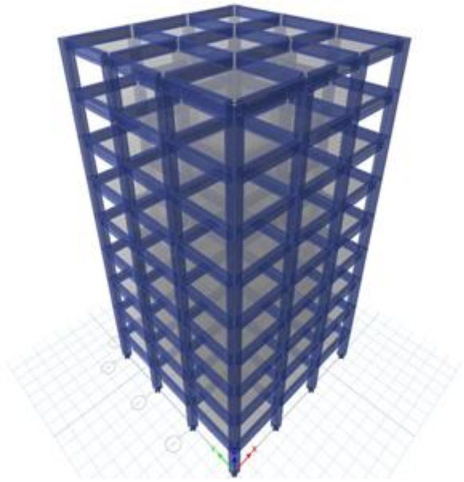

Figure 1: 3D view

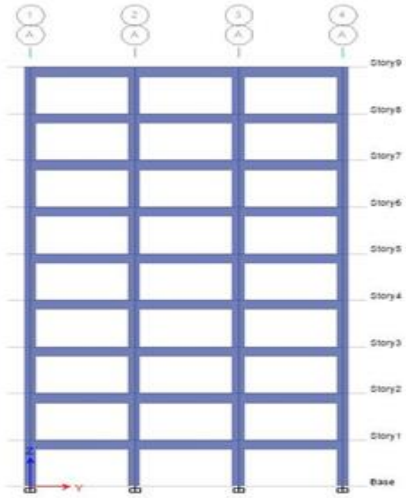

Figure 2: Elevation View

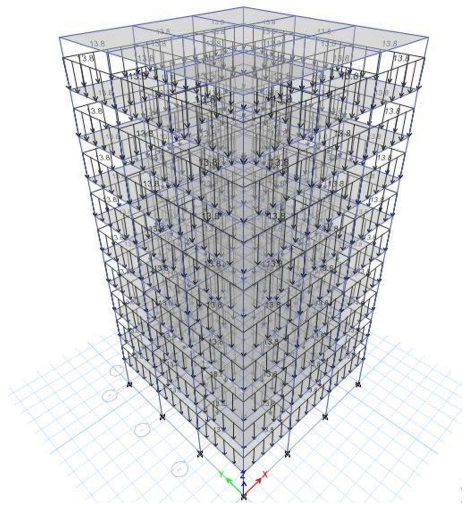

Figure 3: Wall load

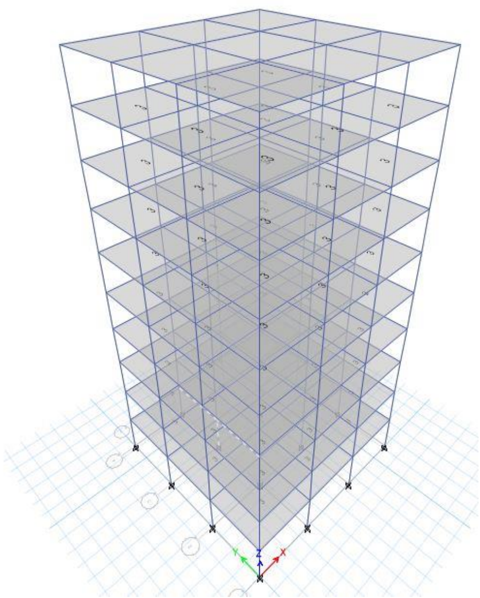

Figure 4: Live load

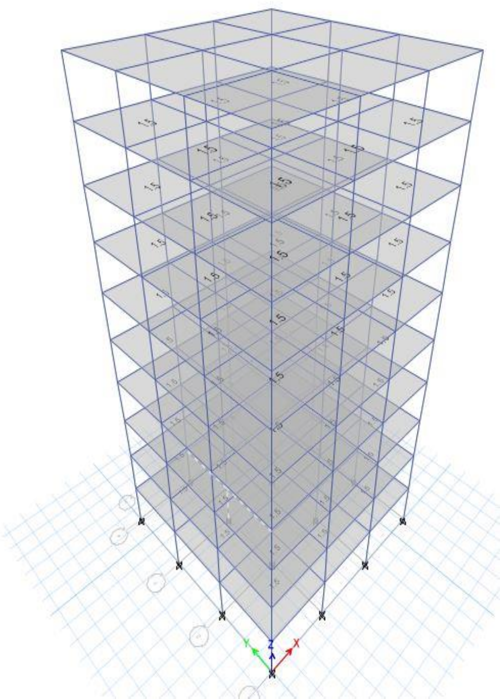

Figure 5: Floor FInish load

V. RESULTS

A. Displacements

Table no.1 shows that Model 2 has the higher displacement than model 1. This shows that building analyzed by NBC 105:2020 has higher displacement value than building analyzed with IS Code.

Table 1: Displacements of models

Storey Level	Displacement	
	Model 1	**Model 2**
9	25.908	38.141
8	24.913	36.913
7	23.085	34.619
6	20.479	31.215
5	17.285	26.841
4	13.69	21.672
3	9.86	15.896
2	5.954	9.754
1	2.267	3.761
0	0	0

Figure 6 which is the graph of displacement for both models which shows that building analyzed by NBC 105:2020 has higher displacement value than building analyzed with IS Code.

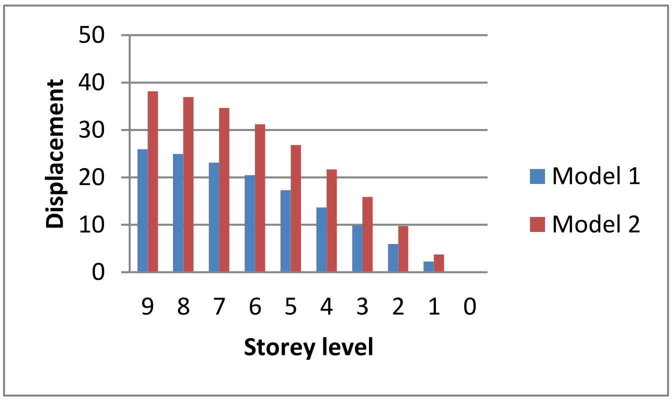

Figure 6: Storey Displacements

B. Drift

Table 2 shows that Model 2 has the higher drift than model 1. This shows that building analyzed by NBC 105:2020 has higher drift value than building analyzed with IS Code.

Table 2: Drift of Models

Storey Level	Drift	
	Model 1	**Model 2**
9	0.000333	0.000412
8	0.00061	0.000765
7	0.000869	0.001135
6	0.001065	0.001458
5	0.001198	0.001723
4	0.001277	0.001925
3	0.001302	0.002048
2	0.001232	0.002002
1	0.000756	0.001254
0	0	0

Figure 7 is showing, which is the graph of drift for both models which shows that building analyzed by NBC 105:2020 has higher drift value than building analyzed with IS Code.

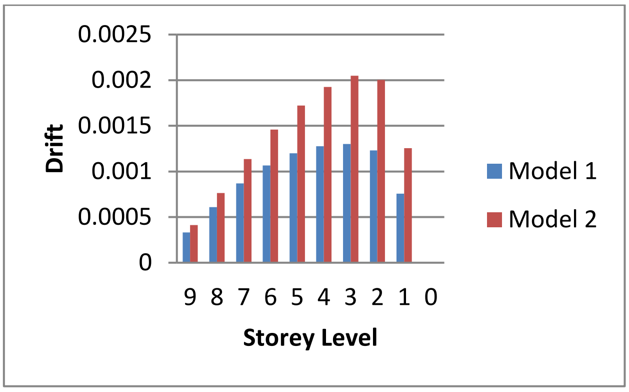

Figure 7: Storey Drifts

C. *Storey Shear*

Table no.3 shows that Model 2 has the higher storey shear than model 1. This shows that building analyzed by NBC 105:2020 has higher storey shear value than building analyzed with IS Code.

Table 3: Storey shear of models

Storey Level	Storey shear kN	
	Model 1	Model 2
9	-241.6427	-266.264
8	-731.4371	-878.6845
7	-1106.436	-1414.5524
6	-1381.9454	-1873.8677
5	-1573.2713	-2256.6305
4	-1695.7199	-2562.8408
3	-1764.5973	-2792.4985
2	-1795.2094	-2945.6036
1	-1802.8625	-3022.1561
0	0	0

Figure 8 which is the graph of storey shear for both models which shows that building analyzed by NBC 105:2020 has higher storey shear value than building analyzed with IS Code.

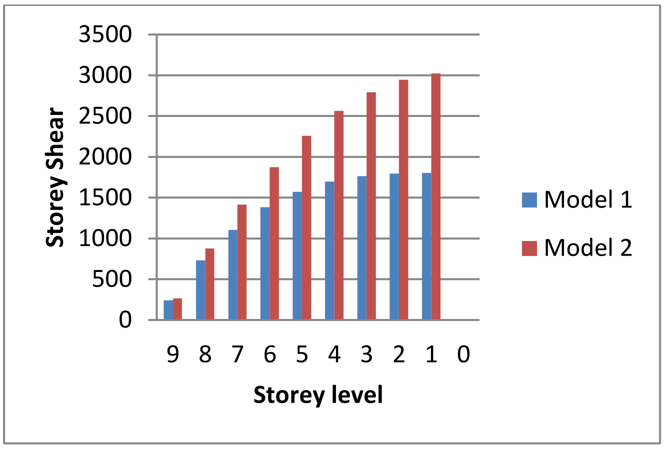

Figure 8: Storey Shear

D. *Overturning Moments*

Table no.4 shows that Model 2 has the higher overturning moment than model 1. This shows that building analyzed by NBC 105:2020 has higher overturning moment value than building analyzed with IS Code.

Table 4: Overturning moment of models

Storey Level	Overturning moment (kNm)	
	Model 1	Model 2
9	0	0
8	-724.9281	-798.792
7	-2919.2395	-3434.8454
6	-6238.5475	-7678.5026
5	-10384.3836	-13300.1058
4	-15104.1976	-20069.9974
3	-20191.3573	-27758.5198
2	-25485.1491	-36136.0151
1	-30870.7773	-44972.8258
0	-36279.3647	-54039.2942

Figure 9 which is the graph of overturning moment for both models which shows that building analyzed by NBC 105:2020 has higher overturning moment value than building analyzed with IS Code.

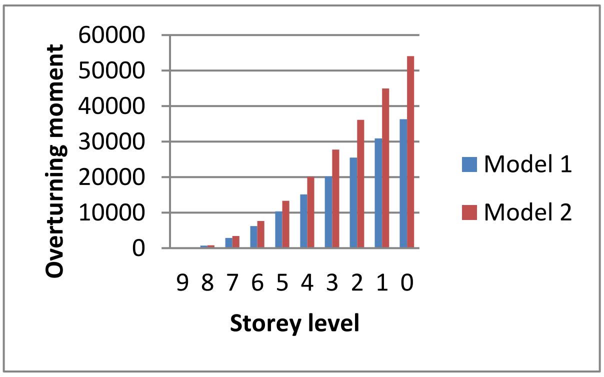

Figure 9: Overturning moment

E. Base Shear

Table no.5 shows that Model 2 has the higher base shear than model 1. This shows that building analyzed by NBC 105:2020 has higher base shear value than building analyzed with IS Code.

Table 5: Base shear of models

Models	Base shear in kN	
	EQX	EQY
Model 1	1802.8625	1802.8625
Model 2	3022.1561	3022.1561

Figure 10 which is the graph of base shear for both models which shows that building analyzed by NBC 105:2020 has higher base shear value than building analyzed with IS Code.

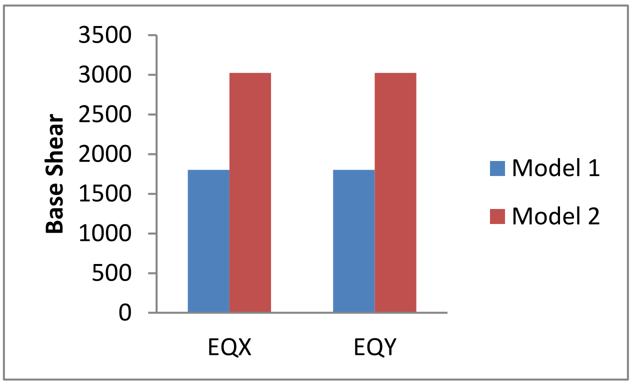

Figure 10: Base Shear

VI. CONCLUSIONS

After analyzing the buildings we get following conclusion:

- The displacement of 9-storey building analyzed using NBC 105:2020 is more as compared to that of building analyzed with IS code.
- The drift of 9-storey building analyzed using NBC 105:2020 is more as compared to that of building analyzed with IS code.
- The storey shear of 9-storey building analyzed using NBC 105:2020 is more as compared to that of building analyzed with IS code.
- The fundamental time period of the building with IS code get reduced.
- The overturning moment in building analyzed with IS code is more than building analyzed with Nepal building code.
- The base shear of model analyzed with IS code is less as compared to NBC.

From above we can see that new Nepal building code has higher value in displacement, drift ,storey shear and base shear in comparison with is code.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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