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A COMPARATIVE STUDY OF SEISMIC DESIGN CRITERIA FOR A 15-STORIED BUILDING UNDER IS CODE 1893 (PART 1): 2016 AND NEPAL BUILDING CODE NBC 105:2020: IMPACTS ON STRUCTURAL PERFORMANCE AND SAFETY

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ABSTRACT
Comparative analysis of the codes is carried out by examining their influence on key aspects such as base shear, lateral forces, inter-story drift, and overall structural performance under seismic loads. By utilizing advanced structural analysis methods, the study evaluates how the differing approaches of these codes impact the safety, cost-effectiveness, and design efficiency of buildings in seismic-prone regions. [1]There was the significant impact due to Gorkha Earthquake in 2015 on building due to which there was a recognized need for updated regulations to ensure the safety and structural integrity of buildings for its design and construction practices in Nepal. [2]There is the study on focusing on different reinforced concrete (RC) building analyzing between Nepal National Building Code and indian standard (IS) codes. There was focus on both previously existing and revised standards using various response parameters through different approaches, including linear and non-linear static and linear dynamic methods. [8] The research specifically examines the RC design codes of Nepal and India to identify the strengths and weaknesses of these codes, particularly in terms of loading analysis, design analysis, usability, and economic factors.
Keywords: High rise building, IS Code 1893 (Part 1): 2016, Nepal Building Code NBC 105:2020, seismic design criteria.

I. Introduction
The existing NBC 105:1994 code was deemed insufficient following the catastrophic Gorkha earthquake and advancements in seismic design. So recognition for an updated code, NBC 105:2020, which incorporates new provisions for various analytical methods and design considerations [1]. The construction of reinforced concrete (RC) buildings has been a prevalent practice for many decades, where was some limitations of traditional unreinforced masonry. The latter often fails to meet the necessary requirement along with integrity and ductility criteria required for safety, especially in seismic regions[2]. Nepal is located in a seismic zone lies within Indian and Eurasian plate. High seismic activities is necessary to minimize damage. Nepal's NBC 105:1994 was the primary code until 2020, revealing shortcomings post-2015 earthquake. Study help to find out different seismic parameters and costs for a residential building using both codes[9].Before the introduction of the Nepal Building Code (NBC) in 1994, structural design for reinforced concrete (RC) buildings in Nepal primarily relied on Indian Standards (IS). This reliance was logical due to Nepal's geographical proximity to India. The NBC 105:1994 was implemented in Nepal after 1994, marking a significant shift in seismic design practices. Despite this, the Indian Standards continued to be popular among engineers, as there were no restrictions on their use at the government level also[12]. There was Comparisons using both code NBC 105:2020 and IS 1893:2016 by comparing ES and RS analyses for a building with three-dimensional FEM analysis conducted based on soil type investigations[13]. Asymmetric structures are at higher risk of collapse or damage during earthquakes. Symmetrical buildings are preferred and have a centered mass and smooth vertical alignment. In the field buildings often have irregularities in design, height, and weight distribution. Vertical irregularities refer to uneven geometry or stiffness in higher stories[14].

II. Literature

Auto CAD

All type of drawing is generally created in the AutoCAD software. This software give the plan, elevation with different layers and colors for the easy understanding of drawing and good presentation for the users. Due to the autocad the job for the engineer is make easy due to its working and better understanding and also easy to change the plan make faster because of layers and its provide too many options for working.

Historical Context of RC Construction:

Actually it has just been four years that reinforced concrete (RC) construction practice in Nepal as a response to the inadequacies of traditional unreinforced masonry (URM) buildings. This change in pattern of construction and implementation of code was necessary to improve structural integrity and ductility, especially in a seismically active region like Nepal [1]. Focusing on the differences between the old IS 1893-2002 and the new IS 1893-2016 code incorporates more realistic assumptions about the behavior of concrete structures, such as using cracked section properties for analysis, which is crucial for accurate seismic performance assessments [4].

Impact on Design Practices:

The revised NBC 105:2020 code will significantly impact the design and assessment of low-rise reinforced concrete buildings in Nepal which encourages structural engineers to adopt more resilient and collapse-preventive designs, moving beyond mere code compliance to ensure better performance during seismic events [1]. The importance factor in seismic design, which varies based on the occupancy and use of the building have introduce an importance factor of "1.2" for residential or commercial buildings with high occupancy, emphasizing the need for enhanced safety measures in such structures [4]. Key performance metrics in seismic analysis included as maximum storey nodal displacement, storey drift, shear force, and bending moments. These metrics help in predicting the seismic performance and behavior of building frames under different load scenarios [14].

Methodology:

The study utilizes both linear and non-linear static analysis, as well as linear dynamic analysis, to assess the performance of low-rise reinforced concrete buildings. This comprehensive approach allows for a thorough evaluation of how different codes impact structural behavior under seismic loads [1].

The study analyzes two types of building models: a 2-storey and a 3-storey structure. These models are essential for understanding how different building heights respond to seismic forces under the two codes involves conducting an equivalent static analysis for the seismic evaluation of the building models. [3].

The analysis mainly focus on storey drift, lateral sway, base shear[3].The study focused on a G+21 reinforced concrete (RC) frame building. Analysis was conducted on the seismic response of buildings underlying different soil type. The researchers utilized ETABS 2016 for the analysis and design of the building models for structural analysis, particularly for buildings, enabling detailed simulations of seismic behavior. The analysis mainly focus on base shear, displacement, design reinforced quality [7].

The study involves two 10-storey buildings, each designed with a regular plan. Both buildings consist of three bays in each direction using ETABS, a widely used software for structural analysis and design. Research include both static and dynamic analysis methods focusing on key parameters such as displacement, storey drift, storey shear, overturning moment, stiffness, base shear, time period, and forces in columns [10].

The study employs two primary dynamic analysis methods: Response Spectrum Analysis and Time History Analysis. These methods are essential for evaluating how structures respond to seismic forces during earthquakes. The analysis is conducted using advanced structural engineering software,

specifically SAP2000 and ETABS to compares the results of Time History analysis with those from Response Spectrum analysis to highlight the differences in predicted structural behavior [11].

III. Conclusion

The study focus on fundamental difference in the design basis between the Indian Standard Codes and the Nepal Building Code. The Indian codes utilize a deterministic approach for seismic hazard analysis, while the revised NBC 105 adopts a probabilistic approach [1].

The results from the analyses using both codes are compared to determine which code leads to higher responses in terms of base shear, lateral sway, and storey drift. The findings indicate that the building models designed using the NBC code exhibit higher values for these parameters compared to those designed using the IS code [3].

The results from the analysis were compared to determine how each code performed under various conditions. For instance, it was found that IS code exhibited higher base shear and displacement for certain soil types, while NBC showed higher values for others [7].

There is the change of approximately 2-2.5% between static and dynamic analyses for the result of drift for G+9-storey building, storey shear calculated using static forces was greater than that obtained from dynamic forces for the 10-storey building. The base shear values from static analysis were lower than those from dynamic analysis. [10].

The results demonstrate that Time History analysis provides a more accurate prediction of structural responses compared to Response Spectrum analysis. The analysis also highlighted the role of infill walls in reducing displacements and increasing base shear, which contributes to the overall stability of high-rise buildings during seismic events [11].

The seismic weight of the building was calculated to be 23820.41 kN under NBC 105:1994 and 23967.71 kN under NBC 105:2020. The analysis showed that the base shear calculated using NBC 105:2020 was considerably higher as 28.59% more for Ultimate Limit State (ULS) and 22.74% more for Serviceability Limit State (SLS) . Also the maximum story displacements were found to be much greater under NBC 105:2020 [13].

IV Future scope

Future research could involve analyzing a wider range of building models, including those with varying heights (e.g., G+20 or G+30) and different architectural configurations.

Can focuses on static analysis, incorporating dynamic analysis methods could yield deeper insights into the time-dependent behavior of structures during earthquakes.

A detailed cost-benefit analysis comparing the economic implications of using NBC versus IS codes could help stakeholders make informed decisions regarding building design and compliance.

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