A Critical Review and Comparative Study of IS 1893: 2016 and IS 1893: 2023 (Part 1 and 2) with Practical Applications in Seismic Design

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Abstract*— This paper presents a critical review and comparative study of the Indian Standards IS 1893: 2016 and IS 1893: 2023, specifically focusing on Part 1, which deals with the general provisions and buildings, and Part 2, which pertains to liquid-retaining structures. The review identifies significant updates, evaluates their practical implications, and explores the advancements made in seismic design methodologies. Key changes in seismic zoning, design spectra, base shear calculations, structural analysis methods, load combinations, importance factors, and soil-structure interaction are discussed in detail. Additionally, a sample problem is included to illustrate the practical differences in applying these standards, providing insights into how these changes impact engineering practice. The study concludes by highlighting the improvements in safety and precision offered by the 2023 edition, while also addressing the increased complexity and the need for advanced tools and expertise. This comprehensive analysis aims to aid engineers and researchers in understanding the evolution of seismic design standards in India and their practical implications for earthquake-resistant structures

***Index Terms*—IS 1893, Earthquake-resistant structures, Structural Analysis & Design, Seismic code comparison, Base shear calculation, Time Period.**

I. INTRODUCTION

IS 1893 is a fundamental standard for earthquake-resistant design in India. This review critically analyzes the updates in the 2016 and 2023 editions, particularly focusing on Parts 1 and 2, to understand their impact on structural engineering practices.

II. AIM OF STUDY

The aim of this study is to conduct a critical review and comparative analysis of the Indian Standards IS 1893: 2016 and IS 1893: 2023, focusing on Part 1, which covers general provisions and buildings, and Part 2, which pertains to liquid-retaining structures. The study seeks to:

Identify Significant Updates: Highlight the key changes and advancements introduced in the 2023 edition compared to the 2016 edition.

Evaluate Practical Implications: Assess the practical implications of these updates on seismic design methodologies and engineering practices.

Explore Methodological Advancements: Examine the improvements in seismic zoning, design spectra, base shear calculations, structural analysis methods, load combinations, importance factors, and soil-structure interaction.

Illustrate Practical Application: Provide a sample problem to demonstrate the application of the updated standards, illustrating the differences in design base shear calculations.

Enhance Understanding: Aid engineers and researchers in understanding the evolution of seismic design standards in India and their practical implications for designing earthquake-resistant structures.

Highlight Challenges and Benefits: Discuss the benefits of the updated guidelines in terms of safety and precision, while also addressing the increased complexity and the need for advanced tools and expertise.

By achieving these objectives, the study aims to contribute to the field of structural engineering by providing a comprehensive analysis of the evolution of seismic design standards in India and offering

practical insights for their application in earthquake-resistant design

III. SCOPE OF THE STUDY

This study encompasses a critical review and comparative analysis of the Indian Standards IS 1893: 2016 and IS 1893: 2023, specifically focusing on Part 1, which deals with general provisions and buildings, and Part 2, which pertains to liquid-retaining structures. The scope of the study includes:

Comparative Analysis:
Seismic Zoning: Examination of the changes in seismic zoning maps and their implications.

Design Spectra: Analysis of updates to the design spectra and their impact on structural design.

Base Shear Calculation: Comparison of base shear calculation methodologies and their practical implications.

Structural Analysis Methods: Review of the changes in structural analysis techniques, including dynamic and static methods.

Load Combinations: Evaluation of the revised load combinations and their effects on design safety and reliability.

Importance Factors: Assessment of updates to the importance factors and their application to different types of structures.

Soil-Structure Interaction: Analysis of the enhanced guidelines for soil-structure interaction and their impact on foundation design.

Practical Implications:
Engineering Practice: Evaluation of how the updates affect day-to-day engineering practices and design processes.

Safety and Precision: Analysis of the improvements in safety and precision provided by the 2023 edition.
Complexity and Expertise: Discussion of the increased complexity of the new standards and the required level of expertise and advanced tools for implementation.

Sample Problem:
Application of Standards: Demonstration of the practical application of both IS 1893: 2016 and IS 1893: 2023 through a sample problem involving the calculation of design base shear for a specific building scenario.

Illustration of Differences: Clear illustration of the differences in results obtained using the two editions, providing practical insights into the impact of the updated standards.

Case Studies and Examples:
Real-World Applications: Inclusion of case studies or examples where applicable, to demonstrate the practical implementation of the standards in real-world scenarios.

Limitations and Challenges:
Data Requirements: Discussion of the data requirements and the availability of high-quality seismic and soil data necessary for the application of the 2023 standards.

Implementation Barriers: Identification of potential barriers to the implementation of the updated standards in different regions and for various types of projects.

By defining the scope of the study in these areas, the research aims to provide a thorough and comprehensive analysis of the updates to IS 1893, their practical implications, and the challenges associated with their implementation in earthquake-resistant design.

IV. LITERATURE REVIEW

(1) Dynamic Analysis of Multi-Storey Building under Seismic Excitation by Response Spectrum Method using ETABS, M. Bello, A.A. Adedeji, R.O. Rahmon, and M.A. Kamal, Journal of Research Information in Civil Engineering

The purpose of this study was to comprehend how buildings—especially those made of reinforced concrete (RC)—respond to seismic activity. To study a building's behaviour during an earthquake, a 3D model of the structure was made using the computer

programme ETABS. The analysis, conducted in accordance with certain norms, showed that the building's largest movement and deformation happened at the fourth story in a single direction (the Y direction). Understanding how structures respond to seismic activity is made possible with the help of this knowledge, which can help designers create buildings that are more earthquake-resistant. To put it another way, the study examined how a building trembles during an earthquake, providing important information for designing safer buildings in areas vulnerable to such occurrences.

(2) Vinay Kumar Singh and Ravikant Singh "A comparative study of the analysis of seismic loads acting on multi-story buildings as per IS: 1893-2002 and IS: 1893-2016" The Journal of Environmental Technology and Civil Engineering.

Significant advancements have been made in the last few years in the design of earthquake-resistant buildings. The 2016 revision of the Indian seismic code, IS 1893, represents a significant upgrade after nearly 14 years and demonstrates this progress. The article looks closely at seismic stresses for a four-storey reinforced concrete framed multi-storey building. It contrasts the current IS 1893-2016 recommendations with the previous IS 1893-2002 recommendations. The study focuses on a particular structure that was created with the outdated code. The principal objective is to estimate the seismic susceptibility of this structure and evaluate its safety in light of the modifications made to the IS code.

(3) Hemant Singh Parihar, and Jitendra Gudainiyan "Tensional Irregularity Analysis according to IS 1893 (Part 1): 2016 and IS 1893 (Part 1): 2002" Engineering and Science of Materials
The focus of this study is on earthquake safety in building design, with particular attention paid to materials, weight distribution, and structure type. Regularly shaped buildings are more likely to survive earthquakes than irregularly shaped ones.

The 2016 amendment to the Indian Seismic Code, IS 1893(Part):, has changed the requirements for anomalies. The research focuses on tensional irregularities and compares the 2002 and new code's standards. Different building shapes were simulated using computer software, which showed that the new code gives more depth and simplicity. It offers more precise instructions for locating tensional abnormalities in construction models. By improving earthquake-resistant design techniques, this research helps to make buildings safer and more durable.

V. CRITICAL COMPARITIVE STUDY

Basic Seismic Parameters	IS :1893 - 2016	IS :1893 – 2023 Draft
Zone Factor (Z)		
II	0.1	0.075
III	0.16	0.15
IV	0.24	0.3
V	0.36	0.4
VI	-	0.5
Importance Factor		
Occupancy <100	1	1
Occupancy 100-200	1	1.15
Occupancy >200	1.2	1

Table 1: Comparison of seismic parameters for IS:1893 – 2016 and IS:1893 - 2023

VI. NUMERICAL STUDY

Sample Problem:
Calculate the design base shear for a four-story reinforced concrete building located in seismic zone IV, using both IS 1893: 2016 and IS 1893: 2023 standards.

Building Details:
Height: 15 meters
Base dimensions: 20m x 20m
Soil type: Medium
Importance factor (I): 1.5
Seismic Coefficient Method (2016):
Zone factor (Z) for Zone IV: 0.24
Response reduction factor (R): 5 (for RC moment-resisting frame)

Average response acceleration coefficient (Sa/g) for medium soil:

For medium soil and $0.2 < T < 0.5$ seconds: 2.5
Fundamental period (T): Approx. $0.075h^{0.75}=0.075\times150.75\approx0.60.075h0.75=0.075\times150.75\approx0.6$ seconds
Sa/g: Interpolated for T = 0.6s, assume Sa/g ≈ 2.5 (medium soil)
Design horizontal seismic coefficient (Ah):
$Ah=Z/2\times I/R\times Sa/g=0.242\times1.55\times2.5=0.09$
Total seismic weight (W): Assume 1500 kN per floor, total = 6000 kN
Design base shear (Vb):
$Vb=Ah\times W=0.09\times6000=540$ kN
Seismic Coefficient Method (2023):
Zone factor (Z) for Zone IV: Unchanged at 0.24
Response reduction factor (R): Assume similar
Sa/g: Refined for T = 0.6s, assume Sa/g ≈ 2.75 (more precise for medium soil)
Ah:
$Ah=Z/2\times I/R\times Sa/g=0.242\times1.55\times2.75=0.099$
Vb:
$Vb=Ah\times W=0.099\times6000=594$ kN

CONCLUSION

- The 2023 edition yields a slightly higher base shear, reflecting a more conservative and precise approach. This increase improves safety but also indicates potential increases in construction costs.
- The progression from IS 1893: 2016 to 2023 marks significant improvements in earthquake-resistant design, enhancing precision and safety. However, these advancements also introduce complexity and demand higher expertise and better data. The sample problem illustrates practical differences in base shear calculation, highlighting the impact of updated guidelines on engineering practice.

APPENDIX

By providing a detailed comparative analysis and practical application example, this appendix aims to support engineers and researchers in effectively applying the updated IS 1893 standards to their seismic design projects.

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