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Impact of Base Isolators on Both Regular and Irregular Structures in High-Seismic Regions of India

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ABSTRACT
Base isolators offer a groundbreaking approach to mitigating earthquake damage to buildings and infrastructure. Unlike traditional seismic design, which relies on heavy reinforcements, base isolators dynamically separate buildings from ground motion. This study examines the impact of base isolators on regular and irregular buildings in high-seismic zones of India through numerical simulations. It evaluates seismic strength by analyzing acceleration, displacement, and structural response, revealing significant differences in behavior between regular and irregular structures. The potential benefits of incorporating base isolators in seismic-resistant design practices are also assessed. The study models four structures: two regular and two irregular, with one of each type using base isolators. By comparing analysis data, the study concludes the effectiveness of base isolators in controlling deformation.
Keywords **—**ETAB, Base Insolation, High Rise Buildings, Regular and Irregular Structures.

I. INTRODUCTION

In high-seismic regions like India, enhancing structural resilience against earthquakes is crucial. Seismic events pose significant threats to buildings and infrastructure, necessitating innovative solutions like base isolation to minimize damage and ensure occupant safety. Base isolation decouples the superstructure from ground vibrations, reducing the transfer of damaging forces and displacements, which challenges conventional designs. Studying base isolators' efficacy in India's diverse architectural landscape and varying seismic hazards is vital. Different regions present unique challenges, and both regular and irregular structures require tailored seismic mitigation approaches. Understanding base isolators' impact on these structures is essential for effective retrofitting and future construction practices. The socio-economic implications of seismic events underscore the importance of robust structural design. In densely populated urban areas, resilient buildings directly impact public safety, economic stability, and community well-being. This research aims to enhance structural performance, reduce vulnerability, and promote sustainable development in high-seismic regions of India.

Base isolation, a key seismic retrofitting technique, decouples buildings from ground motion using specialized bearings. This reduces damaging forces and enhances earthquake resistance. While extensively studied in low-rise and historical buildings, high-rise applications present unique challenges due to their height and mass distribution.

Recent research has explored base isolation in high-rise buildings, focusing on isolator design, structural dynamics, and performance under various seismic scenarios. These studies highlight the benefits and limitations of base isolation, though gaps remain in understanding long-term performance, maintenance needs, and cost-effectiveness.

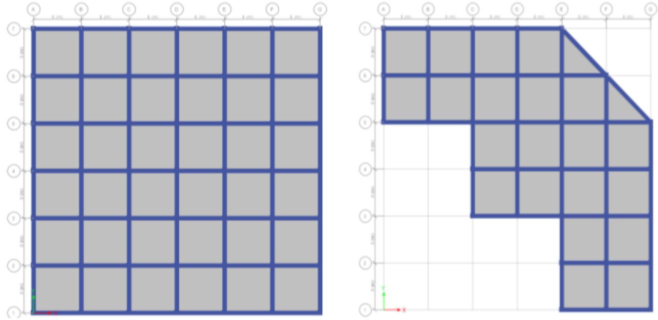
II. PROPOSED METHODOLOGY

Table 1: Geometrical Data

Data	Value
Grade of concrete	M35
Rebar	HYSD 500
No. of stories	G+12
No. of bay along X-direction	7
No. of bay along Y-direction	7
Span along X-direction	5m
Span along Y-direction	5m
Floor height	3m
Column size & Beam size	500*500 mm & 500*400mm
Beam size	500*400 mm
Depth of Slab	200mm
wall load	13.8 KN/m
Live load	3kN/m^2
Software	CSI ETABS
seismic load	IS 1893-2016
Seismic zone	5
Site type	2
Importance factor	1
Response Reduction	5
Seismic Analysis Method	Time History method
Base Isolator	Rubber Isolator

Model Cases

Case-1: Regular Shape Building without Base Isolators
Case-2: Regular Shape Building with Base Isolators
Case-3: Irregular Shape Building without Base Isolators
Case-4: Irregular Shape Building with Base Isolators



i) Regular **ii) Irregular**

Fig 1: Structure in top views

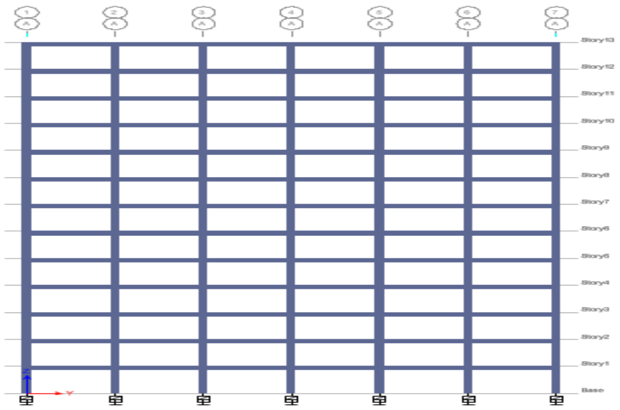
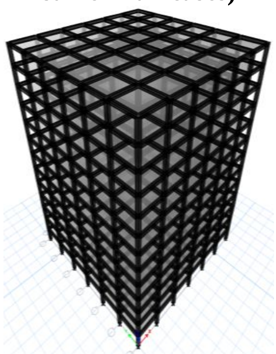
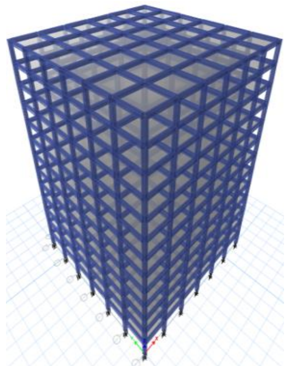


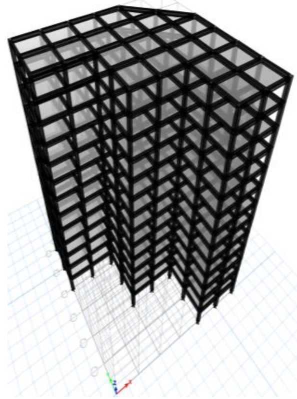
Fig 2: Structure in Elevation view (Elevation view are same in all cases)



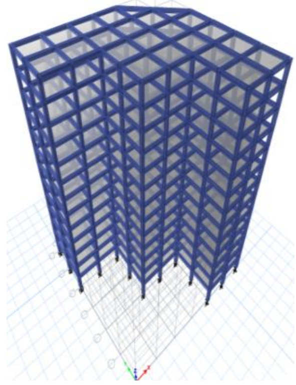
Regular without Base Isolator



Regular with Base Isolator



Irregular without Base Isolator



Irregular with Base Isolator

Fig 3: Structures in Three Dimensional views

III. RESULTS AND DISCUSSION

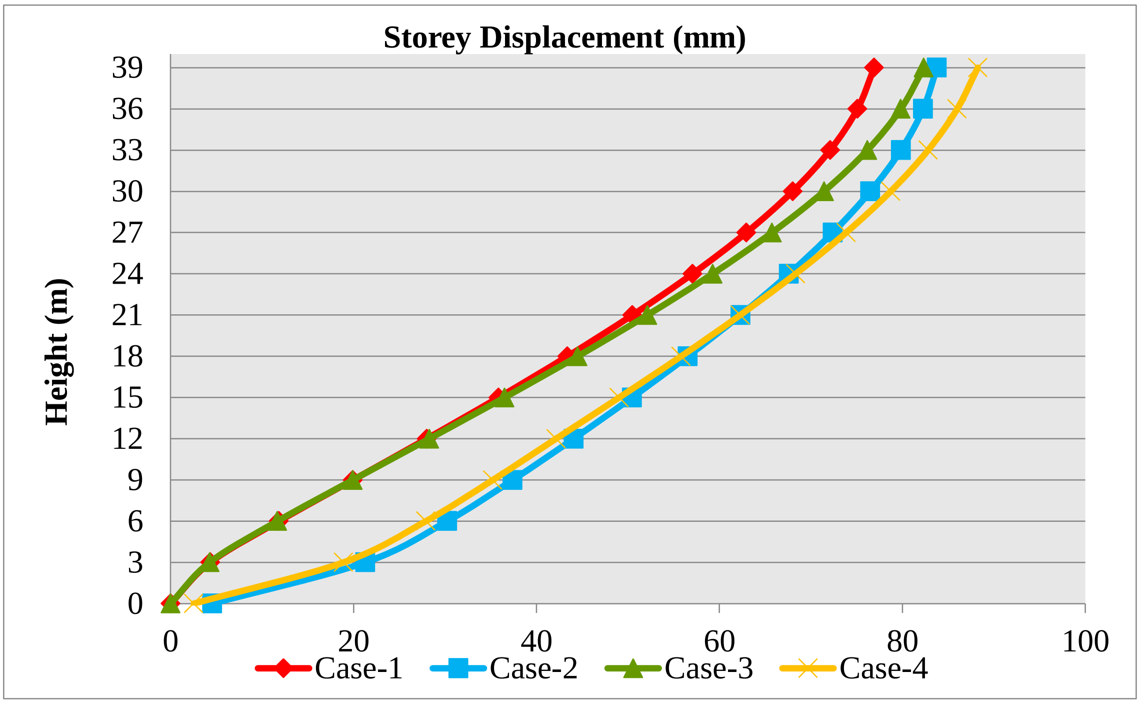


Fig 4: Storey Displacement in different case Scenarios

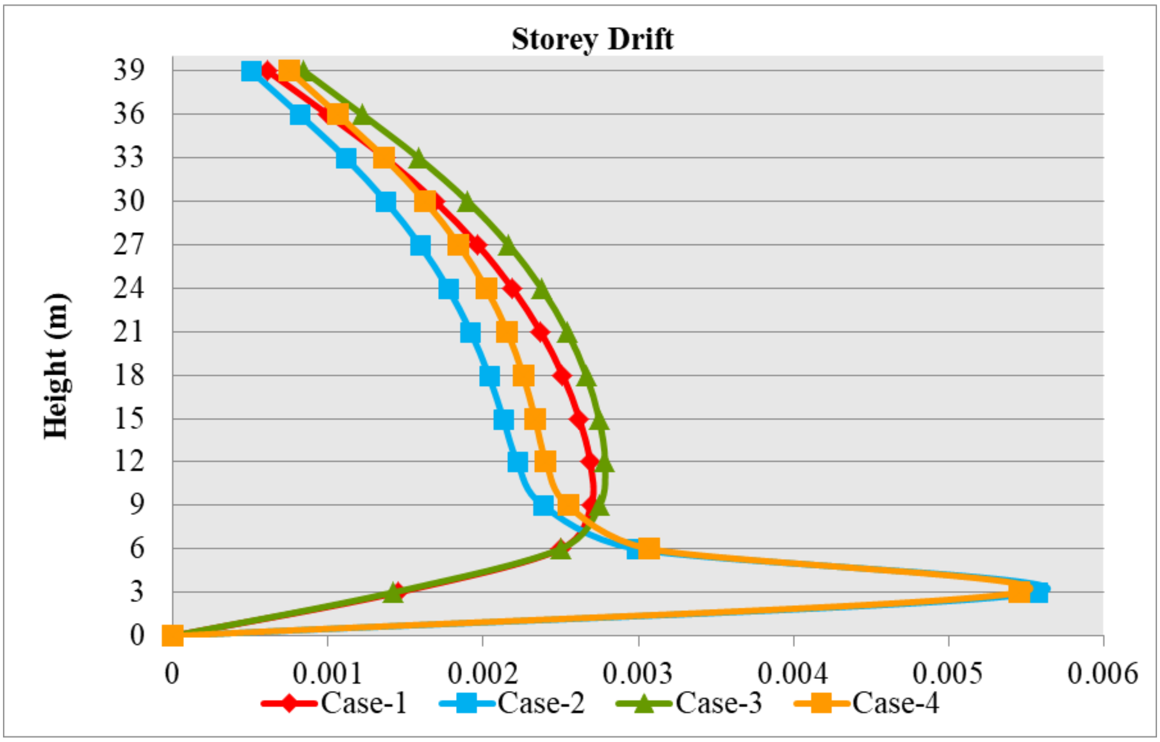


Fig 5: Storey Drift in different case Scenarios

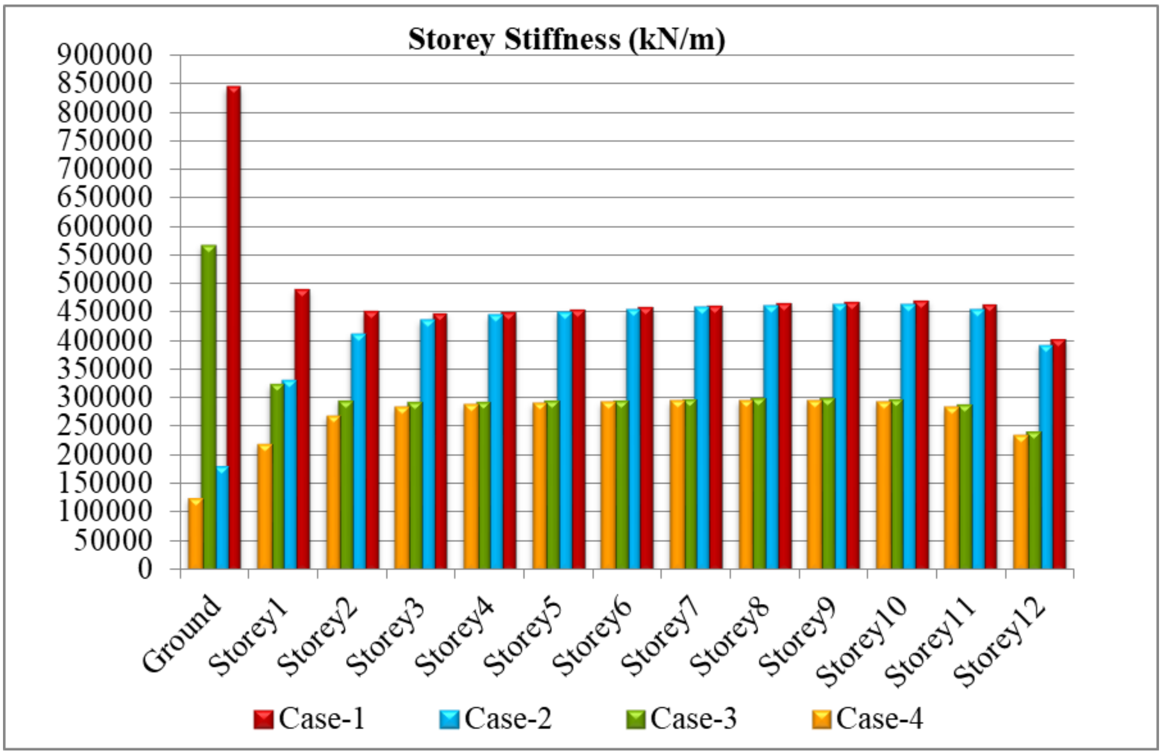


Fig 6: Storey Stiffness in different case Scenarios

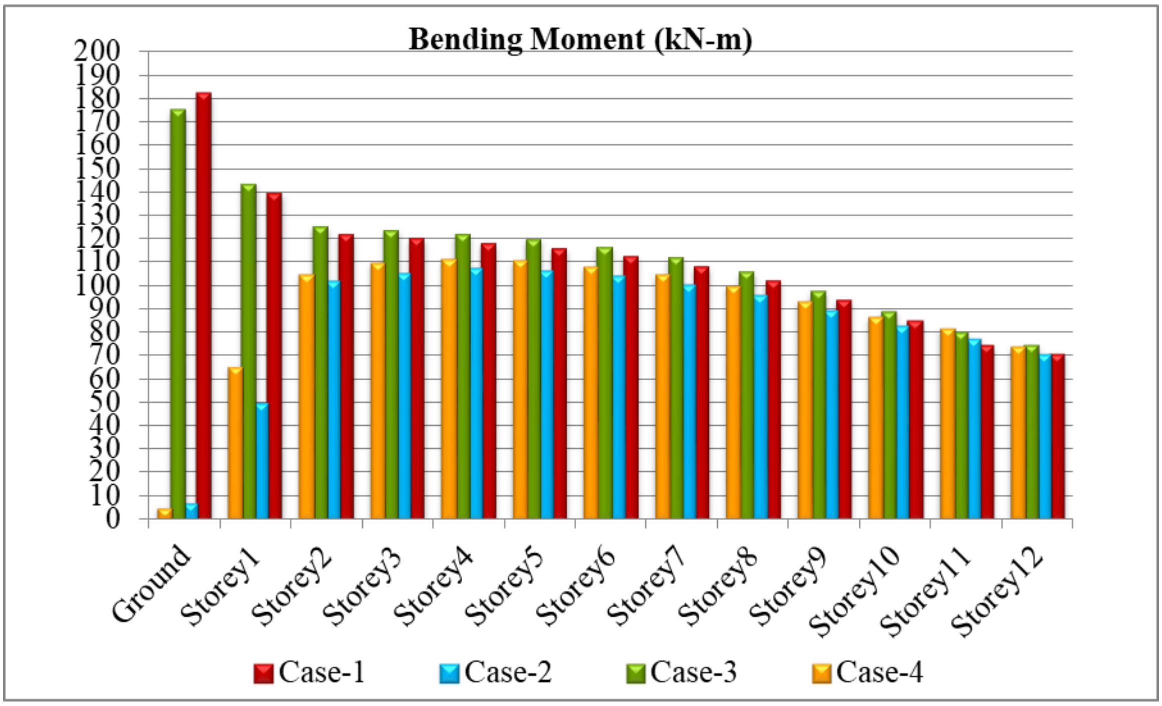


Fig 7: Bending moment in different case Scenarios

IV. CONCLUSIONS

This study compares the impact of base isolators on regular and irregular buildings in high-seismic zones of India through numerical simulations. Key findings include:

- Base isolators increased maximum displacements by 8.91% in regular buildings and 7.14% in irregular buildings.
- Drift values increased with base isolators in both building types.

- Base isolators reduced storey stiffness by 45.05% in regular buildings but increased it by 47.95% in irregular buildings.
- Bending moments decreased by 41.04% in regular buildings and 36.32% in irregular buildings with base isolators.
- Shear forces decreased by 11.32% in regular buildings and increased by 8.23% in irregular buildings.
- Base shear decreased by 19.57% in regular buildings and 17.37% in irregular buildings with base isolators.

Overall, the study highlights the varying effects of base isolators on structural performance, emphasizing their potential benefits in enhancing seismic resilience while addressing specific challenges posed by irregular building geometries in earthquake-prone regions.

REFERENCES

[1] Ruiqi Gao, Keqi Huang, Xiaomin Liu, Junlong Zhou, Qian Zhang, Yikang Li, Hao Xu, Buyuan Tian, Birun Ye and Yichao Zhao, "Analysis and optimization of brace system in scaffold", Journal of Physics: Conference Series, Vol. 2732, The 2nd International Conference on Algorithms, Network and Computer Technology, 2024.

[2] Sapountzakis, Evangelos, Georgios Florakis, and Konstantinos Kapasakalis. "Design and Performance Assessment of Base Isolated Structures Supplemented with Vibration Control Systems." Buildings 14.4: 955, 2024

[3] Manoj Kumar Sharma, Hemant Kumar Sain, "Develop Approximate Analytical Models for Separated Seismic Analysis of Connected Buildings by SAP 2000", International Journal of Engineering Trends and Applications (IJETA), Vol. 11, Issue. 1, pp. 22-26, 2024.

[4] Hemant Kumar Sain, Krishana wadhwani, Rohit Vashishth, Vikash Siddh, "Experimental Study of Floating Concrete With Light Weight Aggregate", Third International Conference on Advances in Physical Sciences and Materials 2022, AIP Conference Proceedings, 2023.

[5] Sneha Mathew, Hemant Kumar Sain, "An Innovative Study on Utilisation of Pareva Dust and Quartz Sand in Concrete", Key Engineering Materials, Vol. 961, pp. 135-140, 2023.

[6] Manoj Kumar Sharma, Hemant Kumar Sain, "A Review on Seismic Analysis of Connected and High Rise Buildings", International Journal of Engineering Trends and Applications (IJETA), Vol. 11, Issue. 1, pp. 18-21, 2024.

[7] Dr. I.C.Sharma Mr Kshitij Gupta, "Structure Health Monitoring Using Vibration-Based Technique", International Journal for research in applied Science& Engineering Technology, Vol. 7, 2019.

[8] Ms Geetanajali Ganguly, Dr. I.C.Sharma, "Sustainable Solid Waste Management, Smart Cities and Swatch Bharat Initiative", Institute of Technology & Engineering Jaipur, 2017.

[9] Binit Gopal*, Hemant Kumar Sain, "Green Concrete Development: Utilizing Coconut Fiber and Rice Husk Ash for Enhanced Strength and Durability", International Journal of Engineering Trends and Applications (IJETA), Vol. 12, 2024.

[10] Pawan Bairwa, Hemant Kumar Sain, "Evaluation of Mechanical Properties of Concrete Reinforced with Natural and Synthetic Fibers", International Journal of Engineering Trends and Applications (IJETA), Vol. 12, 2024.

[11] Ishwar Chand Sharma & Dr. N.C. Saxena, "Engineering Utilization Of Marble Slurry", International journal of civil engineering and technology(IJCIET), Vol. 3, Issue. 2, pp. 1-6, 2012.

[12] Dr I .C.Sharma, Gori Shankar Soni, "Assessment of Limestone Dust and Chips as Eco-friendly Alternatives in Concrete Production", International Journal of Engineering Trends and Applications (IJETA), 2024.