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Seismic Analysis of Fixed Base RC Structure & Base Isolated RC Structure

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Abstract- In the event of an earthquake, the majority of existing buildings that do not meet current seismic requirements may sustain significant damage or possibly collapse. The Base Isolation technique is the most effective seismic protection system to lessen the impact of an earthquake on the structure. By prolonging the structure's life, the base isolation system aims to lessen the inertia force caused by earthquakes. With SAP2000v16 software, the (G+8) storied RC frame structure was examined for two scenarios: fixed base RC structure and base isolation RC structure. Because of its effective outcomes, the analysis's base isolation system is a High Damping Rubber Bearing (HDRB). Models are used for analysis and are designed in accordance with IS 1893:2002. In comparison to the fixed base condition, the final result demonstrates that the HDRB base isolators increase the structure's time period while decreasing storey drift, storey acceleration, storey velocity, and story displacement.

Keywords: Base Isolation, Fixed Base RC Structure ,Seismic Analysis,SAP2000v16 software, HDRB base isolators.

I.INTRODUCTION

Earthquakes pose a significant threat to structures, especially in seismically active regions. Conventional fixed-base buildings are directly subjected to seismic forces, which often result in excessive damage or collapse. The base isolation technique has emerged as a powerful tool for enhancing seismic resilience by decoupling the superstructure from ground motion. This paper presents a comparative study on the seismic performance of a (G+8) reinforced concrete (RC) frame structure under fixed-base and base-isolated conditions using High Damping Rubber Bearings (HDRBs).Fixed Base RC Structure & Base Isolated RC Structure show in Figure 1.

II. PROBLEM STATEMENT

In recent years, earthquakes have caused significant structural damage and human casualties, particularly in buildings not designed to withstand seismic forces. A large number of reinforced concrete (RC) buildings in urban areas were constructed before the implementation of modern seismic design codes. These buildings, especially those with fixed-base foundations, are highly susceptible to seismic damage due to their inability to dissipate or isolate earthquake energy effectively.

Despite advancements in structural engineering, many designers still rely on traditional construction practices, which directly transmit ground motion to the superstructure, resulting in excessive lateral forces, storey drift, and potential collapse. The need for cost-effective and efficient seismic protection

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techniques has led to growing interest in base isolation methods. However, practical implementation and performance evaluation of such systems—particularly using High Damping Rubber Bearings (HDRBs) in mid-rise RC buildings remains underexplored in many regions, including India.

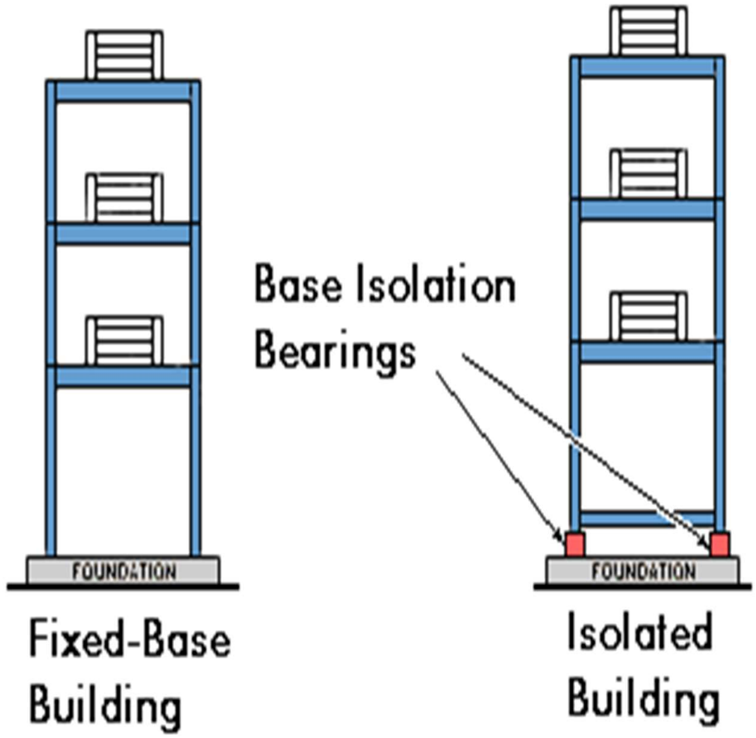

Figure 1: Fixed Base RC Structure & Base Isolated RC Structure.

III. AIM OF STUDY

This study aims to address this gap by analyzing and comparing the seismic response of a fixed-base and base-isolated (G+8) RC structure using HDRBs, based on dynamic analysis performed in SAP2000 software and in compliance with IS 1893:2002.

IV. OBJECTIVE OF STUDY

The main objectives of this research are:

- To model and analyze a (G+8) RC frame structure under two conditions: one with a fixed base and another with HDRB base isolation using SAP2000v16.
- To evaluate and compare key seismic response parameters such as time period, storey drift, storey acceleration, storey velocity, and storey displacement between the fixed-base and base-isolated models.
- To assess the effectiveness of High Damping Rubber Bearings (HDRB) as a base isolation system in reducing earthquake-induced forces and enhancing structural safety.
- To demonstrate the suitability of HDRB base isolation as a seismic mitigation strategy for mid-rise RC buildings in accordance with IS 1893:2002.
- To encourage the adoption of base isolation techniques in the design and retrofitting of earthquake-resistant structures in seismic-prone regions.

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V. METHODOLOGY

Software Used: SAP2000v16
Structure Type: (G+8) RC moment-resisting frame
Modeling Scenarios:
A residential building with (G+8) storey was selected as a test model.The typical floor height is 3m. the plan of the building is as shown in the figure below.

Table 1: Properties of Structure.

Properties	G + 8 Structure
Vertical stiffness (U1)	2812845.46 KN/m
Linear stiffness (U2 & U3)	2454 KN/m
Non-Linear stiffness (U2 & U3)	2069.24 KN/m
Yield strength (Q)	130.14 KN
Damping (β)	0.1

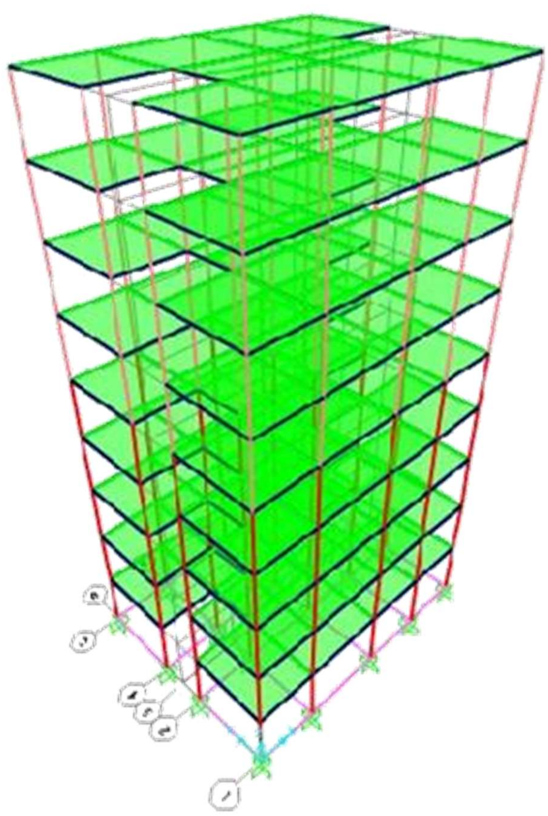

Figure 2: Fixed Base & Base Isolated RC 3D Structure.

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VI. RESULT & DISCUSSION

Case 1: Fixed Base, Case 2: Base-Isolated Design Code Compliance: IS 1893:2002 with Response spectrum analysis was performed, and SAP2000v16 software was used to tabulate and plot the storey displacement, storey velocity, storey acceleration, and time period.

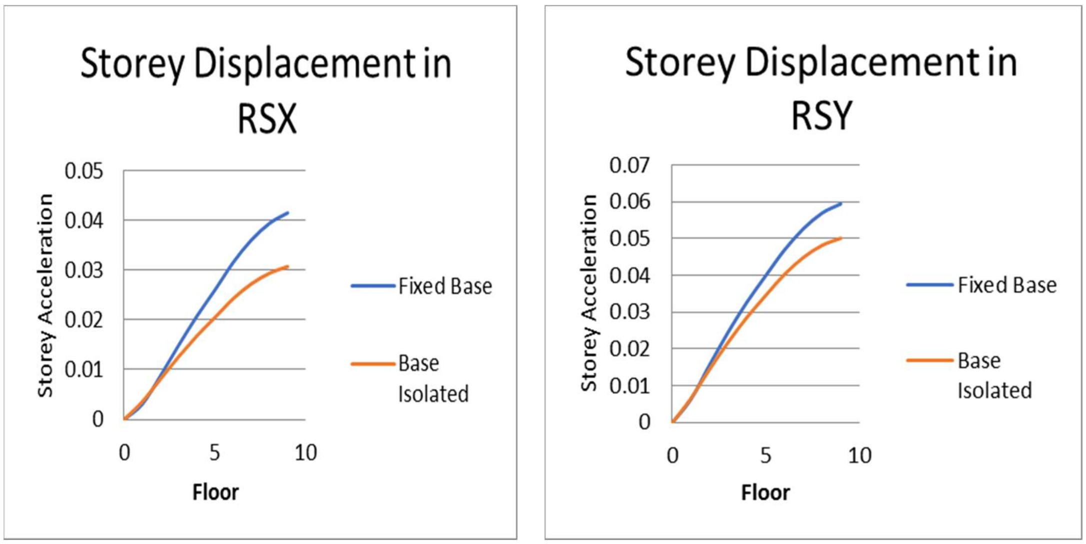

Figure 3: Storey Displacement in X & Y-direction

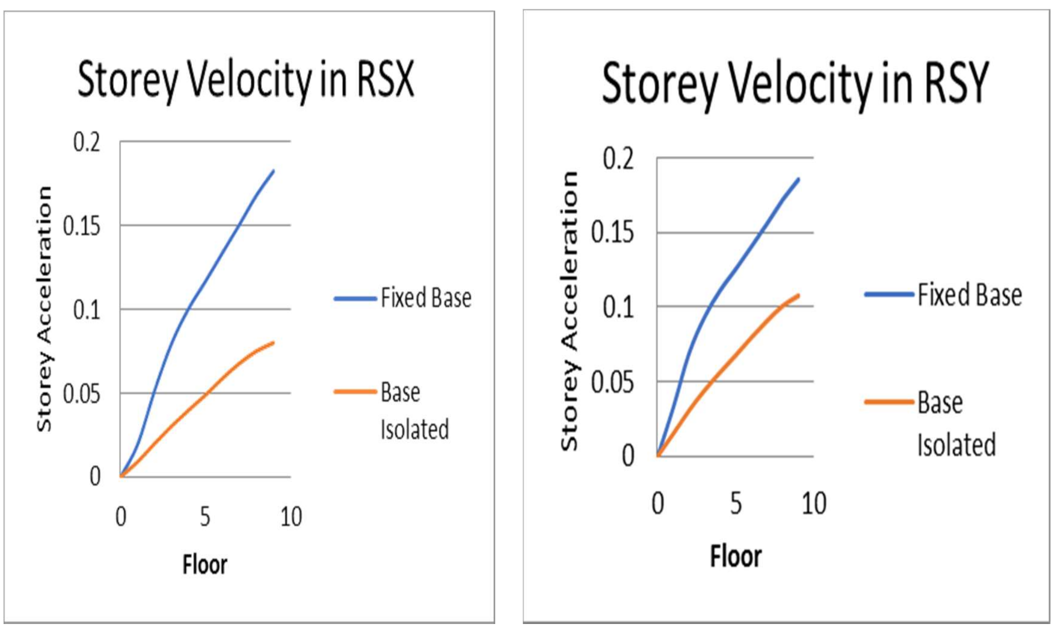

Figure 4: Storey Velocity in X & Y-direction

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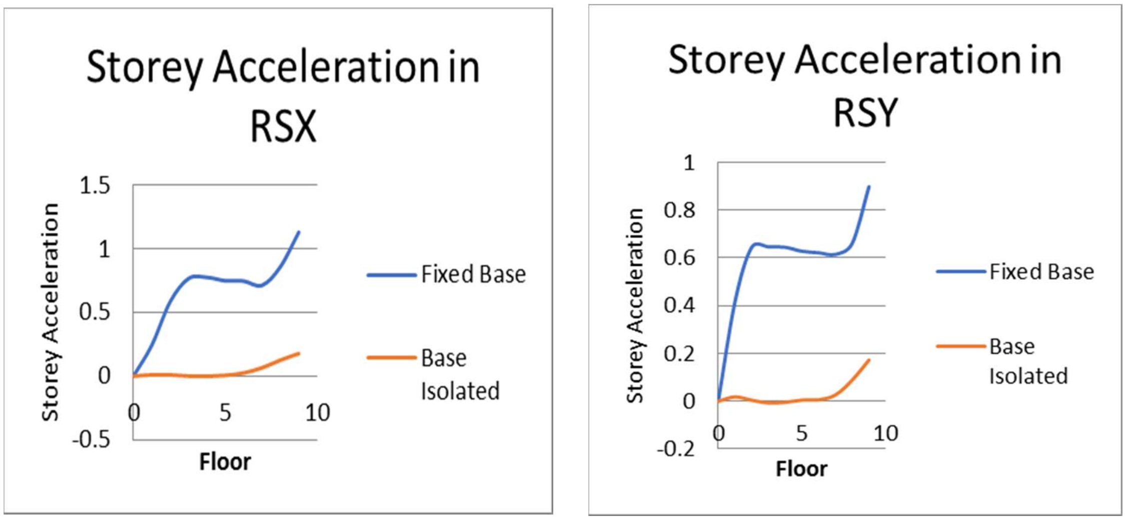

Figure 5: Storey Acceleration in X & Y-direction

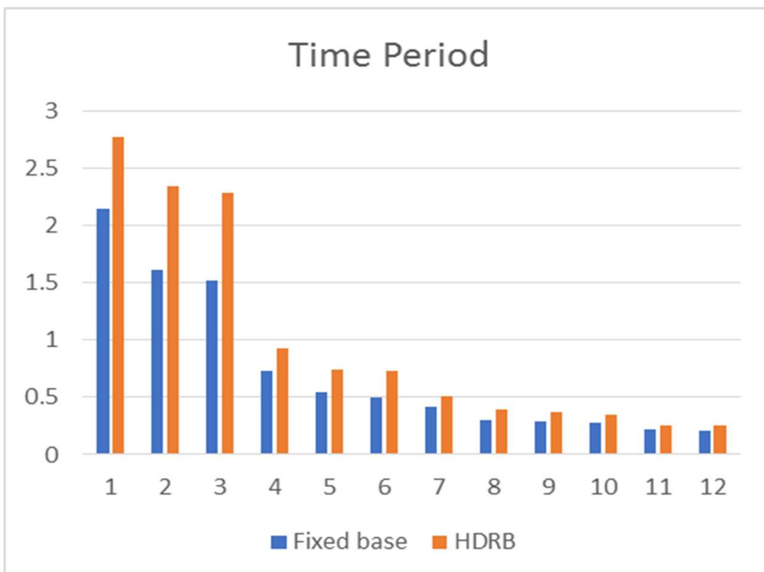

Figure 6: Time Period for fixed base and Base Isolated condition.

VII. CONCLUSION

The following findings are drawn from the comparison of the Base Isolation and Fixed Base methods:

- Compared to permanent bases, HDRB devices aid in protecting buildings from seismic pressures.
- Base isolation also reduces internal forces such as axial force and bending moment in the column, allowing for more efficient design.
- The structure's natural lifespan is significantly extended, resulting in less structural deterioration.

- Storey acceleration is significantly decreased in base-isolated structures with high damping rubber bearings.
- The base isolated structure's time period is longer than that of the fixed base.
- The base isolation approach is effective in many projects since it has been determined to be the most dependable for seismic protection of multistory structures
- In comparison to other systems, base isolation reduces displacement and storey drift in both directions.

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