

## Abstract

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Earthquakes, one of the oldest natural hazards, pose unpredictable threats to buildings and infrastructure, often resulting in significant damage and requiring extensive retrofitting to maintain structural integrity. Despite advances in structural designs, structures remain vulnerable during the hazardous seismic events. Seismic isolation, especially through passive base isolation systems, has emerged as an effective method to enhance flexibility by decoupling a structure's response from ground shaking.

The present study has been divided into six Chapters. In the introductory Chapter, the importance of seismic isolation in structural engineering is highlighted. Seismic isolation serves as the literal and metaphorical safeguard of any structure, ensuring stability and safety during earthquakes. Further, the Chapter 2, review literature sets the stage for the comprehensive understanding of the various seismic base isolation and its effectiveness in mitigating seismic forces. The Chapter 3 investigates the performance of two prominent passive isolators, High Damping Rubber Bearing (HDRB) and Lead Rubber Bearing (LRB), under near-fault and far-fault ground motion conditions. Using ABAQUS CAE for validation, this study provides a comprehensive finite element assessment of HDRB and LRB behavior under various seismic conditions. Initially, each isolator's response is validated against static analysis results from established literature. Subsequently, dynamic simulations under historical earthquake records, including those from Imperial Valley, Northridge, Loma Prieta, Kobe, and ChiChi, events, reveal key insights into each isolator's effectiveness. LRBs demonstrated notable efficiency, with top-of-bearing acceleration reductions reaching 68.42% during the Kocaeli earthquake, while HDRBs provided a 61.80% reduction for the Northridge event. Across various seismic intensities, LRBs consistently showed higher damping capacity, indicating robust performance in minimizing acceleration and deformation.

The research extends to evaluating the dynamic responses of a 10-story reinforced concrete building equipped with HDRB and LRB using SAP2000 in Chapter 4. Parametric variations are introduced to assess the isolators' effectiveness in real-world building applications. Near-fault and far-fault earthquake scenarios are simulated, with ground motions scaled to match the IS 1893 Zone V, medium soil condition, response spectrum using SeismoMatch software. Under both NF and FF earthquake simulations, base isolation systems reduced base shear, peak displacements, and peak acceleration responses, enhancing stability across all floors. These results confirm that base-isolated structures reduce responses significantly, thus protecting both structural and non-structural components.

In Chapter 5, the analysis for sliding isolators with spring combinations has been performed. As accurate dynamic characterization is a cornerstone of effective seismic analysis. This study employs Impact Hammer testing and numerical modeling using Abaqus software to ensure the compatibility of computational models with physical systems. This study conducted the experimental tests on a quarter-scaled by length steel moment-resisting frame using shake table tests compatible with the Pulse Labshop software package. The experimental study examined five configurations: Fixed Base (FB), Sliding Base (SB), Sliding Base with Conical Spring (SB+CS), Sliding Base with Low-Stiffness Linear Spring (SB+LS), and Sliding Base with High-Stiffness Linear Spring (SB+HS), are tested to evaluate the impact of restoring devices on seismic isolation performance.

To verify the mechanical properties of the spring combinations, numerical and experimental force-deformation curves were generated using SOLIDWORKS and a Universal Testing Machine (UTM). The close agreement between these results confirms the reliability of the numerical model. A quarter-scaled three-story moment-resisting

frame was analyzed to compare responses under fixed-base and sliding-base springs combinations, focusing on peak top acceleration response and maximum inter-story drift ratio (IDR). The analysis demonstrates that the sliding base isolation system effectively reduces seismic demands compared to the fixed-base structure. Further, numerical analyses were performed using ABAQUS to verify the experimental results. The close agreement between experimental and simulation data further reinforces the reliability of the developed model. The findings emphasize that while sliding base isolators with spring combinations effectively reduce seismic responses, particularly at high amplitudes and frequencies.

In Conclusion, this study offers a comprehensive assessment of various seismic isolators, affirming the effectiveness of HDRBs and LRBs in mitigating seismic impacts and enhancing structural ability. The numerical and experimental analyses underline the advantages of base isolation, while sliding isolation system with spring combinations present promising avenues for further optimization. Future research could focus on investigating the long-term performance and durability of HDRB, LRB, and sliding bearing hybrid isolators, exploring real life larger structures and varying seismic intensities, and developing advanced computational models to simulate complex interactions in hybrid isolation systems.