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Abstract (Doctor)

Title of Thesis	Seismic Response Control and Pounding Mitigation in Base-Isolated Buildings Equipped with Oblique Short-Stroke Dampers
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Approx. 800 words

Base isolation is a highly effective strategy for mitigating the seismic vulnerability of structures. By interposing low horizontal-stiffness bearings between the superstructure and the foundation, this system decouples the building from horizontal ground motion components, thereby significantly reducing seismic demands. However, severe earthquakes can induce excessive displacements at the isolation layer, particularly when structures are subjected to long-period or pulse-like ground motions. To prevent structural pounding, a sufficient clearance gap must be maintained between the structure and the surrounding perimeter moat wall. Under bidirectional seismic excitation, non-uniform live load distributions (e.g., heavy equipment, furniture, or storage) introduce mass irregularity, even in geometrically symmetric buildings, inducing torsional motions that can trigger localized corner pounding and amplify structural responses. Additionally, conventional design practices frequently assume a perfectly rigid foundation, thereby neglecting soil-structure interaction (SSI) effects, which can significantly alter structural responses depending on the soil characteristics. To address these critical issues, this study systematically evaluates and enhances the seismic performance of base-isolated buildings under pounding conditions, accounting for coupled torsional effects, SSI, and supplemental damping strategies.

In Chapter 2, the impact of uniaxial and torsional pounding on the seismic performance of base-isolated buildings is comprehensively investigated through nonlinear numerical simulations. Linear and nonlinear constitutive contact models are adopted to idealize impact behavior against a concrete moat wall across various clearance gaps and mass eccentricities. The results indicate that narrow clearance gaps increase pounding frequency while significantly amplifying inter-story drifts, floor accelerations, and the impact energy transferred to the moat wall. Furthermore, mass irregularity drives highly non-uniform torsional responses that concentrate peak structural demands and energy dissipation at the building corners.

Chapter 3 evaluates the effects of soil-structure interaction (SSI) on base-isolated buildings featuring varying structural heights and aspect ratios. The soil domain is idealized across hard, medium, and soft geotechnical profiles using modal and nonlinear time-history analyses. Modal analysis reveals that the

fundamental natural periods lengthen with decreasing soil stiffness and increasing building aspect ratio. Conversely, in higher modes governed by rocking behavior, lower aspect ratio structures exhibit more pronounced period elongation. While incorporating SSI generally reduces overall seismic demands, particularly for low-rise structures on soft soil, it significantly increases the base rotation angles of high aspect ratio configurations situated on soft and medium soil profiles.

Chapter 4 proposes and evaluates an implementation scheme utilizing obliquely oriented fluid viscous dampers (FVDs) to mitigate excessive displacements and overcome the stroke limitations of traditional damper layouts under long-period ground motions. Nonlinear time history analyses are executed using five long-period ground motion records scaled to level 2 seismic intensity. The parametric assessment reveals that the damper inclination angle profoundly influences the structural response characterization. Large orientation angles (approaching a horizontal configuration) effectively control isolation layer displacements but amplify inter-story drifts, floor accelerations, and axial stroke demands. Conversely, steeper installation angles mitigate structural drifts and stroke demands at the expense of larger isolation layer displacements. When designed for equivalent target force capacities, smaller installation angles require a larger quantity of dampers but accommodate short-stroke devices, whereas larger angles minimize the device count while increasing individual stroke demands and superstructure accelerations.

Finally, Chapter 5 summarizes the core findings of this study and outlines prominent trajectories for future research.