8th World Conference on Structural Control and Monitoring (8WCSCM)
Orlando, FL, USA 5-8 June 2022

Transmissibility-Based Semi-Active Controller For Enhancing The Seismic Performance Of Base-Isolation Systems

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Base isolation system is widely used to protect important and essential buildings from earthquakes. The base isolator elongates the fundamental period of a structure so that it can effectively reduce the base shear of the isolated structure. When a base isolated structure is subjected to a strong long-period ground motion, however, the base isolation system may not work well because of the resonance effect. In such a case, high damping is effective for reducing the resonance effect. However, high damping increases the acceleration demand under short-period ground motions, leading to a higher risk of damage of nonstructural components. Therefore, low damping may be more beneficial to reduce the acceleration demand under short-period ground motions. The transmissibility-based semi-active (TSA) controller was developed to resolve this issue on base isolation systems, which can make the system damping high under long-period ground motions and low under short-period ground motions by using semi-actively controlled damping devices. In this study, the theory of the TSA controller is introduced, and its performance is evaluated analytically and experimentally. Intensive numerical simulations were conducted for a 3-story building model with magneto-rheological (MR) dampers to obtain the statistical and reliable results with various earthquake ground motions. Additionally, a series of real-time hybrid simulations were also conducted to further validate the performance of the TSA controller experimentally. It was shown that the TSA controller achieves a high level of performance under long-period ground motions, while maintaining the exceptional performance of a conventional base isolation system with low damping under short-period ground motions.