ABSTRACT

This dissertation investigates two alternatives to mitigate the problems generated by internal lateral impacts in structures equipped with frictional isolators. Seismic isolation represents one of the best alternatives in protecting structures. Extreme ground motions that induce internal lateral impacts between sliders of frictional devices and restraining rims of sliding surfaces jeopardize the benefits of using this technology. The first part of this investigation assesses using variable curvature isolators with smooth-hardening behavior as a strategy to mitigate the adverse effects of internal impacts. Although the use of smooth-hardening isolators decreases the probability of observing internal impacts or decreases their intensity, in some cases, employing these devices can decrease the seismic performance of base-isolated structures. Driven by this limitation, the second part of this study presents a new frictional device. The Lateral Impact Resilient Double Concave Friction Pendulum (LIR-DCFP) bearing has an enhanced inner slider. The presence of a plane high-friction interface inside the inner slider provides a mechanism of limiting the maximum force during an internal impact. Furthermore, due to the presence of an internal gap, an additional source of energy dissipation is generated. The last part of this research presents a comprehensive parametric analysis aiming to determine the structural properties that highlight the benefits of using LIR-DCFP devices. LIR-DCFP bearings are recommended for structures designed to behave essentially elastic if the lateral capacity of the isolation system is not overcome. If the non-linear response of the superstructure is exhibited even in the absence of internal impacts, using the new isolator is suggested for rigid structures or for building with relatively high post-yield stiffness. Reductions in the probabilities of exceeding ductility demand thresholds up to 20% are achieved by using LIR-DCFP bearings.

Keywords: Seismic isolation; three-dimensional formulation; Friction Pendulum System; LIR-DCFP isolator; internal lateral impact; high-friction interface; seismic reliability; ductility demand.