

## **The Use of Innovative Base Isolation Systems to Achieve Complex Seismic Performance Objectives**

One concern in the design of base isolated structures is the selection of isolation system properties so that optimal performance is achieved over a range of seismic levels and performance metrics. To withstand very rare ground motions, isolation bearings are frequently designed with significant strength or damping, and as a result such devices provide reduced isolation effect for more frequent seismic events. These frequent events may contribute significantly to expected earthquake losses, and much be considered in the framework of seismic hazard mitigation.

To investigate possible improvements to the design of isolated structures, an extensive research program was conducted. Analytical and experimental investigations are presented to characterize multi-stage spherical sliding isolation bearings capable of progressively exhibiting different hysteretic properties at different stages of response. This presentation summarizes shaking table test results on a 1/4-scale seismic isolated steel braced frame on multi-stage bearings. Behavior of the new triple pendulum bearing is compared with that of linear isolation systems with both nonlinear viscous and bilinear hysteretic energy dissipation mechanisms. From both incremental dynamic analysis and an ensemble of response history analyses, important response parameters for the isolation system and superstructure are reported for all cases considered.

The results of parametric analyses are used to develop a design framework based on targeting a multi-objective Seismic Performance Classification (SPC). This SPC is introduced to describe satisfaction of a complex seismic performance objective, defined as aggregate damage state limitation over multiple levels of seismic hazard. The results of the probabilistic studies demonstrate the importance of limiting both interstory drift and floor acceleration, and the sensitivity of these responses on the level and type of energy dissipation present. The new triple pendulum bearing, along with certain classes of viscous and hysteretic devices, are found to exhibit favorable characteristics toward achieving complex seismic performance objectives.