Impact of near-fault ground motions on the efficiency of viscous-damping systems

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Energy dissipation systems can effectively reduce the seismic demands of structures and protect them from damage. However, the effectiveness of the systems is not entirely independent from the dynamic characteristics of ground motions and may be challenged by long-period velocity pulses in near-fault ground motions. The major focus of this study is to clarify the impact of the characteristics of near-fault ground motions on the effectiveness of energy dissipation systems particularly, structures equipped with viscous dampers.

A series of response-history analyses are conducted using single degree-of-systems (SDOF) with periods varying between 0.2 and 5 seconds and damping ratios between 5% and 50% and subjected to near-fault ground motions. Also, shaking table tests have been performed in National Center for Research on Earthquake Engineering (NCREE) in Taipei, Taiwan. Shaking table tests were conducted to investigate the relationship between the damping reduction factor and the parameter T/Tp, where T is the natural period of the test structure and Tp is the pulse periods of near-fault ground motions used in the test.

The results from both analytical and experimental studies show that the ratio of T/Tp is an important parameter for the damping reduction factor. When the ratio is close to 0.8 through 1, the viscous damping system is more effective in reducing peak displacement and acceleration responses.