Aseismic Protection Of A Nonlinear Base-Isolated Structure Using A Semi-Active Tuned Mass Damper

Liangkun WANG, Satish NAGARAJAIAH, Ying ZHOU

Base isolation can achieve a reduction in floor acceleration and inter-story drift. However, it suffers from excessive displacements under pulse-like and far-field earthquakes. To improve the aseismic performance of passive base-isolated structures, in this paper, a semi-active tuned mass damper (STMD) with variable stiffness and damping is presented. A combined control algorithm based on out-put signals only is developed for the STMD first. Then, the STMD is applied to an eight-story nonlinear base-isolated structure. Lead rubber bearing (LRB) is considered and simulated using the well-known Bouc-Wen model. Eight earthquakes with different spectral characteristics and peak ground amplitudes are chosen, and two passive TMDs are optimized for comparison, while one is tuned to the pre-yield model and the other is tuned to the post-yield model. Numerical results show that, generally, STMD has the best control effect in the nonlinear model. For displacement responses, because STMD can vary its stiffness and damping, it can mitigate the structural first-mode response effectively, and can achieve top story displacement response reduction as well. As for acceleration responses of the top story, STMD achieves excellent performance in the structural second-mode acceleration response mitigation. Therefore, STMD can improve both displacement and acceleration performances of the nonlinear base-isolated structure effectively.