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Vibration-Based Structural Health Monitoring of a 21-Story Building with Tuned Mass Damper in Seismic Zone

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Abstract : The Tuned Mass Dampers (TMDs) are an effective system for mitigating vibrations in building structures. These dampers have traditionally focused on the protection of high-rise buildings against earthquakes and wind loads. The Camara Chilena de la Construction (CChC) building, built in 2018 in Santiago, Chile, is a 21-story RC wall building equipped with a 150-ton TMD and instrumented with six permanent accelerometers, offering an opportunity to monitor the dynamic response of this damped structure. This paper presents the system identification of the CChC building using power spectral density plots of ambient vibration and two seismic events (5.5 Mw and 6.7 Mw). Linear models of the building with and without the TMD are used to compute the theoretical natural periods through modal analysis and simulate the response of the building through response history analysis. Results show that natural periods obtained from both ambient vibrations and earthquake records are quite similar to the theoretical periods given by the modal analysis of the building model. Some of the experimental periods are noticeable by simple inspection of the earthquake records. The accelerometers in the first story better captured the modes related to the building podium while the upper accelerometers clearly captured the modes related to the tower. The earthquake simulation showed smaller accelerations in the model with TMD that are similar to that measured by the accelerometers. It is concluded that the system identification through power spectral density shows consistency with the expected dynamic properties. The structural health monitoring of the CChC building confirms the advantages of seismic protection technologies such as TMDs in seismic prone areas.

Keywords : system identification, tuned mass damper, wall buildings, seismic protection
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