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Active Control Effects on Dynamic Response of Elevated Water Storage Tanks

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Abstract : Elevated water storage tank structures (EWSTs) are high elevated-ponderous structural systems and very vulnerable to seismic vibrations. In past earthquake events, many of these structures exhibit poor performance and experienced severe damage. The dynamic analysis of the EWSTs under earthquake loads is, therefore, of significant importance for the design of the structure and a key issue for the development of modern methods, such as active control design. In this study, a reduced model of the EWSTs is explained, which is based on a tuned mass damper model (TMD). Vibration analysis of a structure under seismic excitation is presented and then used to propose an active vibration controller. MATLAB/Simulink is employed for dynamic analysis of the system and control of the seismic response. A single degree of freedom (SDOF) and two degree of freedom (2DOF) models of ELSTs are going to be used to study the concept of active vibration control. Lab-scale experimental models similar to pendulum are applied to suppress vibrations in ELST under seismic excitation. One of the most important phenomena in liquid storage tanks is the oscillation of fluid due to the movements of the tank body because of its base motions during an earthquake. Simulation results illustrate that the EWSTs vibration can be reduced by means of an input shaping technique that takes into account the dominant mode shape of the structure. Simulations with which to guide many of our designs are presented in detail. A simple and effective real-time control for seismic vibration damping can be, therefore, design and built-in practice.

Keywords : elevated water storage tank, tuned mass damper model, real time control, shaping control, seismic vibration control, the laplace transform
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