

Seismic Applications of Viscoelastic Dampers

by Tsu T. Soong

Abstract

The application of viscoelastic materials to vibration control can be dated back to the 1950's, when they were first used on aircrafts as a means of controlling vibration-induced fatigue in airframes. Its application to civil engineering structures appears to have begun in 1969 when 10,000 viscoelastic dampers were installed in each of the twin towers of the World Trade Center in New York to help resist wind loads. The major objective of this research project was to investigate the feasibility of using viscoelastic dampers in structures to protect against seismic loads. For seismic applications, larger damping is usually required in comparison with that required for mitigation of wind-induced vibrations. Furthermore, energy input into the structure is usually spread over a wider frequency range, requiring more effective use of the viscoelastic materials.

Collaboration

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Both steel and concrete structures were considered in this program. Extensive analytical and experimental investigations have led to the development of a design strategy for incorporating viscoelastic dampers into steel-frame structures. In turn, they have led to the first seismic upgrade of an existing steel frame building using viscoelastic dampers in the United States in 1993. Significant progress has also been made in the quantification of the influence of viscous and elastic stiffness properties of dampers during the inelastic response of reinforced concrete structures. Furthermore, it has been shown that a design procedure for viscoelastic dampers as applied to concrete structures can be formulated similar to that developed for steel frame structures.