Protective Systems for Bridges: Sliding Seismic Isolation Systems

by Michael Constantinou

Abstract

A significant number of bridges are seismically isolated throughout the world. Applications of bridge seismic isolation systems in the U.S. have been primarily with lead-rubber bearings, and a few with sliding bearings. Currently in the U.S., about 60 isolated bridges with a total deck length exceeding 12 km, have either been completed or are in the construction or design stage. Japan recently moved towards a cautious implementation of modern isolation systems in bridges, having previously used an early form of a sliding bearing-viscous damper isolation system in over 100 bridges of the Shinkansen. So far, the application is restricted to primarily longitudinal isolation using elastomeric systems.

Despite the wide implementation of sliding isolation systems in bridges, their evaluation has been largely based on component testing and analysis, without large scale shake table testing having been conducted. Furthermore, a number of sliding isolation systems have been implemented in buildings but not evaluated for bridge applications, while other systems have been proposed but not experimentally evaluated.

In 1991, NCEER and Taisei Corporation began a collaborative research program on the experimental study of advanced sliding seismic isolation systems for bridges. The project had the objectives of producing and experimentally verifying a class of sliding isolation systems by modifying and/or adapting existing technology. Particular emphasis was given to the adaptation and use of aerospace and military hardware Furthermore, the project included the study of established sliding isolation systems which have been used in a number of other applications.

A 160 kN, quarter length scale bridge model with flexible piers was used for the test program. The model could be configured to resemble either a non-isolated multiple-span bridge, or singly-, two- and multiple-span isolated bridges. Three isolation systems were tested. (a) systems consisting of flat sliding bearings and restoring force devices in the form of rubber springs with fluid dampers or fluid restoring force/damping devices, (b) spherically shaped (friction pendulum system) sliding bearings; and (c) lubricated sliding bearings with yielding steel dampers.

All systems were configured for areas of strong seismic loading such as California and Japan, and all were characterized by significant energy absorption capability. However, the design criteria were different in the three basic types. In systems type (a), the design criteria were to reduce the transmission of force to the bridge substructure while restricting bearing displacements to less than 200 mm (8 in) in prototype scale In systems type (b) and (c), the design criteria were to minimize the transmission of force to the bridge substructure without restricting the bearing displacements

Collaboration

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