Development of Passive and Semi-Active Sliding Bearings

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Abstract

Design and construction of buildings, bridges and other constructed facilities to satisfy their performance criteria such as life-safety, durability and human comfort under severe environmental conditions such as strong earthquakes have been the challenge to the civil engineer. The recent emergence of high-tech materials and precision instrumentation techniques are playing an important role in responding to this challenge on the part of the civil engineer. Utilization of active, semi-active and hybrid (including base isolation) control techniques to confine the structural response within the response criteria has begun to be recognized as a viable alternative to designing and constructing structural systems strong enough to perform under the worst possible loading conditions.

This study demonstrates that friction base isolation systems, especially those equipped with a friction controllable device, offer more desirable base isolation characteristics. This demonstration was done through experimental analytical and numerical effort, by developing sliding base isolation systems with and without friction controllable devices and by verifying their base isolation capabilities for bridges and buildings through shake table tests and a numerical simulation study

For bridges, passive sliding base isolation systems were primarily used. The shake table experimental results strongly suggested that the deck acceleration and pier shear force of the bridge isolated by a sliding system can be confined to constant values independent of intensities of input ground (shaking table) acceleration In particular, with the rubber restoring device installed, there was no residual displacement in the sliding system after each earthquake. It was also shown that numerical simulation is highly reliable and can be used for design purposes.

For buildings, friction controllable base isolation systems were tested, analyzed, and used for semi-active control of building motion. The advantage of the friction controllable sliding isolation system was such that, for small to medium earthquakes, the friction is controlled to make the building slide easily so that the transfer of the seismic force to the building is minimized For stronger earthquakes, the friction is controlled to confine the sliding displacement of the structure to an acceptable range and at the same time the transfer of seismic force can be kept under an acceptable level. The control of the friction force can be achieved by means of the instantaneous optimal control algorithm which is implementable for real-time and on-line control operations Finally, it is important to note that the reliability of this system can be more easily tested and established through field experiences than the passive sliding isolation system, since this system is more likely to be activated under smaller earthquakes which occur more frequently.

Collaboration

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