

SEISMIC PROTECTION OF MUSEUM ARTIFACTS USING BASE ISOLATION

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INTRODUCTION

Base isolation technologies have been used traditionally to improve the seismic performance of buildings and other large structures such as bridges. In recent years, the application of base isolation has been gradually extended to smaller structures (e.g., private housing, computer servers storing valuable data and seismic protection of museum artifacts). Installation of base isolation systems beneath showcases or sculptures displayed inside or outside museums provides effective protection of important and rare cultural properties and works of art.

Avoiding the permanent loss or breakage of irreplaceable or expensive assets during a seismic event is very important.

Generally, stiff structures (i.e. buildings with predominant vibration periods in the range of 0.1 to 0.4 sec in which category the majority of museum buildings can be grouped) tend to amplify the incoming earthquake ground motion approximately 2 to 3 times. Therefore, special measures need to be considered in order to reduce the intensive shaking that leads to damage during seismic events.

Current seismic design codes consider showcases, preservation racks and shelves as non-structural elements or components. Their seismic design is covered by code provisions for non-structural elements, which focus mainly on the design of the connection of the non-structural elements to the main structural system. Ensuring the seismic integrity of the connection between the building structure, shelves, and showcases does not guarantee the safety of the showcase or shelf contents. Significant motion of artifacts supported on or housed within display cases can occur even during moderate seismic events generating peak ground acceleration of 1 to 2 m/s^2 (see Figure 1), leading to damage. To improve the seismic performance of non-structural components and avoid the permanent loss or breakage of irreplaceable or expensive assets, application of effective technologies, that can control the seismic response of non-structural components, is needed.

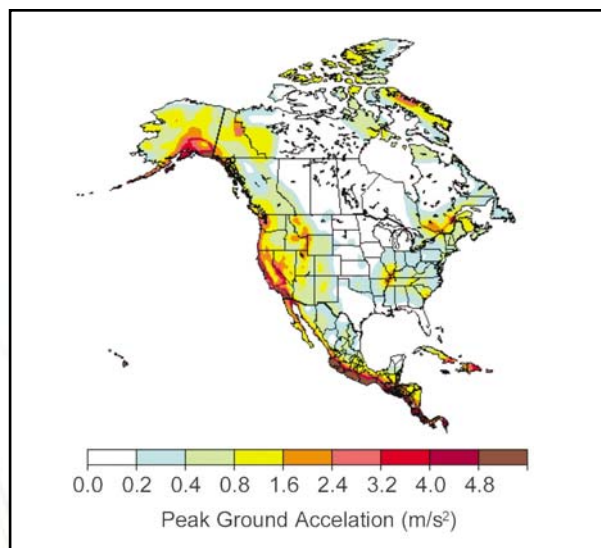


Figure 1: North American Seismic Activity
Peak Ground Acceleration (m/s^2)

RECENT DEVELOPMENTS AND APPLICATIONS

Recently developed compact base isolation systems for small-scale structures are based on sliding, rolling and rubber bearing techniques. Among them, the rolling type design has been used in museum showcases and has proved to be a very effective base isolation system for seismic protection of museum artifacts.

HOW BASE ISOLATION WORKS

Two horizontal platforms (Figure 2) that can move freely against each other in one orthogonal direction only are installed underneath existing or new showcases. By tuning the dynamic characteristics of the base isolation system so that its motion in the presence of a seismic event offsets the motion of the supporting structure, a significant reduction of the seismic response can be achieved (Figure 3). Depending on the showcase or display location inside the museum, the base isolation design can be easily adapted to meet the aesthetic and seismic performance requirements. For the existing showcases enclosed directly against a wall, the base isolation system can be designed in the form of an integrated set of isolated platforms that can be installed within the showcases, offering a cost and time effective solution. Applications are not limited to indoor use as base isolation systems have been installed outdoors for sculptures and statues.

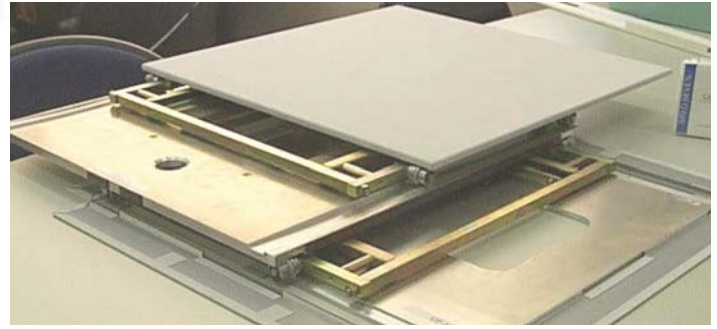


Figure 2: Two platforms move freely against each other in one orthogonal plane (courtesy of AS Inc., Japan)

OTHER IMPORTANT CONSIDERATIONS

The evaluation of seismic performance of base isolation systems for museum artifacts requires detailed information on the system's fundamental dynamic response properties as well as a reliable prediction of input motion characteristics (i.e., ground motion during an earthquake) at the site where the museum is located. This would normally lead to additional analysis to generate site-dependent input ground motions needed for performance evaluation.

In most cases, analytical methods are used for seismic performance evaluation. However, in some complex situations, shake table testing may be required.



Base Isolation System

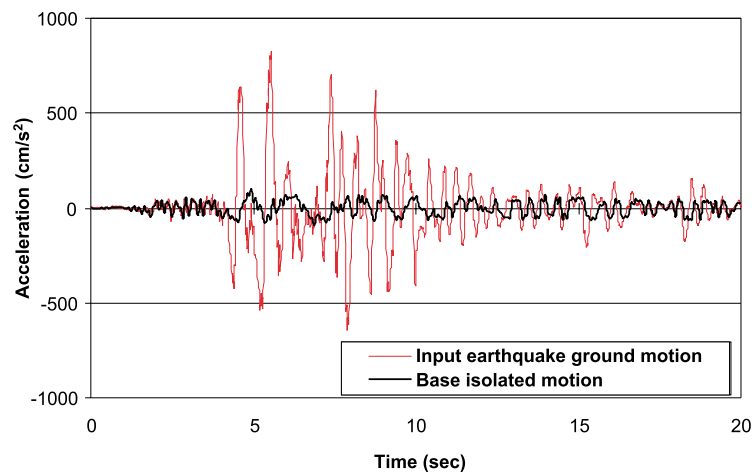


Figure 3. Illustration of beneficial effects of base isolation application to the museum artifacts (courtesy of AS Inc., Japan)

REFERENCES

Myslimaj, B., Gamble, S., Chin-Quee, D., Davies, A. and Breukelman, B. (2003). Base Isolation Technologies For Seismic Protection Of Museum Artifacts. *The 2003 IAMFA Annual Conference in San Francisco, California*. September 21-24, 2003. (see the paper at <http://go.rwdi.com/t21>)



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