Research on seismic performance of cabinet stored artefacts and related damping methods

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ABSTRACT

The forbidden city, the former Chinese imperial palace, now houses the Palace Museum. It is not only famous for its splendid wooden palace complex, but also prestigious for the millions of precious artefacts stored. The forbidden city is located in the centre of Beijing, which is a high seismic hazard zone. Wooden structures usually perform well during earthquakes because of their large deformation and damping capacities. Meanwhile most artefacts are fragile due to their delicate shapes and aging issues, and also due to their unanchored place form. Only a few of those artefacts are on exhibit, while most of the others are placed in cabinets and stored in warehouses. This paper focuses on seismic protection of these cabinet stored artefacts. Considering the tremendous amount and the rigorous requirements for moving the artefacts, base isolation is not a favoured method. Using base isolation requires lifting the artefacts or cabinets while installing isolation bearings and this is very time consuming because of the rigorous requirements for moving artefacts. Also, artefact damage might happen during this process. Thirdly, much more spaces are required to accommodate the potential isolation deformation. Considering all these adverse aspects, this paper tries to use dampers to connect all adjust cabinets to enhance the integrity and increase the damping ratio and thus protect the stored artefacts. This method is applicable for both new and existing cabinets. No artefact movement and extra space are required. All the dampers are installed with mechanical buckles and the whole installation is reversible. In order to validate the effectiveness of this method, shake table tests and finite element analyses based on practical cabinet layout with and without this damping method are designed and conducted. Dynamic responses of the cabinets with and without dampers are observed and compared. Meanwhile, effectiveness of this damping method is compared with rigid connection. Rigid bars are used to connect the adjusting cabinets which can offer better integrity but less damping capacity. Seismic responses of the artefacts in the cabinets under non-control, damper connection and rigid bar connection are compared. Seismic performance of stored artefacts based on indices including overturning and sliding under these control schedules are evaluated. Both test and numerical results demonstrate the damper connection is effective at reducing cabinet and related artefacts responses, it performs better than rigid connection.

KEYWORDS

Artefacts, cabinet stored items, overturn, seismic protection, slide, the Forbidden City

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