Development of a Wireless Acceleration Measurement System

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ABSTRACT

In Japan, since the occurrence of the 1995 Southern Hyogo Prefecture earthquake, there has been a growing interest in the study of earthquake resistance of historical buildings such as traditional wooden buildings. Therefore, a considerable amount of research and examination have been conducted on this subject. Currently, it is common to conduct seismic diagnosis of historical buildings, quantitatively evaluate seismic performance, and perform seismic reinforcement.

In seismic diagnosis of historical buildings, it is important to understand the building vibration characteristics using seismic measurements. However, it is necessary to conduct such measurements nondestructively to prevent damage to the structure. To conduct nondestructive seismic measurements, using a wireless acceleration measurement system which can be easily installed without any wiring is effective. However, wireless acceleration measurement systems with high accuracy of time synchronization, which can be used in buildings and structures, are few.

Therefore, we developed a wireless acceleration measurement system that can be easily installed in historical buildings. The recently developed low-cost, high-precision micro–electro–mechanical systems sensor is adopted as the acceleration sensor with a communication frequency of 920 MHz, which offers stable communication even in a building with many obstacles.

To analyze building vibrations, high accuracy of time synchronization between sensors is required. By conducting a synchronization test to confirm the time synchronization accuracy between the developed sensors, it was confirmed that the time synchronization error between each sensor is within 3 milliseconds.

In addition, to compare the measurement accuracy of the newly developed acceleration measurement system with that of the wired acceleration measurement system, we conducted an excitation experiment using a model. It was confirmed that the newly developed system had the same measurement accuracy as that of the wired system.

Subsequently, the measurement system was installed in a real building for a comprehensive test, and a demonstration experiment of communication status and seismic measurement was conducted. During several earthquakes, which occurred during the demonstration test, the response acceleration generated in the building was measured, and measurement records were easily collected at remote locations.

The abovementioned results confirm that the newly developed wireless acceleration measurement system is capable of stable acceleration measurement and communication in buildings.

REFERENCES

[1] Cultural Properties Protection Department, “Guidelines for Assessing Seismic Resistance of Important Cultural Properties (Buildings), June 21, 2012.