Study for Achieving Real-Time Seismological Observation

Background and Purpose

In recent years, earthquake disasters have occurred frequently, and the building safety became a problem during the 2016 Kumamoto Earthquake and the 2011 Tohoku-Pacific Ocean Earthquake.
Research on seismic observation and structural health monitoring (SHM) of buildings is underway, but there are very few examples of high-density seismic observation of buildings.
Therefore, we ultimately aim to develop structural health monitoring of buildings. To that end, we will enhance the seismic observation records inside the building. Reporting seismic observation information in real time is important information for proper initial response to earthquake disaster countermeasures.
In this study, we will carry out seismic observations on buildings and ground.We will consider how to acquire and publish seismic observation information in real time.
We think that what kind of index should be calculated from the seismic waveform data will be useful for disaster prevention and mitigation.

Buildings conducting seismic observations

● : MEMS sensors 24 units

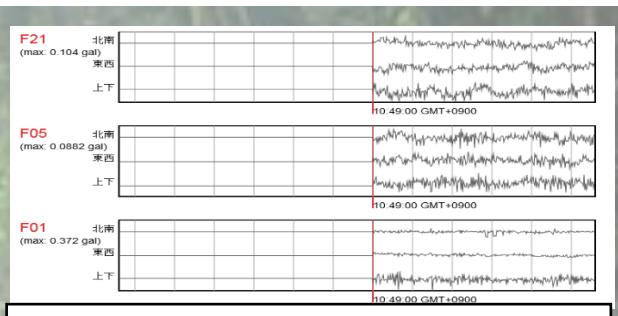
■ : Servo sensors 8 units

◆1 basement floor, 8 floors
◆SRC structure
◆Solid foundation of RC
◆Torsionally coupled building
◆Design 1989
◆Completion 1991

Installation situation 1

Installation situation 2

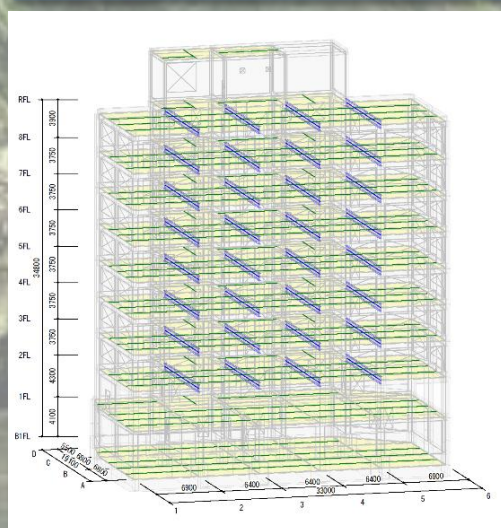
Installation situation 3



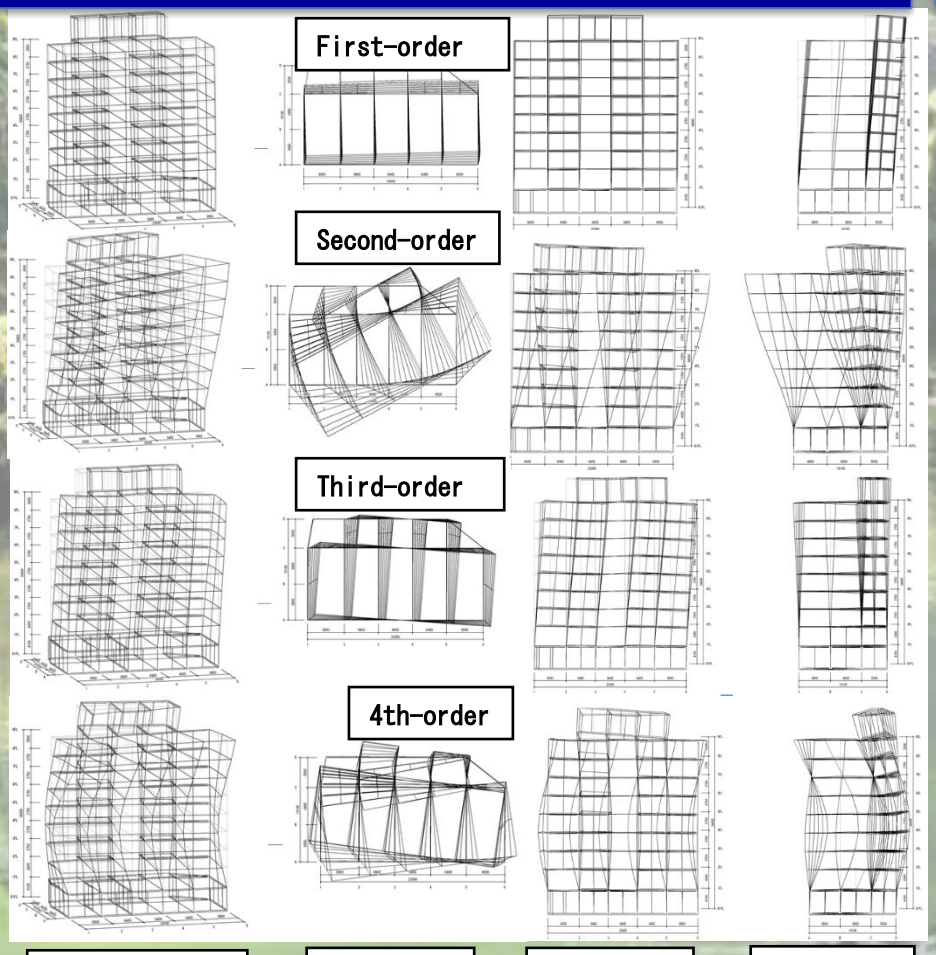
Observation example

・Two seismographs will be installed at both ends of the office room on each floor for the purpose of capturing torsional vibration. We compare the performance difference between servo sensors and MEMS sensors.
・A total of 24 seismographs were installed at 3 locations on each floor.
・Instead of laying a cable dedicated to seismographs, we built a seismograph network by connecting to an existing LAN.
・Time synchronization is performed from the network (NTP server).

Verification



Modeled with a 3D frame at the member level, and the mode was confirmed by eigenvalue analysis.
■Results of eigenvalue analysis
X direction(First-order) : 0.457 Sec.
Y direction(First-order) : 0.791 Sec.
torsional(First-order) : 0.669 Sec.



Isotometrics | X-Y Plane | X-Z Plane | Y-Z Plane

Future tasks

◆We will continue to study how to utilize the real-time data from this seismograph and how to provide (visualize) information.
◆As much as possible, we aim to develop a system that provides easy-to-understand information to building users and building managers without the need for specialized knowledge.
◆Issues related to seismograph installation
1) Securing power supply
Observation during a power outage
2) How to install in a place without LAN
It takes time to lay the Lan cable
3) The trouble of laying cables
Battery-powered, wireless, and high-precision time with a single seismograph

CASE STUDY September 4, 2020: Seismological observation at an office building during an earthquake centered in Fukui Prefecture

Around 9:10 on September 4, 2020 (Friday), there was an earthquake observing a maximum seismic intensity (JMA) of 5 lower in Fukui Prefecture. The epicenter was in Minekita, Fukui Prefecture, the depth of the epicenter was about 10km, and the JMA magnitude of the earthquake was estimated to be 5.0. Seismic intensity (JMA) 1 is also observed in Fukushima Ward and Yodogawa Ward next to Kita Ward, where the company building is located, in Osaka.

Time history and Pseudo-velocity response spectrum