Application of Earthquake Early Warning System and Real-time Strong-motion Monitoring System to a High-Rise Building

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We apply Earthquake Early Warning System (EEWS) and Real-time Strong-motion Monitoring System (RSMS) to reduce earthquake-related damage of the 29-story building of Kogakuin University in the downtown Tokyo, Shinjuku. EEWS, which is operated by NIED (National Research Institute for Earth Science and Disaster Prevention), is the system to provide earthquake information, such as the location and magnitude of an earthquake, the arrival time of the S-wave, and the estimated seismic intensities, before the actual arrivals of S-waves. In particular, for the case of subduction earthquakes (i.e., the Tokai earthquake), we can expect a couple of minutes before the building"s largest response, because it is shaken by the surface waves with a slow speed less than 1 km/s, which are exited in the Kanto sedimentary basin.

We use EEWS for the emergency control systems of the elevators by estimating quickly ground motions at the Shinjuku site and the corresponding building response. To do this, first, we construct a Green"s function library to estimate roughly the strong ground motions including the surface waves using the wavenumber integration method for various seismic regions. To check the accuracy of the library, we compared between the observed record for the 2004 Chuetsu Earthquake and the estimated waves, which are band pass filtered from 0.2 Hz to 1 Hz. The results show good agreements with the observations in the first half of the records in not only in the arrival time, but also the amplitudes. Next, we construct a library of the corresponding maximum response values of the building using the modal analysis. Once an earthquake occurs, the ground motion and the building response are quickly estimated using the proposed method. And, when the estimation exceeds a threshold value, the emergency control systems stop automatically the elevators at the nearest floors to prevent people from trapping.

On the other hand, RSMS of Kogakuin University, which consists of 40 channels of accelerometers and data servers, is the system to monitor the building response and to estimate the building damage in real-time. We estimate the threshold condition for stopping the elevator before arriving the long-period ground motion using observation data and corrected data that the elevator in this building stopped by the long-period ground motion. Furthermore we apply the P-wave data of a borehole of RSMS to the emergency operation control system of elevators, and these systems to make announcements to prevent panics and secure safeties of students and staffs in the building during earthquakes.