Application of Earthquake Early Warning System to Estimation of Long-period Ground Motion for High-Rise Building in Tokyo, Japan

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We apply Earthquake Early Warning System (EEWS) to reduce earthquake-related damage of the 29-story building of Kogakuin University in the downtown Tokyo, Shinjuku, Japan. EEWS, which is operated by 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.

Using EEWS, we estimate not only the arrival time and the amplitude of the S-wave and the surface waves, but also the building response. We apply EEWS to the emergency control systems of the elevators by estimating ground motions at the Shinjuku site and the corresponding building response. In addition, we use EEWS on disaster drill to promote it to the staffs, teachers and students in the building.

To do this, we estimate the arrival time and make a condition for operating the elevator emergency control before an earthquake (Figure1).

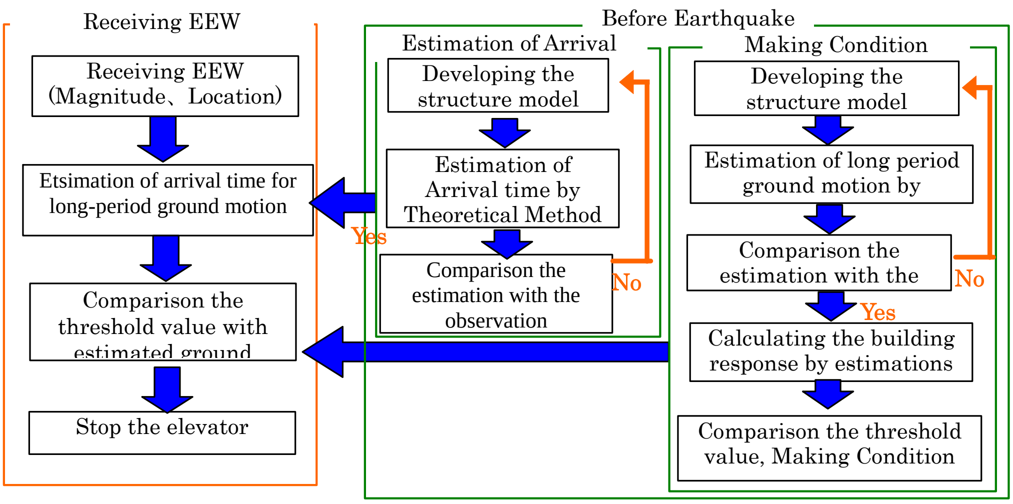

Figure 1. The flow diagram of the elevator emergency operation for long-period ground motion

First, we develop the structure model at the site, and estimate the arrival time by the theoretical method (Hisada and Bielak 2003). Secondly, we compare the estimation data with observation data near the site or on site (Figure2 and 3).

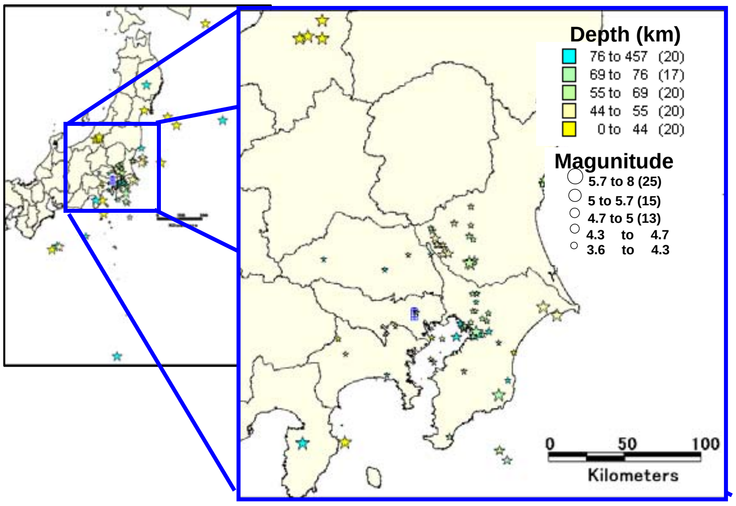

Figure 2. The distribution of the epicenter in the observation data

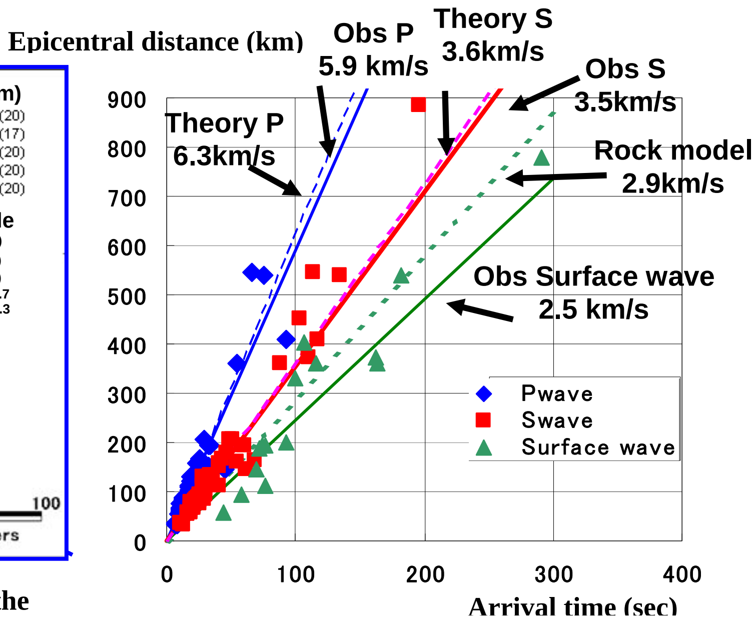

Figure 3. The plot of the arrival time versus the distance between hypocenter and Kogakuin site

Next we make a condition for operating the elevator emergency control. We first estimate the long-period ground motion by Green's Function (Hisada 2008) using the developing structure model. Secondly, we compare the estimation data with the observation data. Third we calculate the building response by the estimated long-period ground motion. Finally, we make a condition for operating the elevator emergency control by comparison the threshold value based on the elevator stop cases and elevator damage.

We apply our proposal flow that is shown by Figure1 to some earthquake events that the long-period ground motion is observed in Kanto area, such as 2004 Tokaido offshore Earthquake, 2004 Niigata Chuetsu Earthquake. As a result, the estimated waves between 2 sec and 4 sec almost correspond the observed waves, but the estimated waves between 4 sec and 6 sec underestimate the observed waves because of the 3D effects of the Kanto sedimentary basin. Thus, we estimate the long-period ground motion to the estimation on the side of prudence given the assumption of the source model, because EEWS provides only the location and magnitude of an earthquake. We confirm that the proposed method is able to control the elevator for the long-period ground motion.

Table1 shows the elevator emergency control condition on the Kogakuin University.

Table 1. The elevator emergency control for long-period ground motion on Kogakuin University case.

	JMA Magnitude	Fault width	Fault Length	Depth*	Epicentral distance **
Long-period Ground Motion	6.5≦	12km	24km	35km≧	Within 200km
	7.0≦	21km	42km	50km≧	Within 450km
	7.5≦	37km	74km	80km≧	Within 500km
	8.0≦	66km	132km	120km≧	Within 650km

In addition, we have each floor members to develop the disaster prevention map (Figure 4) and let them to notice about something harmful in each floor. We also will use EEWS to gather the emergency operation member as the trigger.

Figure 4. The disaster prevention map of Kogakuin University