Disaster mitigation information system in Japan (3)
- Earthquake Early Warning -

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Japan is one of the most earthquake-prone countries in the world. Including earthquakes that are too small to detect by human beings, the total number of earthquakes that occur each year exceeds 100,000. In Japan, there is an old proverb "Earthquakes, thunders, fires and fathers are the most horrible things in the world." The reason why earthquakes are included in this proverb is that earthquakes cause devastating damage, and people are "suddenly" subjected to a strong motion without any warning.

However, even though we cannot tell the exact occurrence of a fault motion producing a strong motion, we can estimate the strong motion arrival by the prompt detection of seismic wave. This is the Earthquake Early Warning (EEW). The concept of this warning system exists since late 1800's, and finally, we achieved the practical use about 100 years later due to the progress of computer and data transfer technologies. The EEW provided by the Japan Meteorological Agency (JMA) is designed to enable public officials, key safety personnel, and the general public to take an action before the arrival of earthquake strong motion.

Source parameters that the EEW system provides are the estimated origin time, hypocenter location, magnitude of the earthquake, expected maximum seismic intensity (in the JMA intensity scale, http://www.jma.go.jp/jma/en/Activities/earthquake.html#S_I), and arrival time (in seconds) of the strong motion for each county. They are immediately estimated when the primary seismic wave detected by one of the seismometers. Then, the EEW is transmitted by the television, radio, mobile phone and dedicated terminal promptly (Fig.1).

Figure.2 shows an example of the earthquake early warning for an earthquake on 14 March 2010 (Mw 6.7). The concentric circles with numbers show the

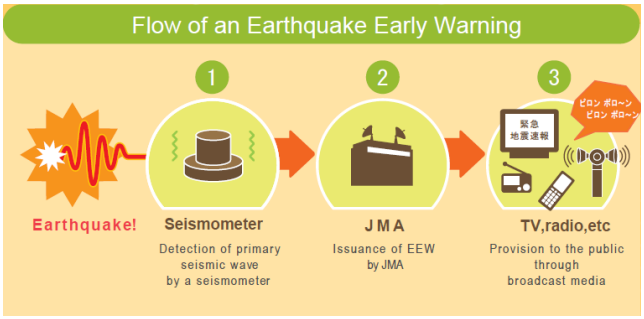

Fig.1 Flowchart of an Earthquake Early Warning

available warning time. Since this earthquake is a subduction event, the EEW can provide before the arrival of strong motions. Table 1 shows the time history of the updated EEW.

When this EEW was provided, the following actions may be taken.

- Stop the elevator at the nearest floor automatically.

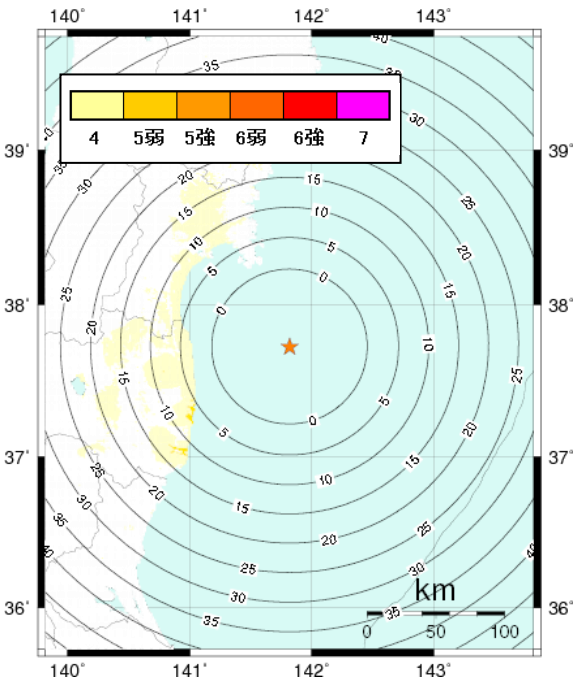

Fig. 2. Concentric circles denote contour curves of available time, in seconds. Star denotes the epicenter.

- Evacuate from by freezing chamber by the radio communications system.

- Duck and cover under the table

- Keep an evacuation route by opening the door.

For the system to be effective, it is essential that JMA educates public people teaching the principle and purpose of the warning messages, the technical limits of EEW, and the proper actions to be taken when a warning is received. This is particularly important given the very short warning times (a few to a few tens of seconds) so that EEW can be used effectively without unnecessary confusion. Therefore, the issue of EEW to public people started in October 2007, after enough education has been done by the TV, informational leaflets, and internet website (Fig. 3).

For the near future, efforts for speed up of the provision and improvement of accuracy of EEW are required. More understanding of the system will be achieved when people experience receiving EEW before ground motion arrival. Therefore, it is necessary to increase opportunities to receive the EEW as well as to demonstrate the advantage of this technology to public people.

Fig.3 Informational leaflet prepared by the Japan Meteorological Agency for the public people

Table 1. Time history of the estimates for hypocenter, magnitude and maximum seismic intensity estimation in each issuance of EEW for the off Fukushima pref. earthquake on 14 March 2010.

Issueance		Lapse time after the first seismic wave detection (sec)	Estimated focal parameter				Estimated maximum seismic intensity	Warning
			Lat. (Deg)	Lon. (Deg)	Dep. (km)	Magnitude		
Detection time	17:08:19.3							
1st information	17:08:22.5	3.2	37.7	141.9	40	6.7	4	
2nd information	17:08:22.9	3.6	37.7	141.9	10	6.9	5 lower	*
3rd information	17:08:24.1	4.8	37.7	141.9	40	6.7	4	
4th information	17:08:27.6	8.3	37.7	141.9	20	6.8	5 lower	
5th information	17:08:30.1	10.8	37.7	141.9	20	6.8	5 lower	
6th information	17:08.38.6	19.3	37.7	141.9	20	6.5	4	
7th information	17:08:49.2	29.9	37.7	142.0	20	6.6	4	
8th information	17:09:09.3	50.0	37.7	141.9	10	6.6	4	
Final information	17:09:16.6	57.3	37.7	141.9	10	6.6	4	