P2 Masaki

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Development of alarm network using Earthquake Early Warning

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1. Summary

For earthquake disaster mitigation, Disaster Prevention Research Center(DPREC), Aichi Institute of Technology(AIT), Japan, has organized the Consortium with enterprises in Mikawa area, central Japan, where many automobile plants and machine factories are located but is one of the most risky region for large earthquakes in Japan. Main research of DPREC is to re-distribute the Earthquake Early Warning (EEW) developed by Japan Meteorological Agency. DPREC estimates seismic intensities and send them to plants, factories and offices at Mikawa area by using internet system before arriving P- and S-wave arriving. The system is useful for earthquake disaster reduction by performing workers-evacuation and stopping line-system before arriving strong shaking. A seismometer network has been installed by DPREC in the same area for observing seismic intensities to compare with estimated intensities.PC monitor installed at a central office shows an epicenter, a magnitude, a seismic intensity and an arriving time estimated by EEW. Animated P and S-wave propagating front are also displayed on a monitor. Observed seismic intensities are took back from the sites to the server at DPREC on time by internet system and send back the distribution map of seismic intensities observing to monitor at other sites.The system developed by DPREC is installed at fifty factories and offices and working for seismic disaster prevention.

2. Earthquake Early Warning (EEW) System

Japan Meteorological Agency (JMA) estimates the earthquake information (origin time, hypocenter and magnitude) by using P-wave information observed at nationwide seismometer network installed by JMA and National Research Institute for Earth science and Disaster Prevention and informs EEW to users including second supplier to inform with in five seconds (average) after detecting P-waves. Disaster Prevention Research Center (DPREC), Aichi Institute of Technology, Japan, receives EEW and informs offices and factories in Mikawa Area, Japan, of EEW from several and dozens of seconds before arriving strong motions. Fig.1 shows the conception diagram of EEW system.

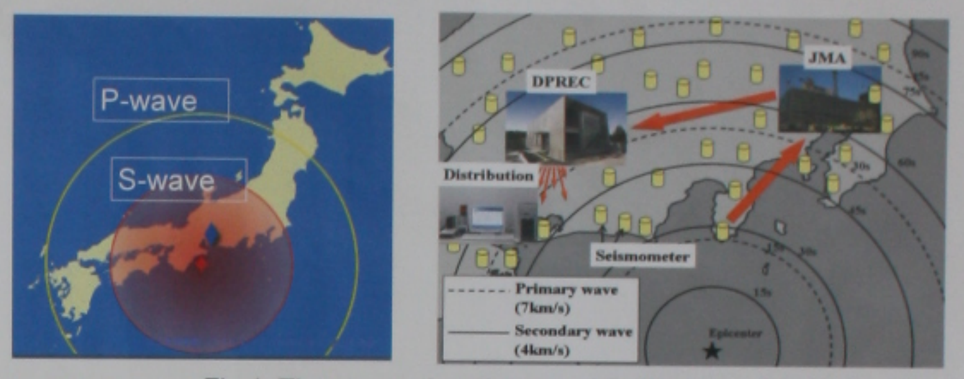

Fig.1 The conception diagram of EEW system.

3. Networl System

3.1 Network System

Fig.2 shows a network system in Mikawa Area installed by DPREC. E-catcher type seismometer has real time communication function with the main server installed in the DPREC office for sending seismic intensity in Japanese scale Ij, maximum acceleration αmax and spectral intensity SI via PC terminal system by using internet. ETNA type seismometer does not have real time communication function, however can obtain high quality data with high sensitive sensors. The data are collected by PHS lately. AIR type seismometer has high sensitive sensor and send high quality on-line data to DIPREC server.

EEW terminals and three types of seismometers are installed every 20km in Mikawa Area, and connected mutually through the server in DPREC via internet. By using this network system (Ai-system), EEW and observed seismic intensities are distributed to users who can confirm arriving seismic motions on the monitor in the terminal system in their office and fabrics on-time.

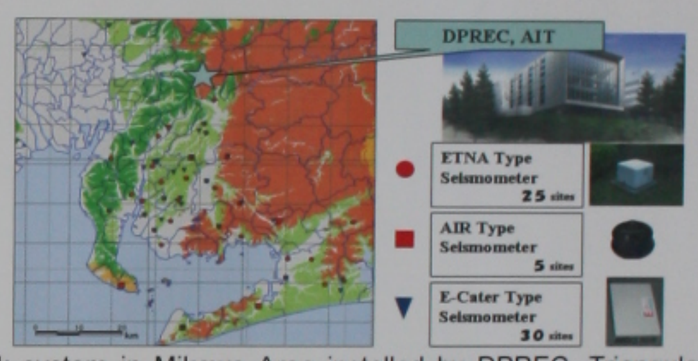

Fig.2 Network system in Mikawa Area installed by DPREC. Triangular symbols show the sites (companies) where EEW receiving terminal system and E-catcher type small seismometers are installed. Open circles and squares show the places where ETNA type seismometers and AIR type seismometers are installed respectively.

3.2 Terminal system

Photo 1 shows the terminal system installed at sites. Fig. 3 shows the monitor screen which can display the information as follows.

(1) An epicenter and dynamic state of propagating P-wave (yellow) and S-wave (red) front from an epicenter to predicting site marked by a triangle symbol. Numerical values are seismic intensities at five sites described in (3)(upper central).

(2) Estimated seismic intensity and a margin time before arriving strong motions at the site predicted (upper left).

(3) On-time data of acceleration and seismic intensity observing by AIR type seismometers installed at five sites (central left).

(4) Time histories of seismic intensity, acceleration and SI value at the site predicted where E-catcher seismometers are installed. Two lines show values observed by two seismometers at different positions (bottom left).

(5) Outside state monitoring by cameras (bottom right).

(6) Seismic intensity distribution observed by E-catchers at other companies marked by circles. Color shows maximum intensity observed by that time at that site. Changes and increasing of seismic intensities are displayed at other companies. Propagation of strong motions in this area can be also understood (upper right).

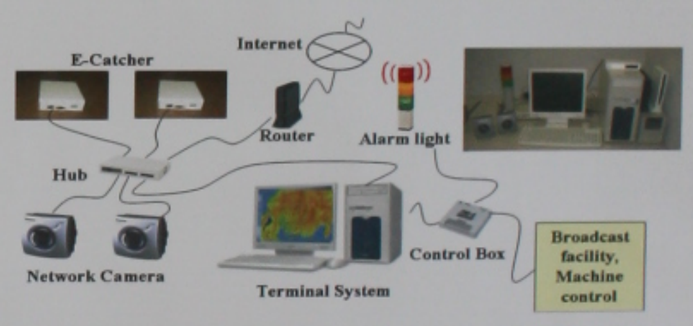

Photo 1 Terminal system installed at sites. A terminal system is consist of a router, a main body of PC, a monitor, an alarm device, a contact box for controlling machines and facilities, digital cameras, a pair of E-catcher seismometers and a no blackout device by basic constitution.

4. Practical use of EEW system

4.1 Companies and organizations distributed

DPREC distributed EEW information to thirty companies which are mainly manufacturing industries (automobile, machinery, chemical materials, etc) including big companies employed a member of several thousand employees and small ones. University, school and medical facilities are also included. Some companies have several offices, factories and plants at other locations far from head office. So DPREC distributes EEW to about fifty places in total.

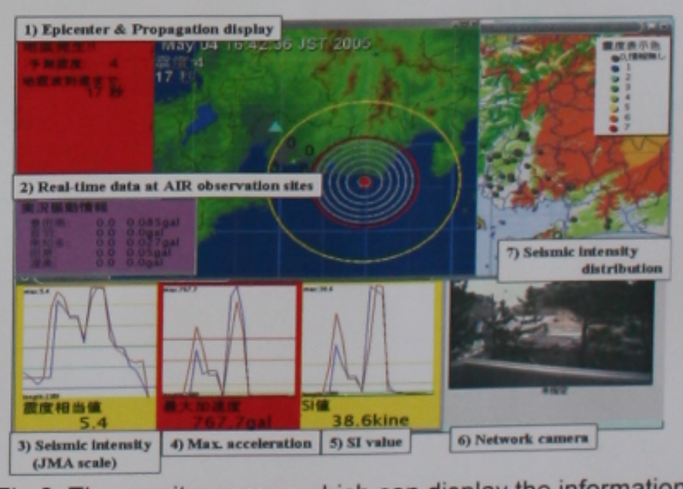

Fig.3 The monitor screen which can display the information.

Fig.4 shows a new system developed recently for the users who hopes to introduce EEW system in his other factories. A host server installed in the main office receives EEW from the DPREC server and redistributes EEW to terminals in other factories via internet or LAN.

4.2 Examples of practical use

In Japan, EEW is used in many cases, for examples: factories, train, school, elevator control, construction site, etc. In the group of DPREC main purpose of using EEW is for evacuation of employees in factories with alarm buzzer and sound broadcast by emergency broadcast facilities triggered automatically by EEW. Aichi Institute of Technology started evacuation system for evacuation in lecture rooms and laboratories with alarm buzzer and sound broadcast. All students and professors are required to act evacuation as soon as possible, maybe within several seconds from EEW alarm.

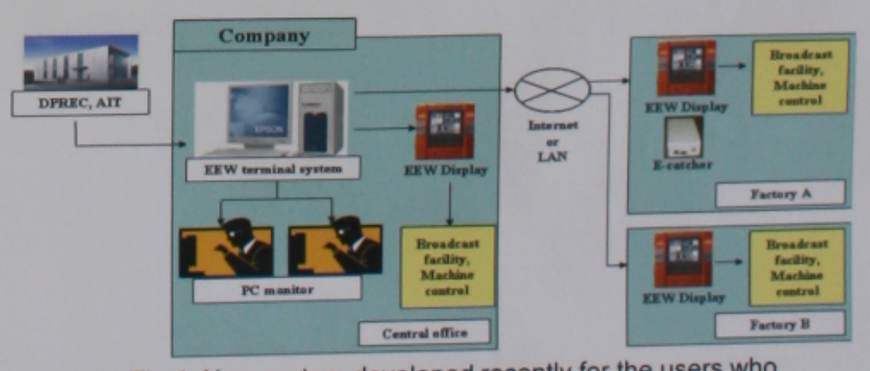

Fig.4 New system developed recently for the users who hopes to introduce EEW system in his other factories.

Photo 2 shows an example of shutdown system by a valve attached to a tank of toxic materials. In semiconductor factories, EEW also is used for stopping supply of dangerous liquid and materials. In some offices, use of EEW is planning to stop elevators at nearest floor and open its door before arriving strong motions.

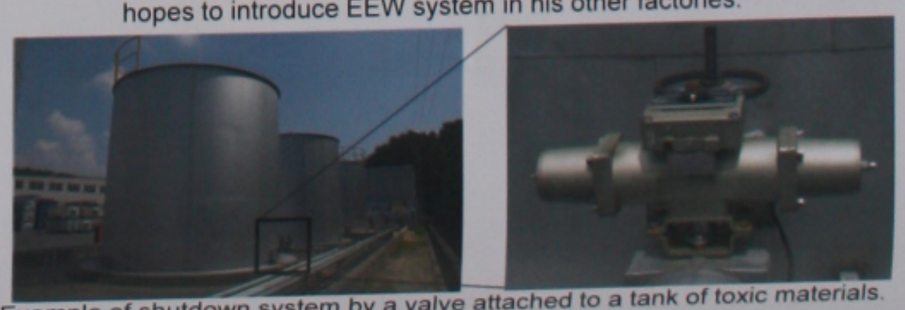

Photo 2 Example of shutdown system by a valve attached to a tank of toxic materials.

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