Real-time ground motion prediction with high accuracy using waveform data at a front site

Masato Motosaka[1]

[1] DCRC, Graduate School of Engineering, Tohoku University

http://www.disaster.archi.tohoku.ac.jp/

1. Introduction

It is one of the important topics in earthquake engineering to mitigate human and physical damage during earthquake by issuing alarm leading to mechanical control and/or human evaluation. The expectations to the early earthquake alarm system are rising socially. JMA started to provide Earthquake Early Warning (EEW) from October 1, 2007. The estimated seismic intensity based on the conventional empirical formula from tentatively determined point source, have limitation in accuracy. The social demand for enhancing the accuracy of ground motion prediction is very high for advanced engineering application.

The authors have developed an integrated regional earthquake early warning (EEW) system having on-line structural health monitoring (SHM) function, in Miyagi prefecture, Japan [1]. The system makes it possible to provide more accurate, reliable and immediate earthquake information by combining the national(JMA/NIED) EEW system, based on advanced real-time communication technology. The authors have proposed a highly accurate ground motion prediction method using Artificial Neural Network(ANN).

This paper describes the verification of applicability of the method by using observation data sets of 39 earthquakes (M4.0-M7.2) occurred in Miyagi Oki area (refer to Fig.1)[2], [3]. The prediction of ground motion parameters for PGA and PGV are described as an example results.

2. Peak ground motion prediction using waveform data at a front site

Using the initial part of P-waveform data at Oshika site, a front site for the approaching Miyagi-ken Oki earthquake, ground motion parameters of PGA and PGV at 4 sites including Sendai were predicted by combining the source information of EEW from JMA. In this case, the arrival time of EEW from JMA was assumed to be 5.5s and this time length of P-waveform at Oshika site was used as wavefrom data at a front site. Fig.2 shows the information used for the ground motion prediction using ANN. The 35 earthquakes" 5.5s p-waveform data and the peak values in the time section at K-NET Oshika (MYG011) were used as the training data for the ANN with 3-layer structure, together with information of prediction points" location, and site conditions.

The remaining 4 earthquakes" data were used as blind prediction of PGA and PGV at Sendai (MYG013), Taiwa (MYG009), Shiogama (MYG012), and Ishinomaki (MYG010). Fig.3 shows the predicted ground motion parameters by the proposed method using ANN compared with those by conventional empirical formula [4]. It is found that the drastic enhancement of accuracy is recognized.

Acknowledgment

K-NET data were used in this paper. The authors are grateful to whom may it concern.

References

[1] Masato Motosaka, Makoto Honma, Serdar Kuyuk, Francisco Arrecis,DEVELOPMENT OF AN INTEGRATED EARLY WARNING AND STRUCTURAL MONITORING SYSTEM TO REAL TIME EARTHQUAKE INFORMATION, AIJ Technol.Des.Vol.14,No. 28, 669-674, Oct., 2008

[2] H. Serdar Kuyuk and Masato Motosaka: Real-Time Ground Motion Prediction Using Artificial Neural Network For Earthquake Early Warning System, 6JAEE, 200-201, 2008

[3] KUYUK, H. S. and MOTOSAKA: Spectral Forecasting of Earthquake Ground Motion using Regional and National EEWS for Advanced Engineering Application against Approaching Miyagi-ken Oki Earthquakes, 14WCEE, Beijing, China, 2008

[4] Hongjun SI, and Saburoh MIDORIKAWA, New attenuation relationships for peak ground acceleration and velocity considering effects of fault type and site condition, J.Struct. Eng., AIJ, No.523, 63-70, 1999. (in Japanese)

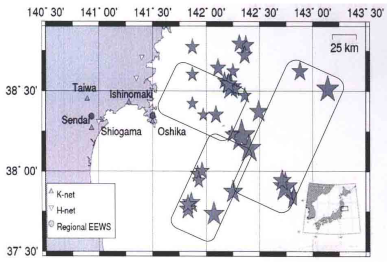


図１　検討に用いた宮城県沖で発生した
39 地震の震央

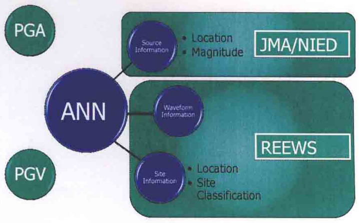
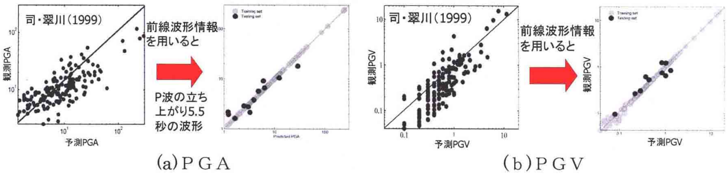


図２　地震動の最大値予測のための
ＡＮＮ構築用情報



(a)ＰＧＡ　(b)ＰＧＶ

図３　地震動の最大値予測における高精度化