Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SSS26-05 Room:304 Time:May 20 10:00-10:15

Quick estimation of moment magnitude based on real-time displacement waveform

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1. Introduction

The 2011 off the Pacific coast of Tohoku Earthquake was the greatest earthquake in Japan as the magnitude of 9.0. But the first report of JMA (Japan Meteorological Agency) magnitude estimated at 3 minutes after initiation was 7.9. Furthermore, the moment magnitude which should be calculated at 15 minutes after initiation was not calculated due to the saturation of broad-band seismometers. As a result, the tsunami height was underestimated causing loss of many lives unfortunately. Now southwestern Japan faces a great earthquake of Nankai trough, so it is extremely important to construct the quick estimation system of unsaturated magnitude. Previously we developed a method to estimate the permanent displacement accurately based on an acceleration record [1)]. Applying the method, we propose a scheme to estimate moment magnitude quickly using the relation between the displacement and hypocenter distance.

2. Method

Relation between the permanent displacement u due to the earthquake and the hypocenter distance r is expressed as

$$u = M_0 A / Gr^2, \quad \text{... (1)}$$

where M_0 is the seismic moment, A is a coefficient to consider the direction effect, G is the rigidity. Taking the logarithm of eq. (1), we obtain

$$\log u = -2 \log r + \log (M_0 A / G) \quad \text{... (2)}$$

Namely, plotting displacements versus hypocenter distances in double logarithmic chart, the seismic moment M_0 can be calculated from the intercept of line of slope -2.

In this study, based on the acceleration waveform recorded by the strong ground motion observation network KiK-net, we obtained the displacement waveform and permanent displacement according to Hirai and Fukuwa (2012) [1)]. Applying this procedure to many observation point, the seismic moment and moment magnitude were calculated.

3. Result and discussion

The result for the 2011 off the Pacific coast of Tohoku Earthquake is shown in the Figure. Figure (a) shows the permanent displacement distribution, (b)-(g) show estimated values of the magnitude at each time, respectively. According to the Figure, it is found that the estimated value of the magnitude grows increasingly and that the earthquake can be obtained as M_w~9 class great at 4 minutes after the initiation. This value is consistent with that from the inversion of co-seismic crustal deformation observed by GPS network [2)]. Therefore, the availability of this method was suggested.

References

1) T. Hirai and N. Fukuwa, Estimation of crustal deformation distribution due to the 2011 off the Pacific coast of Tohoku Earthquake based on strong motion records, *J. Struct. Constr. Eng., AIJ*, **77**, 341-350 (2012).

2) T. Ito, K. Ozawa, T. Watanabe, T. Sagiya, Slip distribution of the 2011 off the Pacific coast of Tohoku Earthquake inferred from geodetic data, *Earth Planets Space*, **63**, 627-630 (2011).

Acknowledgment

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Keywords: moment magnitude, quick estimation, parmanent displacement, strong motion record

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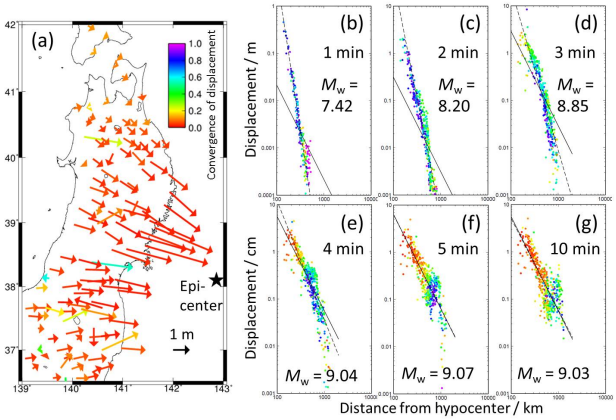

Fig. (a) Permanent displacement distribution. (b)-(g) Real-time magnitude estimation.