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Specifying Strikes of Fault-Unspecified Sources Based on Seismotectonics for Seismic Risk Assessment

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1. Introduction

We developed a method to determine strikes of fault-unspecified sources on the basis of statistically-derived probability distributions of strikes of active faults within each seismotectonic zone. The proposed method is capable to reduce uncertainty associated with unknown strikes of faults by considering geographical extent of strong motions and contributes to performing more reliable hazard and risk assessment.

2. Statistical analysis of strikes using "Digital Active Fault Map of Japan"

The earthquakes studied herein are those which occur on land where active faults have not been specified and modeled for development of at National Seismic Hazard Maps for Japan (2008)[1)]. The inland crustal areas in Japan are divided into 24 zones based on seismotectonics by Kakimi et al[2)]. Assuming that falult mechanism is common in the same seismotectonic zone, statistical analysis procedure were performed as follows,

i) Fault traces of four types of active faults (distinctly-specified, indistinctly-specified, concealed and estimated) were extracted from Digital Active Fault Map of Japan [3)].

ii) All fault polylines were split into straight lines. After removing duplicated lines, the number of fault lines was 193,237, and their total length was 10,031 km. The strike of each fault line is calculated and grouped into eight discrete strikes from N-S to SSE-NNW.

iii) Fault lengths are aggregated by strike group for each seismotectonic zone. On this basis, the probability mass functions of strike distribution were obtained for each zone.

3. A fault plane setting based on strikes of existing active faults

Seismic sources for fault-unspecified earthquakes are modeled as fault planes at every 0.1 degree (latitude) by 0.1 degree (longitude) grid point. Maximum magnitudes, Mmax, are assigned for each each seismotectonic zone according to historical earthquakes except for fault-specified ones. Minimum magnitudes, Mmin, are uniformly assigned as 5.0. Magnitudes were assigned between the minimum and maximum magnitude with an increment of 0.1.

i) Fault length, L, was determined based on Matsuda's formula, $M=(\log10L+2.9)/0.6$, which is employed by the Headquarters for Earthquake Research Promotion.

ii) Strikes are determined according to the d'Hondt method which is frequently adopted as legislative apportionment method for proportional representation elections.

iii) First, the number of earthquakes ($=(Mmax-Mmin)/0.1+1$) at each grid point was considered as the number of seats in an election. Next, the vote counts were calculated by multiplying the probability of each strike group and one million. Applying the d'Hondt method, the number of appearances of strikes was obtained.

iv)Finally, the sequence of appearance of strikes for a set of magnitudes at each grid points, was randomized. All fault planes were assumed to be vertical. Thus, spatial patterns of fault strikes over the entire area were obtained for fault-unspecified seismic sources on the basis of seismotectonic characteristics in each zone.

4. Conclusion

In this study, a method to determine strikes of fault-unspecified sources was developed. With this method, one can appropriately evaluate the geographical distribution of seismic motion intensities, which has been impossible with point source assumption, and open the door to more reliable seismic risk assessment considering fault-unspesified earthquakes.

References

1) Earthquake Research Committee, Headquarters for Earthquake Research Promotion: Report : ' National Seismic Hazard Maps for Japan (2005)', 2005. 2) Toshihiro KAKIMI, Tokihiko MATSUDA, Isamu AIDA and Yoshihiro KINUGASA: A Seismotectonic Province Map in and around the Japanese Islands, Journal of the Seismological Society of Japan, No. 2, Vol.55, pp.389-406, 2003. 3) Takashi NAKATA and Toshifumi IMAIZUMI: Digital Active Fault Map of Japan, University of Tokyo Press, 2002. (DAFM0542)

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