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A Study on the Percentile Calculation Method of Seismic Hazard

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1. Introduction

A seismic hazard assessment by probabilistic seismic hazard analysis (PSHA) is a determination of an annual exceedance probability to peak ground acceleration (PGA), and an estimation of the seismic hazard curve. The seismic hazard at PSHA is the weighted hazard by the probability of input parameters. The seismic hazard curve presents weighted average and percentile (15%, 50% and 85%) for showing the uncertainty range that was caused by uncertainty of input parameters. Therefore, the percentile performed a important part, which indicated uncertainty of the calculated seismic hazards. For the determination of the influence caused by the percentile calculation method, this research performed PSHA to the selected Shinuljin 1&2 site as a reference site [1,2].

2. Percentile Calculation Method

A percentile calculation method can be divided by an interpolation and a calculation method. The interpolation method stands in a row by hazard level like as weight accumulation method and weighted hazard method. The calculation method can be performed so that the seismic hazard follows a lognormal distribution. The maximum likelihood method and moment method are examples of calculation method. In this study, the percentile of seismic hazard was calculated using the same data and the results from each methodology were compared. Each methodology are summarized in this section.

Weight Accumulation method

Weight accumulation method is a methodology that is influenced by the weight of hazards. The methodology stands in a row the calculated hazard from small hazards to large hazards by seismic hazards level, and arranges the weights by their hazards. Percentile can be calculated by the values that accumulated the ratio of each weight to sum of each hazard weight using interpolation.

Weighted Hazard

Weighted hazard method estimates the percentile of hazards using the methodology that multiplied their weights to seismic hazards. The methodology stand in a row the multiplied hazards from small hazards to large hazards by hazard levels, and estimates percentile (15%, 50% and 85%) using interpolation like weight accumulation method.

Maximum likelihood Method

Maximum likelihood method assume that the calculated hazard follow a lognormal distribution, and derives the mean and deviation of lognormal distribution directly in the calculated hazard [3]. The computed mean is 50 percentile, and 15 and 85 percentile can be computed by the mean and a deviation of lognormal distribution using a probability function.

Moment Method

Moment method calculates the average and standard deviation in the computed hazard, and estimates the mean and deviation of lognormal distribution using relation equation of the average and lognormal distribution. The estimated mean is 50 percentile, and 15 and 85 percentile can be calculated by the mean and a deviation of lognormal distribution using a probability function like maximum likelihood method.

3. Percentile Calculation Result

To calculate the percentile of seismic hazard, this study computed the hazard using a best estimation of 4 expert panels that used in PSHA for Shinuljin 1&2 site [1]. A, B, C and D team mean each expert panel. Fig. 1 shows the estimated hazard curve to methodology of each team. The legend of Fig.1 illustrates the median of each method which WA, ML, MO and WH each means weight accumulation method, maximum likelihood method, moment method and weighted hazard method, respectively. According to the calculated percentile of each team, the difference between 15 and 50 percentile of B, C and D team enormously appeared. The calculated 15 and 50 percentile of B, C and D team by weight accumulation method, maximum likelihood method and weighted hazard method took very smaller values than 1.0E-20. The calculated 85 percentile of B and C team by maximum likelihood method showed a quick variation according to the peak ground acceleration. The calculated 85 percentile of D team by maximum likelihood method appeared a very small difference from 0.01g to 0.1g. The reason why the difference was very small is that the property of hazard program which the smaller hazard than 1.0E-20

computes as zero. The hazard program computes the smaller hazard than 1.0E-20 as zero in this study, but zero is unusable data on the maximum likelihood method. So, this study assumed that zero is 1.0E-20.

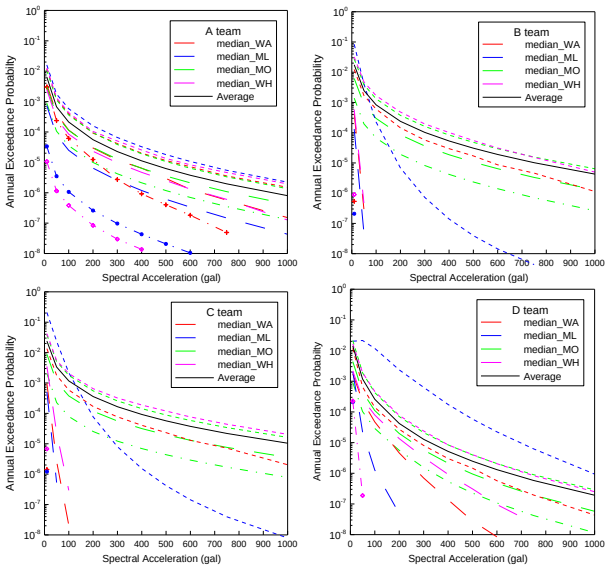

Fig. 1 Seismic hazard curve to methodology of each team.

For searching the reason why the difference of the estimated percentiles to the methodology very enormously appeared, this study performed PSHA for unit source of B, C and D team, which included a site.

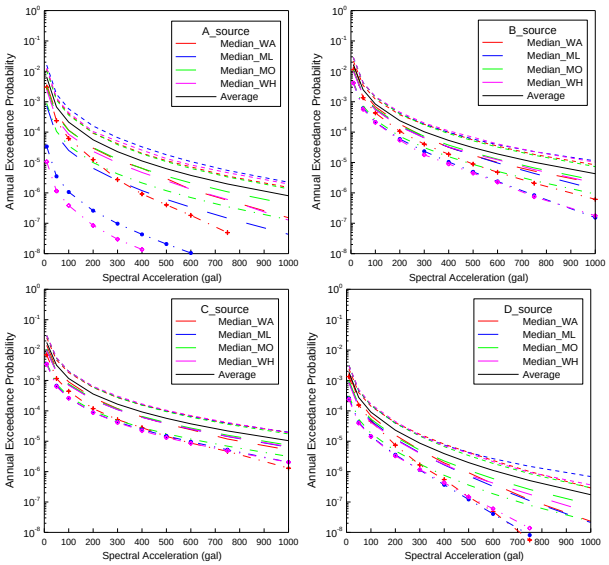

Fig. 2 Seismic hazard curve to methodology of unit source that included a site of each team

Fig. 2 shows hazard curve according to methodology of unit source of each team. The difference of the calculated percentiles of unit source becomes smaller than the difference of the calculated percentiles of original source. The difference of the calculated 85 percentile according to the methodology was reduced from 267.7 times to 1.7 times. In addition, the range between 15 and 85 percentile get a smaller maximum 13.5 times.

4. Conclusion

This study investigated the methodology for percentile calculation of seismic hazard that estimated at PSHA. The hazard curve to each methodology showed the disagreement. The range between the calculated 15 and 85 percentile by moment method was narrow, but the range by weight accumulation method, maximum likelihood method and weighted method was extremely wide. To analyze the reason, this study performed the comparison of the percentile of original source and the percentile of unit source, which included a site. The results showed small differences to the average, but it presented large differences to the percentile. The difference to source was large because very small seismic hazards were calculated at the source that excluded site or existed far from the site [1]. Moreover, many sources in PSHA mean requirements of additional input parameters that have probability, so uncertainty of seismic hazard become greater.

As a result, the methodology for percentile calculation must select a interesting object in property of original hazards, probability of input parameters, and range of uncertainty.

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