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AN IMPROVED METHOD OF SEISMIC HAZARD ASSESSMENT FOR THE SITE OF IMPORTANT ENGINEERING STRUCTURES

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ABSTRACT

In this paper, an improved method has been proposed in seismic hazard analysis for determining the seismic hazard assessment for the site of important engineering structures to consider these key factors on potential seismic sources, and its seismicity, attenuation relation and its model which are likely to affect obviously to the correction value estimated seismic hazard for the site. Using the method is increasing reliability and with obvious economic effectness in seismic hazard assessment for the site of important engineering structures.

KEYWORDS

seismic hazard; potential seismic sources; seimicity parameters; attenuation relation

INTRODUCTION

In order to ensure the important engineering structures are sufferd earthquake to be kept operation of earthquake safety and economy aseismic design. The correction seismic hazard assessment of the site for important engineering structures is an important project. In order to increase the engineering precision and high ratio of benefit-cost for seismic hazard assessment of the site, an improved method for probability assessment of seismic hazard of the site for important engineering structures has been proposed in this paper to investigate these key factors which are likely to affect obviously to the correction value estimated seismic hazard for the site (Zhang Xue-Liang *et al.* , 1987). The factors are emphatically considered as folowing.

POTENTIAL SEISMIC SOURCES

When using probability method of seismic hazard, the calculating results and engineering practice show, for seismic hazard analysis of the site for improtant engineering, that considering a region within a radius of 320KMS around centre of site is divided into three subareas included within a radius of 25KMS around centre of site, 25 to 100KMS and 100 to 320KMS in which incorporating information about the geological tectonics, distribution of historical earthquake, seismicity and correlation between active fault and seismicity are investigated with various degree to identify the potential seismic sources in the three subareas. It is not only increasing reliability but also enhancing ratio of benefit-cost (Zhang Xue-Liang *ect.* , 1993).

SEISMICITY PARAMETERS

In fact, seismicity is in spacial nonuniform and time nonstationary, but in usual method of seismic hazard assessment is limited the occurred position of large earthquake as possible as small through the identifaction potential seismic sources and its seismicity parameters such as the ratio of large and small earthquake, annual occurrence rate and maximum earthquake. It is used to consider the seismicity in spacial nonuniform and time nonstationary. Adopting the method is induced risk for low estimated large earthquake. For the purpose is that contribution of seismic hazard analysis for the site is not low estimated on high magnitude, the seismicity is considered in spatial nonuniform and time nonstationary which is simplified to dispose as uniform and stationary as following steps.

1. The seismicity level is changed with time in the range of statistical region of earthquakes and according the maximum seismicity tendency in the future to determine the b value, annual average occurrence rate and maximum magnitude.

2. According to porbability density function of earthquake space for each potential seismic source of magnitude grade, the annual average occurrence rate of magnitude grade of each earthquake can be obtained within statistical area of each earthquake to be determined the potential seismic sources and its maximum magnitude.

ATTENUATION RELATION

Selecting realistic attenuation relation is one key factor in seismic hazard analysis which lead to large variation in seismic hazard assessment of the site of important engineering structures and also affect to the correction value of design ground motion parameters of engineering structures for aseismic design. In order to enhance realiability of seismic hazard assessment of site, researchers have provided a lot of formulae of attenuation relation using various method such as equal magnitude method, equal distance method and statistical method using intensity or ground motion data etc. (Zhang Xue-Liang, 1988). These attenuation formulae were given by these methods in which are not interrelation with the character of potential seismic sources of the regional site of important engineering structures, so that it is difficult to consider the maximum magnitude of major contribution potential seismic sources and distance from its sources to site. It may be underestimated or overestimated in the various character of regional site of the important engineering structures. As stated above, we proposed an improved method is that the attenuation formulas of ground motion is obtained statistically based on the seismic hazard analysis by selecting ground motion data with similar maximum magnitude, hypocentral distance, seismological and geological conditions of major potential seismic sources in the regional of site of important engineering structures and distance from major sources to the site. Using the proposed method, the distribution of seismic intensity observation from historical earthquake felt in the vicinity of the regional site can be fully utilized to obtain the intensity formulas to check the reliability of attenuation formulas of ground motion.

SEISMIC HAZARD ASSESSMENT

For overcome the weakness, adopting the difference of equal intensity contour between long axis and short axis replace faultrepture length (Shen Da-Kai *ect.* , 1987). Considering seismicity in spacial nonuniform and time nonstationary, contribution of seismic hazard of each region of potential seismic sources for site of important engineering structures can be obtained to use segment poisson model. According to segment poisson model and full probability theory, a probability of exceeding of specified peak acceleration of ground motion or intensity at the site can be expressed as follows:

$$P(Y>y) = 1-\exp\{-\frac{2\upsilon}{\beta}\sum_{i=1}^{N}\iiint\sum_{j=1}^{jm} P(Y>y|Ei)\cdot f_m(m_j)\cdot[(1/2)\beta\Delta m]\cdot f(\theta)\cdot f_{i,m_j}\,dxdyd\theta\} \quad (1)$$

in which, $P(Y>y|Ei)$ denotes *i*th source exceeding probability at the site when magnitude is $m_j+(1/2)\Delta m$, $f_m(m_j)$ denotes upper magnitude, $f(\theta)$ denotes tendency probability of fault repture direction. An exceeding probability of a specified value at the site can be expressed in statistical area as follows:

$$P = 1-\prod_{n}^{N}(1-Pn), \qquad (n=1, 2, 3, 4, \cdots\cdots) \quad (2)$$

in which, Pn is exceeding probability at the site of *n*th statistical area.

FOR EXAMPLE

Application of probability method. According to the principle as stated above, the regions of potential seismic source of the site of Qin Shan nuclear power plant are identified within 320KMS as shown in Fig. 1. The attenuation formulae of ground motion and seismic intensity are obtained as follows:
Intensity formula:

Long axis: $I_a = 5.3052 + 1.1486M - 1.4438\,Ln(D+10)$

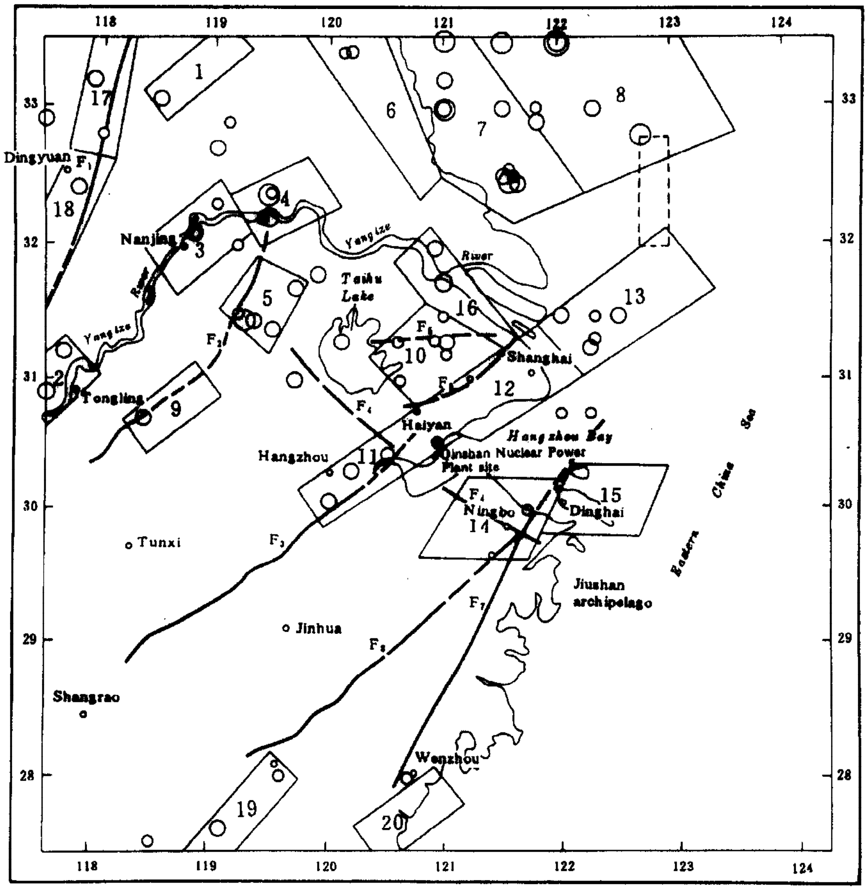
$\sigma_a = 0.5212$

Short axis: $I_b = 5.5530 + 1.1188M - 1.5515\,Ln(D+10)$

$\sigma_b = 0.5612$

Ground motion formula:

Fig. 1. Distribution map of seismological structure, historical equakes and potential seismic sources in the regional site



Main fault and code (F_4) Potential seismic source and number (12) ○ $M_s \geq 6.0$ ○ $5.0 < M_s < 5.9$ ○ $4.7 < M_s < 4.9$ 0 40 80km

Main fault and code: F_1—Tanlu Fault; F_2—Maoshan Fault; F_3—Xiaoshan-Qiuchuan Fault; F_4—Changxing-Fenghua Fault; F_5—Kunshan-Jiading Fault; F_6—Songjiang-Jiashan Fault; F_7—Wenzhou-Zhenhai Fault; F_8—Fenghua-Lishu Fault

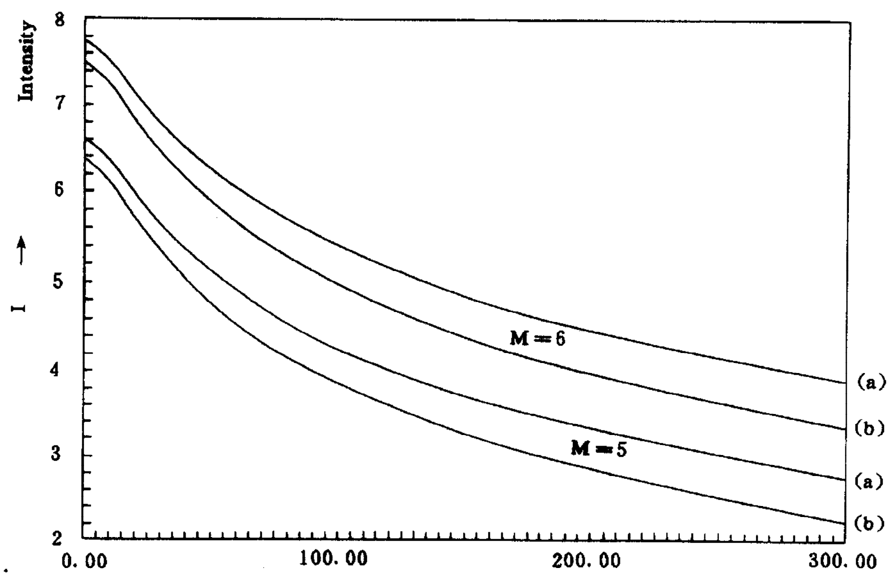


Fig. 2. Intensity Attenuation

$$LnA = 2.3872 + 1.5648M - 1.9505\,Ln(D + 10)$$
$$\sigma = 0.4465$$

in which D is hypocentral distance, R is epicentral distance.

Attenuation curve as shown in Fig. 2. and Fig. 3.. Weight function of earthquake space distribution

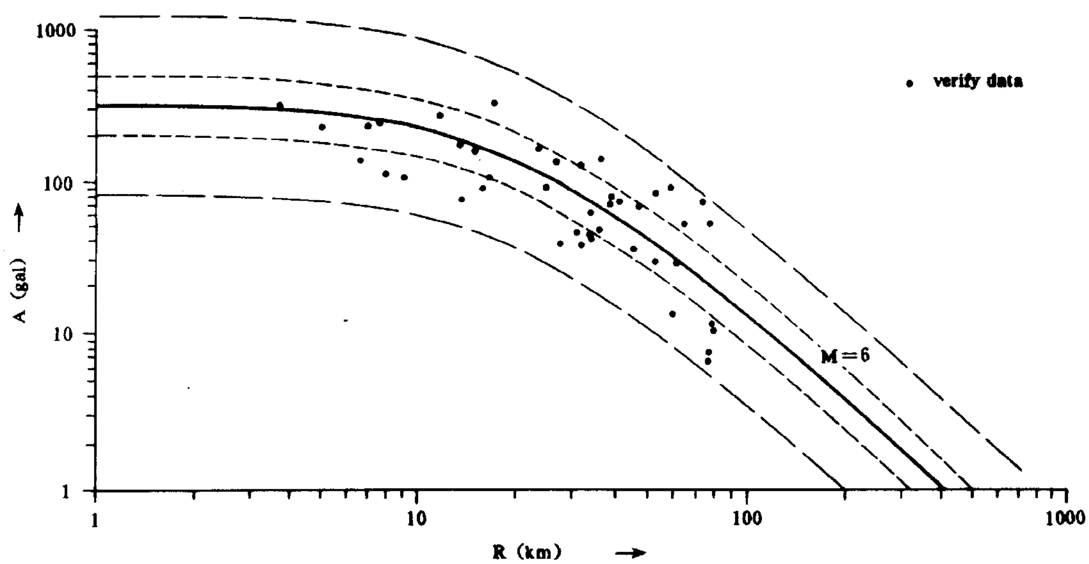


Fig. 3. Acceleration Attenuation of Ground Motion

Table 1. Weight funtion of earthquake space distribution

Source No	Mu	T	b	Q_{i,m_j}					
				4.0	5.5	6.0	6.5	7.0	7.5
1	6.0	2	0.67	0.0195	0.0206	0.0000	0.0000	0.0000	0.0000
2	6.0	2	0.67	0.0289	0.0304	0.0000	0.0000	0.0000	0.0000
3	6.0	3	0.67	0.0281	0.0297	0.0000	0.0000	0.0000	0.0000
4	6.5	3	0.67	0.0258	0.0272	0.1403	0.0000	0.0000	0.0000
5	6.5	3	0.67	0.0185	0.0195	0.1182	0.0000	0.0000	0.0000
6	6.0	3	0.67	0.0523	0.0552	0.0000	0.0000	0.0000	0.0000
7	7.0	3	0.67	0.1171	0.1235	0.2927	0.3339	0.0000	0.0000
8	7.5	3	0.67	0.2828	0.2983	0.2839	0.4585	1.0000	0.0000
9	5.5	2	0.67	0.0171	0.0000	0.0000	0.0000	0.0000	0.0000
10	6.0	2	0.67	0.0359	0.0378	0.0000	0.0000	0.0000	0.0000
11	6.0	2	0.67	0.0353	0.0372	0.0000	0.0000	0.0000	0.0000
12	6.0	2	0.67	0.0435	0.0459	0.0000	0.0000	0.0000	0.0000
13	7.0	2	0.67	0.0763	0.0804	0.0633	0.2071	0.0000	0.0000
14	6.0	2	0.67	0.0406	0.0429	0.0000	0.0000	0.0000	0.0000
15	6.5	2	0.67	0.0350	0.0369	0.0672	0.0000	0.0000	0.0000
16	5.5	2	0.67	0.0348	0.0000	0.0000	0.0000	0.0000	0.0000
17	7.0	2	0.58	0.0208	0.0208	0.0368	0.0300	0.0000	0.0000
18	6.5	2	0.58	0.0366	0.0366	0.0466	0.0000	0.0000	0.0000
19	6.0	2	0.87	0.0447	0.1044	0.0000	0.0000	0.0000	0.0000
20	5.5	2	0.87	0.0376	0.0000	0.0000	0.0000	0.0000	0.0000

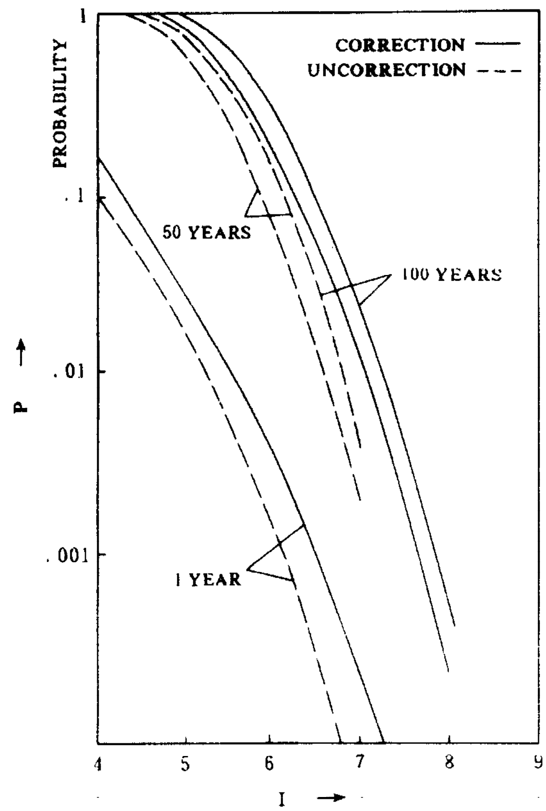


Fig. 4. Annual probability of exceedance (intensity)

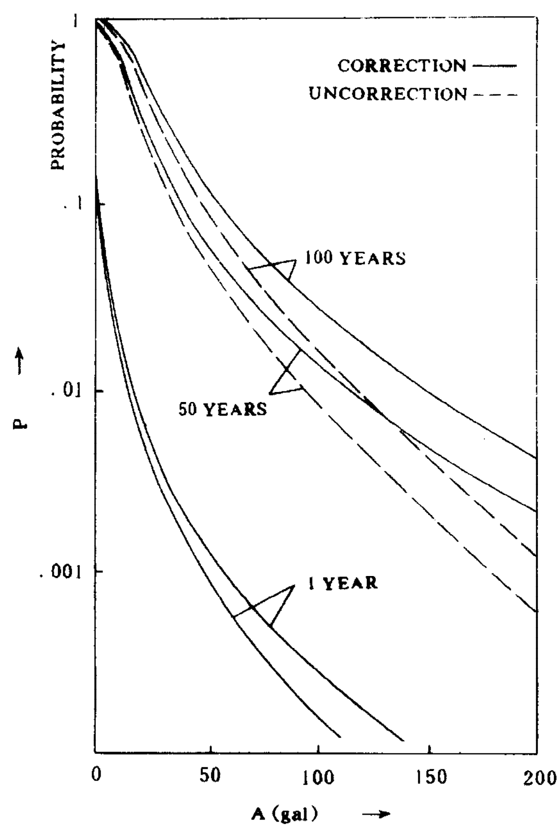


Fig. 5. Annual probability of exceedance (peak acceleration of ground motion)

as shown in table 1.. Using the formulae (1) and (2) can be obtained the seismic intensity value of 10^{-4} year exceeding probability for the site which is 7. 3 and ground motion of safe shutdown earthquake S_2 for the site is 0. 150g, operating basis earthquake S_1 is 0. 075g. Calculating results as shown in Fig. 4. and Fig. 5..

CONCLUSION

The proposed method is used with high engineering precision, thrown lower cost and got higher effect for seismic hazard assessment of the site of structures. This method may be also used for seismic hazard assessment of important engineering and city microzonation.

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