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STATISTICAL EVALUATION BETWEEN SITE EFFECTS OF GEOLOGICAL CONDITIONS AND DETAILED SEISMIC INTENSITY ON THE 1983 NIHONKAI CHUBU EARTHQUAKE

Mitsuo NOGOSHI

College of Education, Akita University
Tegata-gakuencho, Akita, Japan

SUMMARY

The Nihonkai Chubu earthquake (M=7.7,JMA) occurred about 100 km off Noshiro, Akita Prefecture,Japan. Immediately after this earthquake, the detailed seismic intensities were computed by 11000 questionnaires throughout Noshiro City,Akita City,Akita Prefecture,from a viewpoint of engineering seismology. The areas of Noshiro and Akita Cities,and Akita Prefecture were divided into a subarea of 250 m x 250 m,and 1 km x 1 km, respectively. A main object of this paper is to research about statistical evaluation between geological conditions and the detailed seismic intensity (Ref.1),and to discuss about a method of estimation of the detailed seismic intensity.

NTRODUCTION

A large earthquake occurred in the Japan Sea about 100 km off Noshiro, Akita Prefecture,Japan,on May 26,1983. The magnitude of the earthquake was 7.7 on JMA scale and the seismic intensity of the earthquake was V(JMA) in Akita City,Akita Prefecture,Japan. Fig.1 shows the locations of Noshiro City (NOS),Akita Akita City(AKI) and Akita Prefecture,north Japan. In this figure,E1 and E2 show event 1 and event 2 of multiple shock of this earthquake (Ref.2),with G1,G2,G3 and G4 of edges of two fault planes(Ref.3). Since a seismic intensity scale had been proposed formally by Kawasumi(Ref.4),first in 1943,it has been determined by JMA for many earthquakes around Japan. However, when they have been used in investigating the local regions having anomalous intensity, intensity scales determined by the JMA'method were so rough that they could not be used to discuss about local site effects of ground motions. Nogoshi(Ref.5) tried to determine more detailed seismic intensity distribution of the Southeastern Akita Prefecture of 1970, by using a questionnire survey with modified and expanded items which were made by Utsu(Ref.6). In 1974, the questionnaire survey method was developed for evaluating seismic intensities

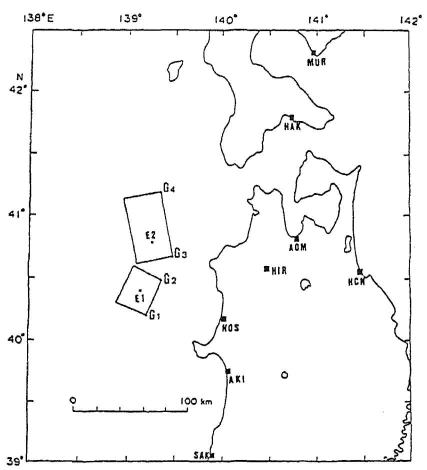

Fig.1 Map showing locations of Akita City(AKI),Noshiro City(NOS) and Akita Prefecture. E1 and E2: Epicenters of event 1 and event 2. G1,G2,G3 and G4: Locations of each edge of fault planes.

by Ohta,et al.(Ref.7), and detailed analyses were carried out by means a computer.

In order to make a study of seismic microzonation with high accuracy, a detailed seismic intensity was calculated at an area divided into subarea with about 250 m x 250 m throughout Noshiro and Akita Cities,and about 1 km x 1 km throughout Akita Prefecture (Ref.8),using the questionnaire method(Ref.7).

In this paper,the detailed seismic intensities were compared statistically with geological sites at subareas of 250 m x 250 m in Akita City,mainly. This comparisons were made on Noshiro City and Akita Prefecture,too. The geological sites mean microtopography and subsurface geology which were investigated in detail by the staff of Akita University (Ref.9) and Akita Prefectural Office(1984).

<u>Method of the Comparison</u> By using an epirical formula(Ref.10) representing the relation between seismic intensity(JMA),epicentral distance and magnitude(JMA), the deviation was computed from detailed seismic intensity and standard seismic intensity in Japan by this formula. The detailed deismic intensities throughout Akita Prefecture and attenuation curves of this formula are shown in Fig.2. Using a curve of formula(M=7.5), the deviations of detailed seismic intensities are shown in Fig.3,as a case of Akita Prefecture. The data of the deviations mean those which removed effects of seismic wave attenuation of distance in the region, for example Akita Prefecture. Those in Akita and Noshiro Cities regions also were calculated in the same way as in Akita Prefecture. Fig.4 shows the result of case of Akita City.

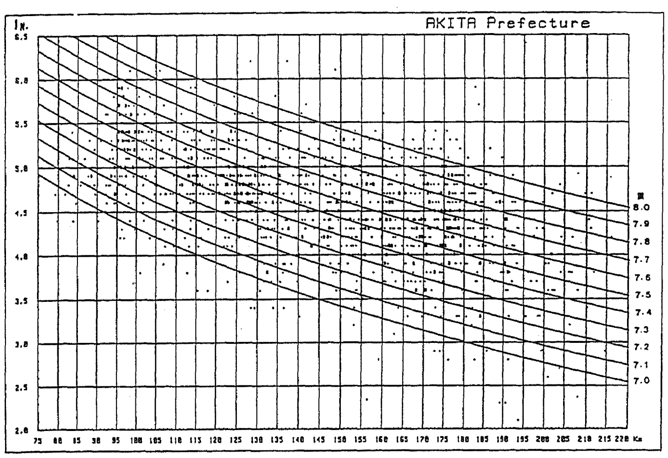

Fig.2 Relation between detailed seismic intensity throughout Akita Prefecture and epicentral distance from point source(El).
Number shows frequency in same epicentral distance.

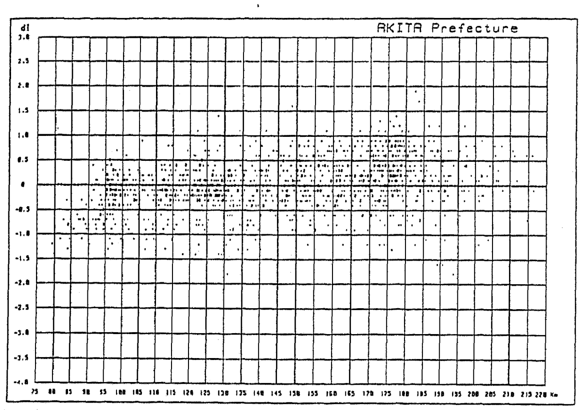

Fig.3 Relation between deviation of detailed seismic intensity throughout Akita Prefecture (dI) and epicentral distance (km).
Number shows frequency in same epicentral distance.

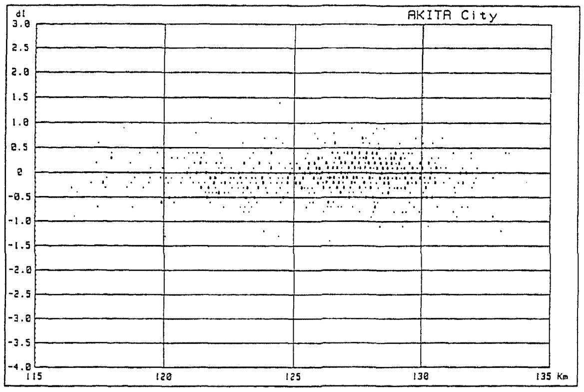

Fig.4 Relation between deviation of detailed seismic intensity throughout Akita City (dI) and epicentral distance (km).
Number shows frequency in same epicentral distance.

Table 1 Classification mark of microtopography(geology) in Akita City, Noshiro City and Akita Prefecture regions

Microtopography	(Geology)	Mark	
Fill-up	(Clay,Sand,Gravel)	F	Softness
Back swamp / Former river channel	(Clay,Silt)	B	↑
Natural Levee / Point bar	(Silt,Sand)	A	
Sand-dune II		C	
Sand-dune I	(Sand)	D	
Terrace	(Sand,Gravel,Clay)	E	↓
Hill	(Sandstone,Mudstone)	G	Hardness

The deviations of detailed seismic intensities were compared with microtopography and subsurface geology in Noshiro City and Akita Prefecture. As shown in Table 1, the microtopography was classified into Fill-up(F), back-swamp.former-river-channel(B), natural-levee·point-bar(A), sand-dune II and I(C and D), terrace (E), and hill(G), in ordering from softness to hardness of soil and geological properties.

RESULTS

The deviation distribution of the detailed seismic intensities were obtained by relation between the detailed seismic intensity and the classified microtopography in each mesh. Histograms of the deviations were made from their relations in each classified microtopography. Fig.5 shows a histogram, for example of a mark B(back-swamp·former-river-channel). These histograms almost represent normal distributions. In Fig.5, V, X, S and N are variance, mean, standard deviation and total number, respectively. This mean value shows " Shaking strength " of a classified microtopography, e.g. mark B, which accepted strong ground motion of 1983 Nihonkai Chubu earthquake. Fig.6 and Fig.7 show the order of " Shaking strength " of each classified microtopography in Akita City and Noshiro City regions, respectively.

These results agree very well with the order from hardness to softness in soil and geology properties of the classified microtopography,as shown in Table 1.

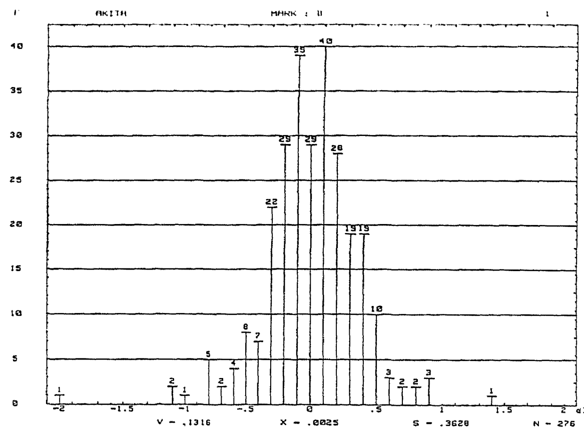

Fig.5 Frequency distribution of deviation of detailed seismic intensity (dI) on mark B of microtopography in Akita City.

V: Variance

X: Mean value

S: Standard deviation

N: Total number

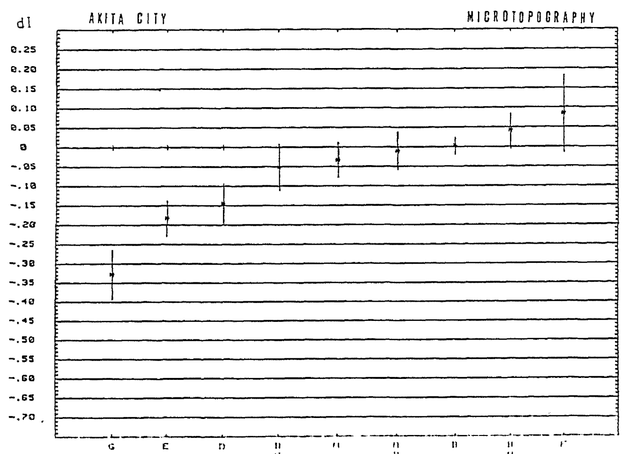

Fig.6 Evaluation in case of assorted mark of microtopography classification by deviation of detailed seismic intensity in Akita City. Bar in figure shows error in case of standard error.

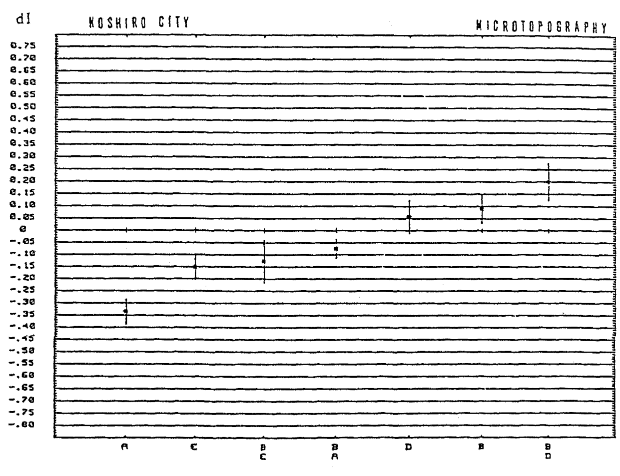

Fig.7 Evaluation in case of assorted mark of microtopography classification by deviation of detailed seismic intensity in Noshiro City. Bar in figure shows error in case of standard error.

On Estimated Formula of the Detailed Seismic Intensity In addition to a classified microtopography and subfurface geology, a depth to the diluvium and tretiary formation was investigated from boring data at a mesh in Akita City by Akita Prefectureal Office(1984). Fig.8 shows relations between the deviations of the detailed seismic intensities and the depths from ground surface to the diluvial formation with marks of the classified microtopography at the mesh. Moreover, the data were divided into Group I, Group II and Group III for the depth of diluvial formation, as shown in Fig.8.

Next, I tried to make an empirical formula for estimating detailed seismic intensities at Group I, II and III, using multiple regression analysis. Detailed seismic intensity is criterion variable, and depth of diluvium, microtopography and subsurface geology are explanatory variables in case of the multiple regression analysis. These results are shown in Fig.9, Fig.10 and Fig.11. As the results, it was clarified that the estimated detailed seismic intensity corresponted well to shallower diluvium formation. In future, I will discuss about the estimated detailed seismic intensities, collecting many boring data and varying distance from epicenter(E1, G1, G2, G3 and G4 as shown in Fig.1.

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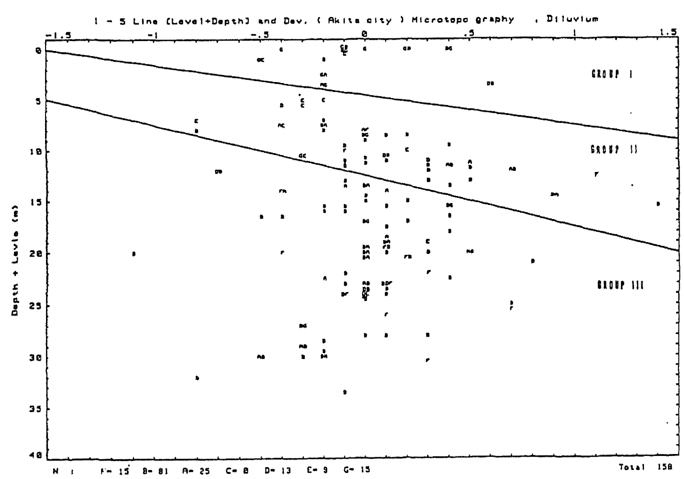

Fig.8 Relation between depth of diluvial formation and deviation of detailed seismic intensity in classified microtopography marks of a mesh in Akita City.
Group I: in case of shallowest diluvium
Group II: in case of shallower diluvium
Group III: in case of deep diluvium

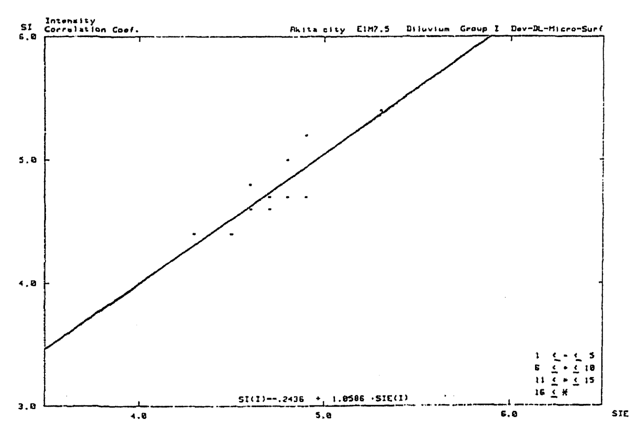

Fig.9 Estimated(SIE) and observed(SI) detailed seismic intensity in case of depth(DL), microtopography(Micro) and subsurface(Surf) of Group I.

Multiple correlation coefficient 0.89

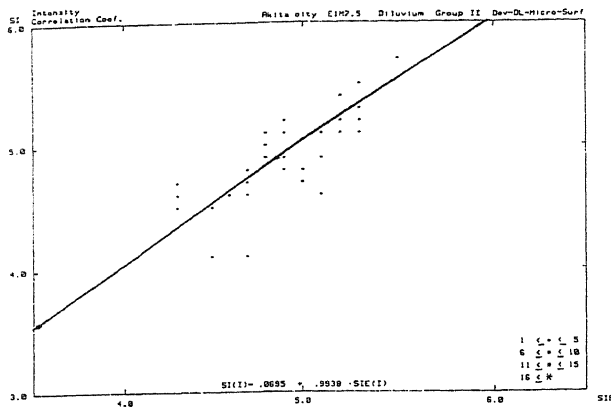

Fig.10 Estimated(SIE) and Observed(SI) detailed seismic intensity in case of depth(DL), microtopography(Micro) and subsurface(Surf) of Group II.
Multiple correlation coefficient 0.82

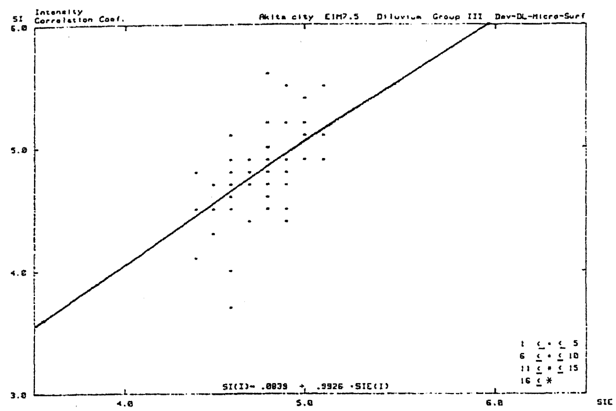

Fig.11 Estimated(SIE) and observed(SI) detailed seismic intensity in case of depth(DL), microtopography (Micro) and subsurface(Surf) of Group III.
Multiple correlation coefficient 0.56

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