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GROUND VIBRATION CHARACTERISTICS OF STRONG-MOTION OBSERVATORY SITE OF AKITA UNIVERSITY SET UP IN THE AREA DAMAGED BY SOIL LIQUEFACTION

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ABSTRACT

The ground vibration characteristics of strong-motion observatory site, which was liquefied by the 1983 Nihonkai Chubu Earthquake were analysed by means of some earthquakes and microtremors on the ground surface and basement under the ground. We analysed about the 1993 Kushiro Oki Earthquake(M=7.8), the 1993 Hokkaido Nansei Oki earthquake(M=7.8), the 1994 Hokkaido Toho Oki earthquake(M=8.1) and the 1994 Sanriku Haruka Oki earthquake(M=7.5). As the results, we obtained to show approximately same frequency characterisics of the site by Fourier spectra for four earthquakes. The characteristics didn't agreed with analysis of microtremors.

KEYWORDS

Ground vibration; soil liquefaction; strong-motion; microtremor.

STRONG-MOTION OBSERVATORY SITE

Arayamotomachi area in Akita City,Akita Prefecture,Japan,was damaged heavily by soil liquefaction during 1983 Nihonkai Chubu Earthquake. A strong-motion observatory (ARM) of Akita University set up at the liquefied site in Araya-motomachi area,in order to investigate directly on relationship between the liquefied site and strong-motion(Nogoshi,1990). Location of the observatory site(ARM) are shown in Fig.1. Geological section(E-W) of the site and locations of 3-component seismometers on the ground surface and basement of about 66 m under the ground are shown in Fig.2.The geology between the ground surface and the basement under the ground are alluvial soil,mainly. P snd S log of the site were reserched in detail. S-wave velocity of the basement under the ground are about 540 m/s.

ANALYSIS OF FOUR EARTHQUAKES

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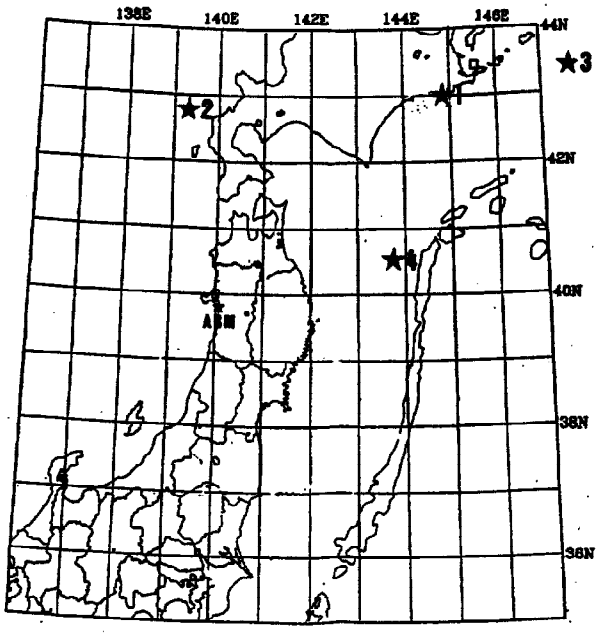

Table 1 Fundamental data of four earthquake

Earthquake	Time	Magnitude	Depth	Distance
Kushiro Oki (AR3115E102: ★1)	1993/1/15	7.8	107 km	515 km
Hokkaido Nansei Oki (AR3712E104: ★2)	1993/7/12	7.8	34 km	353 km
Hokkaido Toho Oki (ARM4104E01: ★3)	1994/10/4	8.1	30 km	753 km
Sanriku Haruka Oki (AR41228E01: ★4)	1994/12/28	7.5	0 km	328 km

Fig.1 Map showing the observatory site(ARM) in Akita City,and locations of four earthqakes.
★1 :AR3115E102,★2 :AR3712E104
★3 :ARM4104E01,★4 :AR41228E01

In this paper, ground vibration characteristics of the strong-motion observatory site were analysed by means of some earthquakes and microtremors on the ground surface and basement under the ground.
Since 1985,some earthquakes(the 1989 Sanriku Oki Swarm Earthquake of M=7.1,the 1993 Kushiro Oki Earthquake of M=7.8,the 1993 Hokkaido Nansei Oki Earthquake of M=7.8,the 1994 Hokkaido Toho Oki of M=8.1, and the 1995 Sanriku Haruka Oki earthquake of 7.6) were observed on the ground surface and basement under the ground at the Strong-motion Observatory site(ARM) of Akita University,Akita City ,northern Japan (Fig.1). Locations(★) of four earthquakes are shown with the strong-motion observatory site in Fig.1,except the 1989 Sanriku Oki Swarm Earthquake.
We showed some fundamental data of four earthquakes in Table 1.
First,using these earthquakes we analysed the ground vibration characteristics of the site of Strong-motion Observatory of Akita University. That is to say,we analysed all waveforms of velocity of the earthquakes observed on and under the ground of the site. The frequency characteristics(3-component) of these earthquakes by Fourier spectra are shown in Fig.3,for example of the 1993 Hokkaido Nansei Oki Earthquake. It is clear that amplification of the seismic waves are shown between the ground surface(GS) and the basement(UB) under the ground in higher frequency range than about 1 Hz in the Fourier spectra. Next,we computed spectral ratios(surface/basement) of 3 components of the earthquakes, and these of resultant($\sqrt{NS^2 + EW^2}$) of the horizontal components. The spctral ratios of horizontal components of 3 earthquakes of the 1989 Sanriku Oki Swarm Earthquake (a main shock and two aftershocks) are shown in Fig.4. Moreover, the spectral ratios of horizontal components of 4 earthquakes(E104,E102,4E01,and 8E01) are shown in Fig.5.

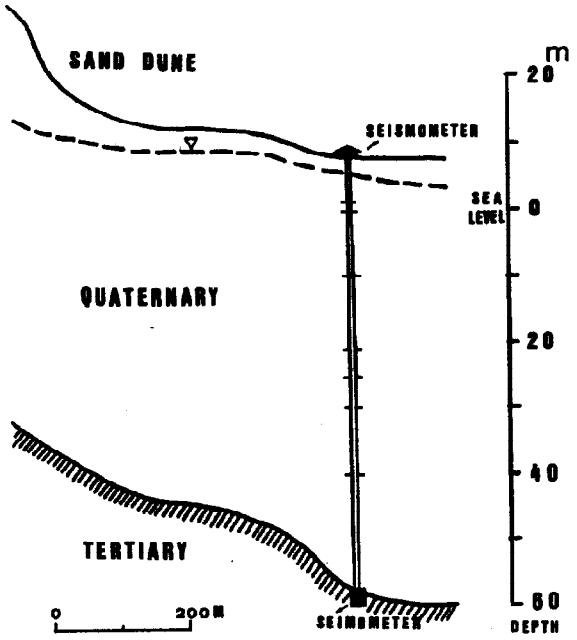

Fig.2 Geological section(E-W) of the site and locations of 3-component seismometers.

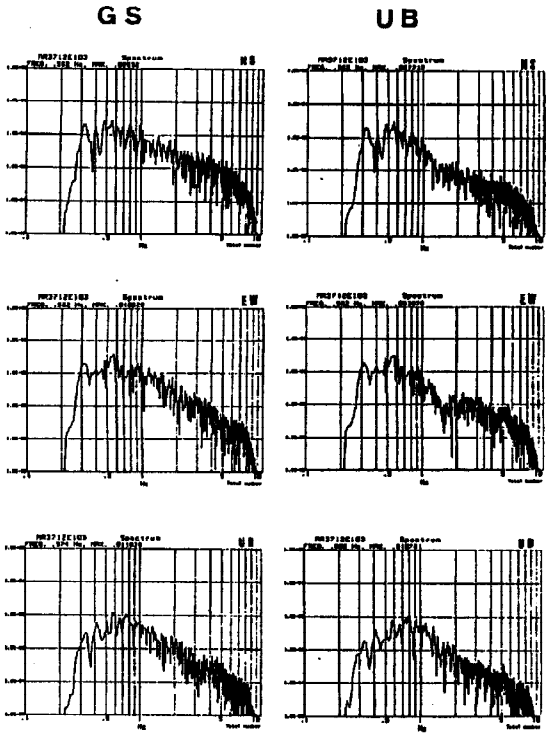

Fig.3 Fourier spctra of the Hokkaido Nansei Oki Earthquake observed on ground surface(GS) and basement(UB) under the ground.

RESULTS

Some results were obtained as follows:

1) Seismic intensities from Kanai's formula(1969) of peak velocity and seismic intensity(JMA) agreed well with detailed seisimic intensities(Nogoshi,1989) near this observatory site.

2) Using some attenuatin formulas for peak velocity of Japan,we compared them with peak velocities of some earthquake. As a result,peak velocities agreed well with them from Hayashi's formula(1989) at hypocentral disitance of this observatory site.

3) We computed spectral ratios(surface/basement) of 3 components of the earthquakes,and these of resultant($\sqrt{NS^2 + EW^2}$) of the horizontal components. The spectral ratios of horizontal resultant components of 3 earthquakes(the 29th Oct .1989 earthauke(M=6.5),the 2nd Nov.1989 earthquake(M=7.1),and the 2nd Dec.1989 earthquake(M=5.6) of the 1989 Sanriku Oki Swarm Earthquake) agreed well. Also, the results of four large earthquakes occurred in another place agreed approximately.

4) The ground vibration characteristics of site obtained from the microtremors were different from those by fouur earthquakes.

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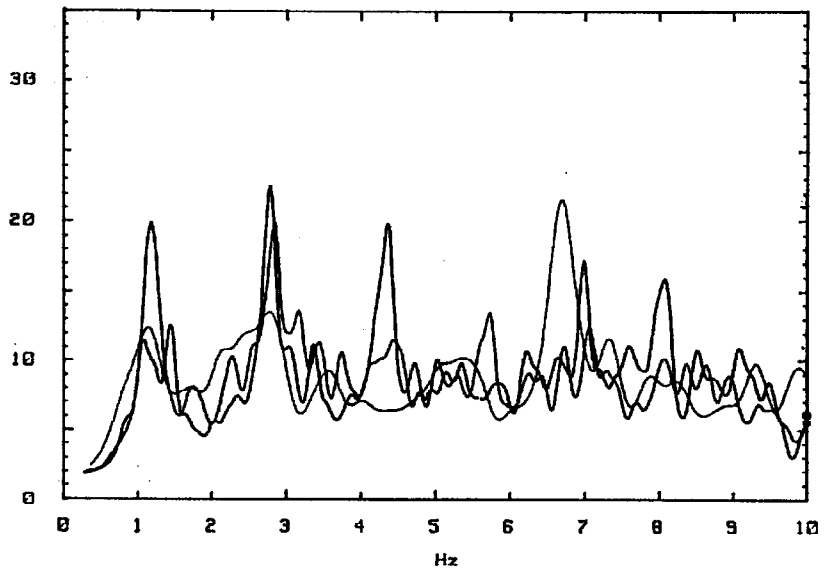

Fig.4 Spectral ratios(surface/basement) of resultant of horizontal components of three earthquakes for the 1989 Sanriku-oki Swarm Earthquake.

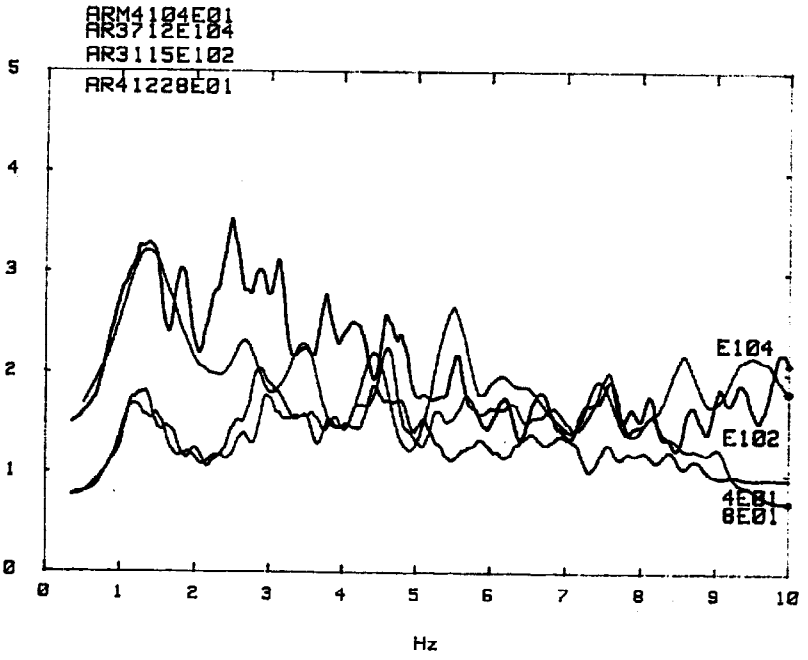

Fig.5 Spectral ratios(surface/basement) of resultant of horizontal components of four large earthquakes occurred in onother place.